Westinghouse

Annual Catalogue of Electrical Supplies

1920

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W... ...TIVES

Location	Westi... Sali...		...tinghouse ...arehouse	Westinghouse Service Repair Shop
Arizona, Tucson	Immigra...		.....	.....
Alabama, Birmingham	Brown-...		.....	.....
California, Los Angeles	I. N. Va...		...y) Shearer St.	2019 Bay St.
San Francisco	1st Nat....		.....	1400 Fourth St.
Colorado, Denver	Gas & E...		...t St.	.....
Connecticut, New Haven	.....		.....	.....
D. C., Washington (Government Business Exclusively)	Hibbs B...		.....	.....
Fla. Jacksonville	Union T... house		.....	.....
Georgia, Atlanta	Candler		...in St.	Mangum & Markham Sts.
Hawaii, Honolulu	Hawaiia...		.....	.....
Illinois, Chicago	Conway		...Morgan St.	32 S. Peoria St.
Indiana, Evansville	.....	Varney Elec. Supply Co.	.....	.....
Indianapolis	Traction Term. Bldg.	Varney Elec. Supply Co.	.....	.....
Iowa, Des Moines	608 Securities Bldg.	.....	.....	.....
Sioux City	.....	The McGraw Co.	.....	.....
Kansas, Witchita	.....	United Electric Co.	.....	.....
Kentucky, Louisville	Paul Jones Bldg.	Tafel Electric Co. Inc.	.....	.....
Louisiana, New Orleans	Maison Blanche Bldg.	Electrical Supply Co.	Maison Blanche Bldg.	.....
Maryland, Baltimore	Westinghouse Bldg.	.....	121 E. Baltimore St.	501 E. Preston St.
Massachusetts, Boston	Rice Bldg.	.....	12 Farnsworth St. 349 Congress St. 421 Atlantic Ave.	12 Farnsworth St.
Michigan, Detroit	Dime Savings Bank Bldg.	Commercial Elec. Supply Co.	80 E. Fort St.	.....
Minnesota, Duluth	Alworth Bldg.	.....	.....	.....
Minneapolis	Met. Life Insurance Co.	.....	.....	.....
St. Paul	.....	St. Paul Electric Co.	.....	.....
Missouri, Joplin	Miner's Bank Bldg.	.....	511 E. 5th St.	.....
Kansas City	Orear-Leslie Bldg.	Satterlee Electric Co.	1214—16 W. 9th St.	.....
St. Joseph	.....	Columbian Electrical Co.	.....	.....
St. Louis	300 N. Broadway	Central Telephone & Elec. Co.	1426-8 North Broadway	1906 Pine St.
Montana, Butte	Montana Elec. Co. Bldg.	Montana Electric Co.	Butte, Montana	.....
Nebraska, Omaha	.....	The McGraw Co.	.....	.....
New York, Buffalo	Ellicott Square Bldg.	McCarthy Bros. & Ford	141-157 Milton St.	141-157 Milton St.
New York	City Investing Bldg.	Northwestern Elec Equip. Co.	461 10th Ave. 500 W. 36th St.	467 10th Ave.
Rochester	Chamber of Commerce Bldg.	Rochester Elec. Supply Co.	.....	.....
Syracuse	University Bldg.	H. C. Roberts Elec. Supply Co.	.....	.....
North Carolina, Charlotte	Commercial Bank Bldg.	.....	P. & N. Rwy., 1st St.	.....
Ohio, Cincinnati	Traction Bldg.	Johnson Elec. Supply Co.	B. & O. 2nd & Smith Sts.	312-322 Sycamore St.
Cleveland	Swetland Bldg.	.....	1220 W. 9th St.	1255 West Fourth St.
Columbus	Interurban Term. Bldg.	.....	181 S. Lazelle St.	.....
Dayton	Riebold Bldg.	.....	.....	.....
Toledo	Ohio Bldg.	.....	.....	.....
Oklahoma, Tulsa	.....	United Electric Co.	.....	.....
Oregon, Portland	Northwestern Bank Bldg.	Fobes Supply Co.	.....	.....
Penna., Philadelphia	Widener Bldg.	H. C. Roberts Elec. Sup. Co.	927-31 N. Front St. 221 N. 23rd St. 227 N. 23rd St.	214 N. 22nd St.
Pittsburgh	Union Bank Bldg.	Robbins Electric Co.	424 Second Ave.	6905 Susquehanna St.
Scranton	.....	Penn. Elec. Engineering Co.	.....	.....
Wilkesbarre	Miner's Bank Bldg.	.....	.....	.....
Tennessee, Chattanooga	Hamilton Nat. Bank Bldg.	.....	.....	.....
Memphis	Exchange Bldg.	Riechman-Crosby Co.	.....	.....
Texas, Dallas	Exchange Bldg.	.....	2107-9 Pacific Ave.	.....
El Paso	Mills Bldg.	Mine & Smelter Supply Co.	513 N. Ochoca St.	.....
Houston	Union Nat'l. Bank Bldg.	Tel. Electric Co.	.....	.....
Utah, Salt Lake City	Walker Bank Bldg.	Intermountain Electric Co.	350 Pierpont St.	350 Pierpont St.
Virginia, Richmond	.....	Tower-Binford Elec. & Mfg. Co.	.....	.....
Washington, Seattle	Alaska Bldg.	Fobes Supply Co.	560 First St.	560 First St.
Spokane	.....	Washington Elec. Supply Co.	.....	.....
West. Va., Bluefield	Law & Commerce Bldg.	Superior Supply Co.	.....	.....
Charleston	Kanawha Nat. Bank Bldg.	.....	.....	.....
Wisconsin, Milwaukee	First Nat'l. Bank Bldg.	Julius Andrae & Sons Co.	.....	.....

Westinghouse electric & manufacturing Company
East Pittsburgh, Pa.

Westinghouse

Annual Catalogue
of
Electrical Supplies
1920

Supersedes
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East Pittsburgh, Pa.

The Lakeside Press
R. R. DONNELLEY & SONS COMPANY
CHICAGO

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INTRODUCTION

The Westinghouse Annual Catalogue of Electrical Supplies presents a list of all apparatus manufactured by the Westinghouse Electric & Manufacturing Company or obtainable through its district offices and agent-jobbers. The information on electrical supplies is given in full. A general outline of the Company's industrial motors, and controllers, railway equipments, and power and marine machinery is also included; complete information on these will be furnished on request.

This catalogue replaces all catalogues issued heretofore on details and supplies.

For the convenience of users of the catalogue a very complete cross-index is given in the pages following; these are printed on blue paper so that they can be quickly located. A style number index, also on blue paper, is located at the back of the book; this will be found convenient in checking invoices.

Approximate Cost Multipliers—Multipliers for convenience in estimating approximate costs are shown on page X. These multipliers, as well as the list prices throughout the catalogue, are included for convenience in estimating and are not offered as a quotation. While approximately correct at time of issue, they are subject to change without notice, and should not be used as a basis for orders unless confirmed by quotation.

Style Numbers—To facilitate ordering and the classification of records, each piece of standard apparatus has a style number, which should be stated in ordering. Each style number designates a definite piece of apparatus as listed.

Weights—All weights given in this catalogue, to enable the calculation of freight charges, are approximate.

Dimensions—All dimensions given in this catalogue are for reference only. For official dimensions, apply at the nearest district office.

See ordering instructions on page viii.

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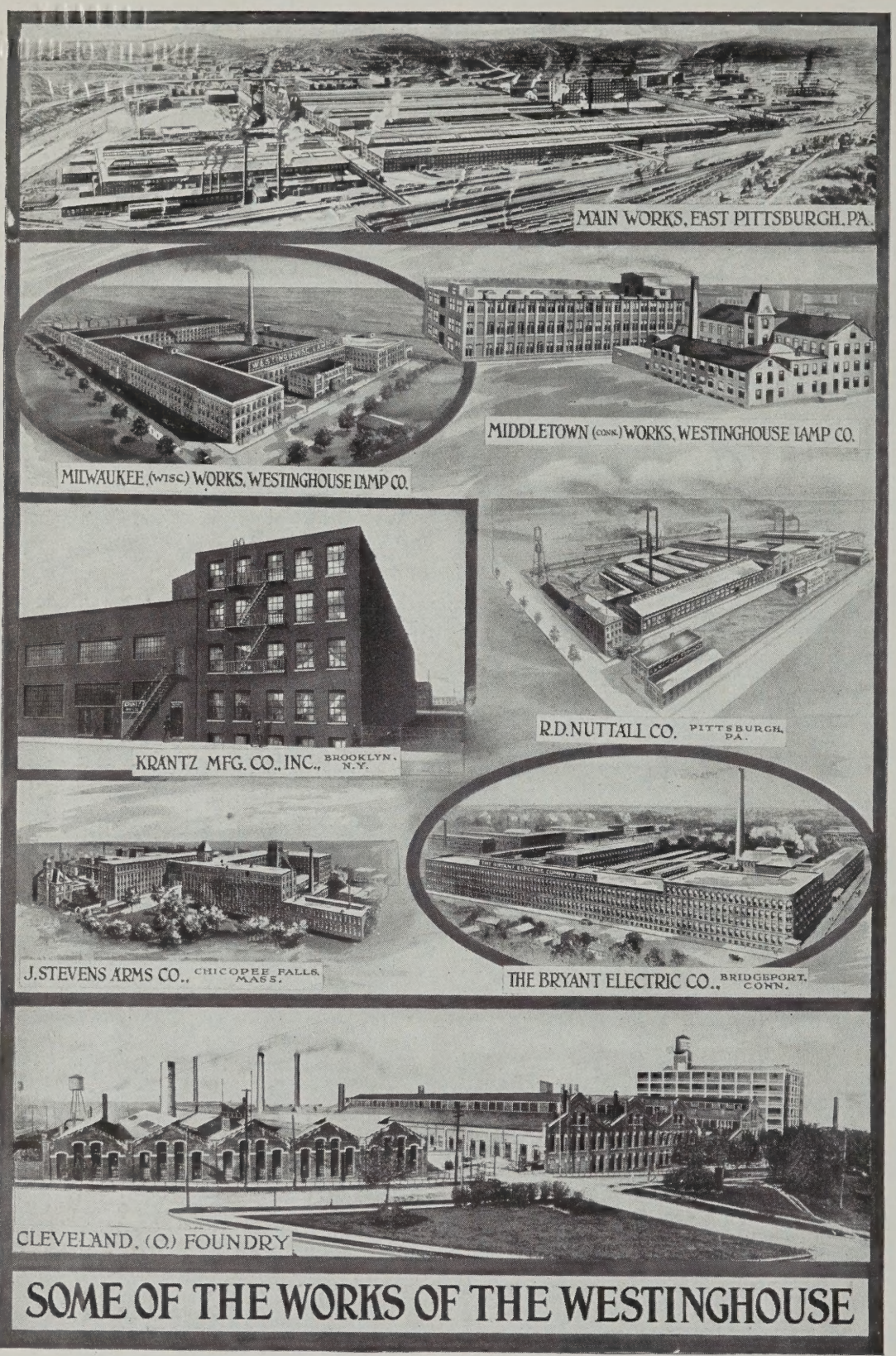
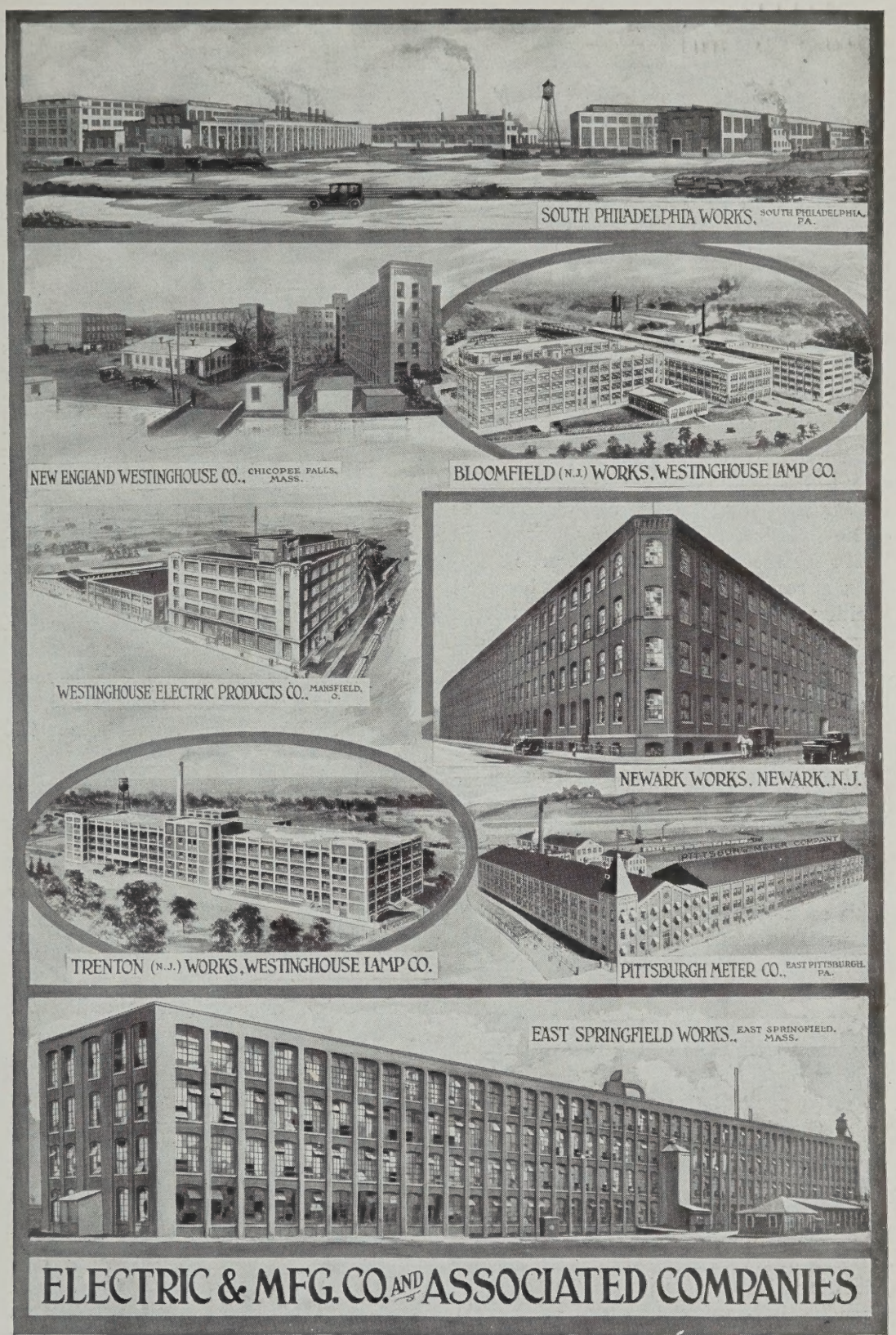

MAIN WORKS, EAST PITTSBURGH, PA.
MILWAUKEE, (WISC.) WORKS, WESTINGHOUSE LAMP CO.
MIDDLETOWN (CONN.) WORKS, WESTINGHOUSE LAMP CO.
KRANTZ MFG. CO., INC., BROOKLYN, N.Y.
R.D. NUTTALL CO. PITTSBURGH, PA.
J. STEVENS ARMS CO., CHICOPEE FALLS, MASS.
THE BRYANT ELECTRIC CO., BRIDGEPORT, CONN.
CLEVELAND, (O.) FOUNDRY
SOME OF THE WORKS OF THE WESTINGHOUSE


SOUTH PHILADELPHIA WORKS, SOUTH PHILADELPHIA, PA.
NEW ENGLAND WESTINGHOUSE CO., CHICOPEE FALLS, MASS.
BLOOMFIELD (N.J.) WORKS, WESTINGHOUSE LAMP CO.
WESTINGHOUSE ELECTRIC PRODUCTS CO., MANSFIELD, O.
NEWARK WORKS, NEWARK, N.J.
TRENTON (N.J.) WORKS, WESTINGHOUSE LAMP CO.
PITTSBURGH METER CO., EAST PITTSBURGH, PA.
EAST SPRINGFIELD WORKS., EAST SPRINGFIELD, MASS.
ELECTRIC & MFG. CO. AND ASSOCIATED COMPANIES

SOME IMPRESSIVE FACTS ABOUT WESTINGHOUSE ELECTRIC

To anyone familiar with the history of electrical development, the name "Westinghouse Electric & Manufacturing Company" stands for achievement.

It is the name—not simply of a great manufacturing organization, but—of a great institution, which has played and continues to play a part of first importance in the promotion of the world's progress.

To trace the history of the Westinghouse Electric & Manufacturing Company is to touch at the source of some of the most striking and far-reaching contributions that electricity has made to civilization.

Founded by George Westinghouse as The Westinghouse Electric Company in 1886 for the manufacture of electric lighting apparatus, it has grown and spread until today its influence is to be felt in every field of electrical endeavor and its products are numbered in the thousands.

To it belongs the credit for having placed electric lighting on a commercial basis, for having made possible the cheap and efficient long-distance transmission of power by the development of the alternating-current system and the induction motor; for having greatly assisted in the success of the steam turbine, by introducing it in this country and helping largely to bring it to its present state of perfection; for having produced and developed the turbine generator.

To it also must go the credit for visioning the possibilities of the marine turbine with reduction gear and for having done a great part of the work in connection with the development and application of this idea; for having produced the apparatus which made possible the harnessing of Niagara Falls; for having given to the world the first induction watthour meter; for having helped largely to bring electric railroading to its position of commanding importance, and for having done countless other acts and made countless other contributions affecting man's well-being through the application of mechanical and electrical science.

Wherever one may go in the civilized world, he is greeted by the name "Westinghouse," for the ramifications of this great organization extend to the very farthest corners of the globe.

An idea of the size and scope of this institution may be suggested by a few figures:

A journey through the East Pittsburgh Works offers a panoramic view of recent developments in the field of electrical industry.

To traverse the entire East Pittsburgh Works requires a walk of over 10 miles.

Employs over 31,000 people.

Coal consumption, over 500 tons per day.

A total floor space exceeding 100 acres.

Capacity power house, 20,000 kilowatts.

Monthly payroll averages over $2,500,000.

Monthly shipments approximate 900 carloads.

Total of 108 electric traveling cranes in capacities of 1 pound to 100 tons in use.

In addition to the Works at East Pittsburgh the Company owns plants at the following points:

South Philadelphia, Pa., a plant covering 500 acres of ground along the Delaware River and employing 1,900 people, where marine propelling equipment and auxiliaries are made.

Newark, N. J., where lighting equipments, meters, sew-motors, automotive equipments, and fans are made. Employs 3,500 people.

East Springfield Works, East Springfield, Mass., manufacturing small motors and automotive equipment. Employs 600 people.

Cleveland, Ohio, and Trafford City, Pa., for making iron castings used by the Company. Employs 1,000 people.

Mansfield, Ohio, works of the Westinghouse Electric Products Company, manufacturers of electric heating appliances and electric ranges. Employs 700 people.

Derry, Pa., works of the Pittsburgh High-Voltage Insulator Company, manufacturers of porcelain and glass insulators. Employs 300 people.

Bridgeport, Conn., works of the Bryant Electric Company, manufacturers of switches and electrical wiring devices of all kinds.

Brooklyn, N. Y., works of the Krantz Manufacturing Company, Inc., manufacturers of safety switches and panel boards. Employs 260 people.

Bloomfield, N. J., Milwaukee, Wis., Trenton, N. J., Middletown, Conn., and Brooklyn, N. Y., works of the Westinghouse Lamp Company, a subsidiary organization, employing 4,000 persons engaged in the manufacturing of incandescent lamps, with an average output of 3,000,000 per month.

Pittsburgh, Pa., works of the R. D. Nuttall Company, manufacturers of tractor, industrial, and railway gearing, expansion joints, flexible couplings and current collecting trolleys. Employs 500 people.

East Pittsburgh, Pa., works of the Pittsburgh Meter Company, manufacturers of water, gas, and air meters. About 450 employes.

Chicopee Falls, Mass., works of the J. Stevens Arms Company, manufacturers of firearms and accessories.

It has never been the aim of the Westinghouse Electric & Manufacturing Company simply to be great in size. Its first purpose has been greatness of achievement and service. To this end it is ceaselessly working for the extension of electricity into new fields, for the improvement of present methods and apparatus, and for the invention and perfection of new apparatus and machinery. While one part of the vast Westinghouse organization is producing today's goods, another is striding ahead towards the future, so that when tomorrow comes Westinghouse shall be ready for it.

ORDERING INSTRUCTIONS

To avoid delays and misunderstandings, note carefully the following points:

1. Send all **correspondence** and **orders** to the nearest office of the Company or the nearest agent-jobber (see list on inside of front cover).

2. When ordering **give style number** and complete description. If modification of standard apparatus is desired, order "Similar to Style No. ..... except (state modification)."

3. In **ordering duplicate** of apparatus not listed, order by the style number or stock order (S. O.) number (one of these numbers is cast or marked on the apparatus). Also give the **serial number** and full description.

4. In ordering **parts**, give style number, complete description, and serial number of the complete apparatus.

5. State whether **shipment** is to be made by freight, express, (and name the route,) or by parcel post. In the absence of instructions, goods will be shipped at our discretion. Shipments ordered by parcel post will be insured only on request. All shipments are at purchaser's risk.

6. Present all **claims for breakage** to the carrier, as we are not responsible for breakage after delivery of goods in good order to the carrier. If we are notified of such claims, however, we shall gladly lend assistance to secure adjustment.

7. Make **claims for shortage** within five days after receipt of shipment; otherwise they will not be entertained.

8. Do not **return goods** to us for credit or exchange without first obtaining written approval with shipping directions from the office through which the order was placed. Notifications of such shipment, with copy of the shipping receipt, must be sent to the district office. The shipment must bear the name and address of the sender. Otherwise, we cannot accept responsibility for credit.

9. **When referring to an order,** always mention the number and date of your order and the name of the consignee.

10. **Prices** in this catalogue are approximately correct at time of issue, and are subject to changes without notice. They are included for convenience in estimating and are **not offered as a quotation.** Exact prices for any apparatus listed will be quoted on request. (See Approximate Cost Multipliers" on page X (second page following).

11. **Terms** are such as the company may extend to the purchaser, not to exceed net cash in thirty days from date of shipment.

12. Small orders should be combined so as to amount to a value of at least $1.00 net, as no invoice will be rendered for an amount less than $1.00. Where the total of the sale is less than this, the material will be invoiced at $1.00.

13. The Company will not be responsible or liable for any loss, damage, detention or delay caused by fire, strike, civil or military authority, or by insurrection or riot, or by any other cause which is unavoidable or beyond its reasonable control; nor in any event for consequential damages.

APPROXIMATE COST MULTIPLIERS

INDEX TO SECTIONS

GENERAL INDEX

For Style Number Index see page 1445

DISCOUNTS giving SALES PRICES can be obtained ONLY FROM NEAREST REPRESENTATIVE

(See list on inside of front cover)

ESTIMATING MULTIPLIERS to obtain APPROXIMATE COSTS are given below

Example:—Style No. 256372; page 7, list price $61.00
Approximate Cost Multiplier for page 7 ..... .60
Approximate Cost (.60 x $61.00) $36.60

Section	Page	Description	Approx. Cost Multiplier	Discount
	6 to 13	Lightning Arresters	.60	Trade, Quantity and Resale Discounts Furnished, on Request, by nearest Representative, See List Inside of Front Cover
	13	Resistors	.60	
1-A	14	CR Lightning Arresters	.60	
	15	G Lightning Arresters	.60	
	16	W Lightning Arresters	.60	
	17 to 56	Ltng Arresters & Choke Coils	.60	
	59	Aluminum Fuse Wire	.57	
		Nickel Silver Fuse Wire	.66	
		Alloy Fuse Wire & Ribbon	1.02	
	60 to 62	Enclosed Fuses	.82	
	62	Enclosed Fuse Tongs	1.00	
1-B	65	Fuse Blocks	1.03	
Part		Fuse Holders	.88	
I	67	Plug Type Fuse Blocks	.52	
	68	Expulsion Type Fuse Blocks	.52	
	71	Safety First Fuse Blocks	.49	
	74 to 84	Type A Front Connected	1.30	
	85 to 93	Type C Front Connected	1.20	
	102 to 114	Type A Rear Connected	1.30	
	115	Type A Motor Starting	1.30	
		Type C Motor Starting	1.20	
	119 to 120	Charging Plugs & Receptacles	.70	
	121	Knuckle Joint Connectors	.70	
	122	Stock Cutout Boxes	1.21	
1-B Part II	123 to 127	Made-to-Order Cutout Boxes	.87	
	128	Service Switches & Boxes	1.50	
	129	Toggle Bolts	.95	
1-B Pt III	130 to 143	Solderless Connectors	.80	
	136 to 148	Motor Starting Switches	1.00	
	149 to 150	House Entrance Switches	1.00	
	151 to 156	Safety Auto-Lock Switches	1.00	
	157 to 177	Safety Panel Boards	.95	
	178 to 189	Live Face Panel Boards	.95	
	190 to 193	Metering Panel Boards	1.00	
12-A	194 to 195	Acme Floor Boxes	1.00	
	196 to 197	Type C T Floor Boxes	1.00	
	198	1945 Floor Boxes	1.00	
	199	Gem Floor Boxes	1.00	
	200	Conduit Bushings	.78	
	201	Fuse Blocks for Glass Fuses	.85	
		Fuse Blocks for Cartr. Fuses	.65	
	203	Wall Mounting Fuse Blocks	.80	
		Switch Board Fuse Blocks	.93	
	204	Limiting Resistors	.84	
1-C	206	Expulsion Fuse Blocks	.94	
Part	208	High-Voltage Fuse Blocks	.71	
I	210	High-Voltage Fused Circuit-Breakers	.69	
	211	Mtr Starting Knife Switches	.77	
	213	Field Switches & Resistors	.70	
	219 to 221	Disconnecting Switches	.65	
	221	Operating Sticks	.65	
	231 to 239	Instrument Switches	.60	
1-C Pt. II	251 to 288	Carbon Circuit-Breakers and Accessories	.60	
1-C Pt III	322 to 396	Oil Circuit-Breakers	.60	
1-D	403 to 450	Burke Horn Gap Apparatus	.65	
2-A	451 to 526	Switchboards	.60	
	534 to 536	Generator Voltage Regulators & Accessories	.225	
2-B	542 to 624	Switchboard Accessories	.40	
3-A	625 to 638	Watthour Meters	.82	
	639	BI Ammeter	.80	
3-B	641	BX Instruments	.72	
	642	EW Instruments	.80	
	643 to 744	Instruments & Relays	.72	
4-A	745 to 775	Distribution Transformers	.75	
4-B	777 to 814	Feeder Regulators, etc	.90	
	816	No. 207, 209, 210, 224, 229, 232, 240, 251 plate, No. 240 tape	.75	
		No. 237 plate	.60	
		No. 228 tape	1.10	
		No. 241, 308 plate	1.00	
		Mica tubes	.75	
	821	No. 213, 217 and Micarta Rod	.80	
		No. 323, 21-X, 327, 21-D 21-H and 32X plate	.85	
5-A		Valve discs	.75	
	822	No. 213 tubing 1/16" to 1/2" ID	.25	
		No. 213 tubing over 1/2" ID	.90	
	823	Gear blanks	.85	
	824	No. 7, 701, 10, 101	1.70	
		No. 12, 15, 1000, 1010, 1007, 1017	1.50	
		No. 20, 30	.90	
	824	Treated Cloth Tapes	1.45	
	825	Treated Cement Paper, Paraffined Express Paper	.85	
		Paraffined Fish Paper, Treated Fullerboard	.75	
	827	All Items Except Fibre	.75	
		1/32" to 5/64" Fibre	.80	
		3/32" to 1 1/4" Fibre	.60	
		1 3/8" to 2" Fibre	.50	
	828	All Items	.75	
	831	Amber Insulator		
		Plastic Insulator	.75	
		Glue		
		Air Drying Insulator		
5-A		No. 5 Cement	.85	
		Solderg Paste, No. 18 Cement		
		Black Finishing Varnish	1.40	
		No. 1 Shellac		
		No. 3 Shellac	1.80	
		No. 14 Shellac		
		Protective Paint	.95	
		Commutator Cement		
		Asphaltum Enamel		
		Flat Black Enamel	1.10	
		A-R-C Cement		
		Switchboard Lacquer		
		Lacquer Thinner	.60	
		H L Oil		
	733	Tape & Splicing Compound	On request	
	847 to 871	All Material	.70	
	872	All Material	.57	
	873	All Material	.48	
	874	All Material	.57	
	875 to 876	All Material	.48	
	877	All Material	.57	
	878	All Material	.70	
6-A	879 to 885	Composition or Bronze	.57	
Part	879 to 885	Malleable Iron	.70	
I	886 to 890	All Material	.57	
	891 to 898	Malleable Iron Bodies	.63	
	891 to 898	Brze or Composition Bodies	.57	
	899	Insulated Crossings	.63	
	899 to 903	All Material	.60	
	904	Section Insulators	.60	
	904	Line Section Switch	.65	
	905	All Material	.57	
	916 to 920	All Material	.60	
	921	Malleable Iron	.70	
6-A	921	Composition	.57	
Part	922	All Material	.58	
II	923 to 927	All Material	.63	
	928 to 934	All Material	.60	
6-A Pt III	935 to 942	All Material	.70	
6-A Pt. IV	943 to 945	All Material	On request	
6-A Pt. V	946 to 955	All Material	.50	
	956 to 976	All Material	On request	
6-A Pt. VI & VII	977 to 1003	All Material	On request	
	1011 to 1066	Insulators	.60	
	1067	PS & PG Strain Insulators	.64	
	1068	P2 Strain Insulators	.60	
13-A		Circuit Break Insulators	.60	
	1069	Pin Type Strain Insulators	.60	
	1070	Wall Bushings	.60	
	1071 & 1072	Wall & Floor Tubes	.64	
6-B	1073 to 1106	All Material	.66	
7-A Pt. I	1107 to 1112	All Material	On request	
7-A Pt. II	1113 to 1126	All Material	.50	
	1134 to 1161	Schedule A, except	.85	
		Reactance Sockets	1.00	
		Shunt Boxes	1.21	
7-A	1162 to 1171	Schedule C, D, E and F	.93	
Part	1174 to 1183	Schedule H	1.00	
1V	1185	Schedule P	1.00	
	1187 to 1208	Schedule I, except	.74	
	1205	Street Village Crooks	1.10	
7-B	1220 to 1228	Rectifier Outfits	1.00	
8-A	1231 to 1243	Electric Fans	On request	
8-C	1245 to 1265	Heatg & Cookg Appliances	On request	
8-D	1272 to 1289	Electric Ranges	On request	
9-A	1296 to 1335	Industrial Heatg Apparatus	.70	

INDEX TO SECTION

Section		Page
1-A	Lightning Arresters	1
1-B	Wiring Devices	59
12-A	Krantz Safety Apparatus	145
1-C	Power Switching and Switchboard Devices	201
2-A	Switchboards	451
2-B	Switchboard Accessories and Generator Voltage Regulators	527
3-A	Watthour Meters	625
3-B	Instruments and Relays	639
4-A	Distribution Transformers	745
4-B	Feeder-Voltage Regulators and Transformer Apparatus	777
5-A	Insulating Materials and Supplies	815
6-A	Line Material	837
13-A	Porcelain Insulators	1011
6-B	Car Equipment Supplies	1073
7-A	Arc Lamps and Lighting Systems	1107
—	Mazda Lamps	1209
7-B	Cooper-Hewitt Rectifier Outfits	1217
8-A	Electric Fans	1229
8-C	Electric Ware	1249
8-D	Electric Ranges	1267
9-A	Industrial-Heating Apparatus	1291
10-A	Babbitts, Solder and Repair Parts	1337
38	Small Motors and Generators	1339
30	Direct-Current Motors and Generators	1387
33	Alternating Current Motors and Generators	1398
45	Mill and Crane Motors	1409
—	Baldwin-Westinghouse Locomotive Equipment	1410
36	Control Equipment	1418
60	Power Equipment	1428
50	Railway Motors	1437
80	Automotive Electric Equipment	1442

GENERAL INDEX

For Index to Style Numbers see Page 1443

	Page
A	
Accelerating Auxiliaries, Bell-Crank	394
Accessories,	
For Arc Lamps	1113
For Automatic Operation for Type C Transformers	782
For Rectifiers	1227
For Type CD Carbon Circuit-Breakers	255
For Oil Circuit-Breakers	386
For Type CA Carbon Circuit-Breakers	266-273
For Type CC Carbon Circuit-Breakers	260
For Small Motors	1384
For Water Heaters	1263
Adjuster-Socket Streethood	1147
Adjuster-Socket Systems	1120, 1146
Advantages of Cutter Streethoods	1132
Air Delivery of Electric Fans	1239
Air Heaters, Type D	1259
Alloy Fuse Ribbon	59
Alloy Fuse Wire	59
Aluminum Wire	59
Ammeters—See Instruments	
Ampere hour Meter Sections	504
Analyzers, Harmonic	704
Anchor Eye, Type JB	930
Anchor Hangers	926
Anchor or Guy Rods	960
Angle Cross-Arm Braces	956
Angle Gear, Boyer	990
Angle-Iron Frame Mounting Brace	612
Application Data for Fuses and Knife Switches	117
Applications, Circuit-Breakers	465
Applications of Carbon Circuit-Breakers	240
Applications of Oil Circuit-Breakers	290
Approaches, Flexible	894
Arcing Horn For Upper Suspension	955
Arc Lamp Accessories	1113
Arc Lamps,	
Flame Carbon, Type H	1107
Metallic-Flame Series	1109
Arc Welding Equipments	1395
Arc Welding Panels, Type JD	482
Armature-Testing Equipments	804
Armor, Trolley Protecting	890
Armored Feeder Insulators	870
Arms,	
Bo-Arrow	966
Bracket	916
Extension	917
Arrester Fittings, Lightning	23
Arresters, Lightning	1
Atmospheric Lightning	1
Auto-Lock Brush Switches	151
Auto-Lock Control Panels	174
Automatic Cut-Out Hangers and Reflectors	1183
Automatic-Reclosing Carbon Circuit-Breakers	466
Automatic Section Insulators	903
Automatic Series-Trip Oil Circuit-Breakers	293
Automatic Time Switch Type 2-19-B	1280
Automobile Ammeters	639
Automobile Ammeters and Voltmeters Type EW	642
Automobile-Engine Heaters	1265
Automotive Electric Equipment	1442
Auxiliaries, Bell-Crank Accelerating	394
Type C	1420
Type F	1424
Auxiliary Apparatus for Distribution Transformer	753
Auxiliary Circuit Fuse Boxes	1080
Auxiliary Control Switches	1087
Axes, Hand	997
B	
Babbits and Solders	1337
Balance Coils, Type S	791
Barrier Brackets	614
Barriers	267
Bars, Crow	1002
Digging	1002
Tampering	1002
Tampering, Hardwood	1002
Bases	267
Battery Charging Panels	
Single-Section	493
Type KD	489
Type SD	496
Battery Charging Resistors	504
Bayonet Immersion Heater	1323
For Domestic Use	1288
Bayonets, Corner	968
Ground Wire	965
Ground Wire, Hot Galvanized	965
Straight	966
Bell-Alarm Signal-Contact Attachments	391

GENERAL INDEX—Continued

	Page
Bell-Crank Accelerating Auxiliaries	394
Bell-Crank Attachments	395
Bell-Ringers	1264
Belts	702
Tool	1000
Beveled Washers	621
Binding Posts and Terminal Connectors	141
Blank Panels, Drilled For Mounting Bolts	576
Blank Sections	504
Blocks, Fuse	64–65
Expulsion-Type	205
For Instrument Circuits	201
High-Voltage	207
Switch Board-Type	203
Transformer	66
With Cast Iron Bases	203
With Insulating Bases	65
Blocks, Snatch	1001
Blocks, Steel Tackle	1001
Bo-Arrow Arms	966
Bo-Arrow Double Arming Sets	968
Bolts,	
Carriage	957
Cutter Toggle	129
Drop Forged Eye	958
Expansion	869
Iusulated	621
Insulated Fork	941
Machine	951
Mounting	393
Spacing	958
Through	957
Uninsulated	621
Bonding Sleeves, Copper	994
Bonding Tools and Appliances	989
Bonds,	
Concealed Rail	983
Rail	977
Soldered Rail	986
Twin Terminals	987
Box, Motor Connection	1098
Boxes,	
Auxiliary Circuit Fuse	1080
Cut-Out	122
Cut-Out Type L	126
Driving Journal	1417
Expulsion Type Fuse	68
Fuse, Type OD Safety-First	69
Railway Fuse	1075
Service	128
Steel Service	122
Stock, Cut-Out	122
Train Line Junction	1088
Transformer Fuse	66
Boyer Angle Gear	990
Braces,	
Angle Cross-Arm	956
Angle-Iron Frame Mounting	612
Cross-Arm	956
Floor	612
Pipe Frame Mounting	612
Wall	612
Bracket Apparatus	504
Bracket Arms,	847
Catenary Suspension	916
Type CH	916
Type GB	916
Type GC	917
Bracket Arm Overhead Construction	840
Bracket Fixtures, Sol-Lux	1181
Brackets, Barrier	614
Broadway Trolley	1199
Commerce	1204
Corridor	1204
Cutter Ornamental	1199
Cutter Streethood	1136
Idler	617
Lamp	571
Meter Swinging	620
Meter Swivel	619
Midget	1204
Mounting	609
Mounting Clamp	616
Ornamental	1204
Panel Swinging	620
Pipes	611
Pipe Mounting	610–611
Reversible	1204
Shunt Supporting	619
Sol-Lux Junior Trolley	1199
Sol-Lux Wall	1203
Special Mounting	392
Streethood	1154
Universal Mounting	607
Brakes, Magnet Operated	1427
Bridge Newels	1202
Broadway Trolley Brackets	1199
Bronze Trolley Frogs	893
Brooklyn Strain Insulators	942
Buffing Motors	1380
Bulbs, Rectifier	1228
Burke Horn Gap Switches	403–417
Bus-Bar Clamps	602
Bus-Bar Copper	624
Bus-Bar Supports Type P	584
Bus-Bar Terminals	603
Bushings, Cable	324
Floor Condenser Type	945
Krantz Porcelain-lined Conduit	200
Porcelain Wall	1070
Roof, Condenser Type	944
Wall, Condenser Type	945
Bus Line Receptacles and Jumpers	1093
Bus-Type Insulators	450

C

	Page
Cable Bushings	324
Cable Conduit	618
Cable Tape	836
Cable Taps	139
Cables For Auxiliary Circuits	569
Messenger	1007
Calibrating Terminal for Secondary Circuit	622
Canopy Switches,	
With Magnetic Blow-Out Coils	1083
Without Magnetic Blow-Out Coils	1082
Cant Hooks	1003
Cap and Cone Insulators	854
Caps for Ends of Pipes	621
Carbon Circuit-Breakers,	
Application of	240
Automatic Reclosing	466
Electrically Operated, Contractor Type	271
General	243
Instructions for Ordering	248
Manually Operated	250-260
Multipole Manually Operated	272
Remote Control	271
Type CA	262
Type CA Electrically Operated	271
Type CC	258
Type CD	249
Type F	286
Card Holders	621
Carriage Bolts	957
Carrying Cases for	
P. W. Ammeter	683
P W Volt-Ammeter	683
Car-Type Circuit-Breakers	1073
Catenary Hangers	922–925
Catenary Material	906
Catenary Suspension Trolley Line Material	911
Ceiling Fans	1238
Cementing Porcelain Insulators	1016
Centering Washer	970
Cents-Per-Hour Meter Panel	542
Chafing Dishes	1253
Channel Pins	994
Charge and Discharge Resistors	36
Charging Battery in Two Sections	493
Charging Receptacles and Plugs	119
Charging Sections	502
Chisels, Socket Framing	996
Stripping	996
Chocolate Warmers	1333
Choke Coils	49
Chucks, Trolley Wire	890
Circuit Break Insulators	1068
Circuit Breaker Accessories, Oil	386
Circuit-Breaker Applications	465
Circuit-Breaker	
Applications of Oil	290
Automatic Series-Trip Oil	293
Automatic Transformer-Trip Oil	293
Carbon, Application of	240

GENERAL INDEX—Continued

Page

Circuit-Breaker
- Automatic Reclosing.. 466
- Instructions for Ordering Electrically Operated Contractor types..... 271
- General..... 243
- Manually Operated 260–271
- Multipole Manually Operated..... 272
- Multipole Electrically Operated..... 272

Circuits-Breakers, Fused, High Voltage..... 209
- Non-Automatic Transformer-Trip Oil.... 293
- Construction..... 299
- Current Rating..... 295
- Current Temperature 295
- Details and Excessories..... 353
- Electric Operation.. 296
- General Information 295
- Large..... 397
- Methods of Operation..... 295
- Methods of Tripping 297
- Tripping Attachments..... 298
- Tripping Combinations..... 299
- Railway Car type...1073
- Type B, Oil..... 397
- Type C, Oil..... 399
- Type CA, Carbon.. 262
- Type CA, Carbon.. 271
- Type CA, Field Discharge..... 272
- Type CC, Carbon... 258
- Type CD, Carbon.. 249
- Type CO, Carbon... 401
- Type D, Oil..... 318
- Type E, Oil..... 398
- Type F, Oil..... 346
- Type F, Carbon.... 286
- Type F-1, Oil..... 355
- Type G, Oil..... 401
- Type H, Oil..... 331
- Type I, Oil..... 315
- Type O, Oil..... 400
- Type QF, Oil..... 341

Circuit Fuse Boxes Auxiliary.....1080

Circular Oscillogram Attachment..... 705

Clamping Ears Type F.... 879

Clamp Pins for High Voltage Installations..... 973

Clamps,
- Bus-Bar..... 602
- Conduit..... 611
- Eccentric Wire..... 999
- Feeder..... 885
- High Voltage Clamp Pins..... 974
- Ground Wire..... 968
- Hanger..... 610
- I-Beam.....610–864
- I-Beam Hanger..... 610
- Parallel Screw..... 999
- Pipe Brace..... 613
- Pipe Cross..... 615

Page

Clamps,
- Pipe End..... 611
- Pipe Saddle..... 611
- Rolled Steel Guy..... 960
- Schaper Forged Guy.. 960
- Splicing..... 998
- Suspension Wire..... 953
- Type AD..... 953
- Type CA Messenger Anchor..... 929
- Type CJ..... 929
- Type DA Messenger Anchor..... 930
- Type EA Anchor..... 930
- Type FD..... 929
- Type FR..... 951
- Type JB Anchor Eye. 930
- Type RE Mine..... 884
- Type RE-1 Mine..... 884
- Type TB Suspension Strain..... 947
- Wedge Type..... 885
- Wire Rope..... 959

Clark Splicing Ears..... 888

Cleveland Trolley Wire Splicers..... 866

Climbers, Pole.....1000

Clinching Irons..... 999

Clippers, Bolt..... 998

Cloth and Papers, Treated. 924

Cloth and Papers, Untreated..... 826

Coasting Time Recorders..1099

Coffee Percolators.....1248

Coil Testing Equipments.. 805

Coils, Balance, Type..... 791
- Choke..... 49
- Reactance.....1122
- Safety.....1125
- Trip..... 388

Choke Coils, Horn Gap.... 425

Coke Oven Type Insulators. 855

Combination Generator and Feeder Panels..... 475

Combination Generator-and-Welding Panels.... 483

Combined Lightning Arresters and Fuses..... 436

Commerce Newels.....1203

Commutating Pole Motors.1387

Commutator Tools.....1104

Commutator Truing Device.....1104

Composition Trolley Cars.. 873

Compounds,
- Insulation..... 829
- Soldering.....829

Concealed Rail Bonds..... 983

Condensers
- Jet.....1431
- Surface.....1431

Condenser Type Roof Bushings..... 944

Condenser Type Wall or Floor Bushings..... 945

Condensing Equipment....1413

Conductor Cable Reels....1414

Page

Conductors, Rail Bond.... 977

Conduit Bushings..... 200

Conduit Clamps..... 611

Cone Insulators..... 854

Connection Box, Motor...1098

Connections, Ground..... 2

Connector Lugs, Back..... 136
- Front..... 136

Connectors,
- Copper Tube..... 604
- Frankel Solders..... 130
- Groundling Tap..... 137
- Knuckle Joint..... 121
- Plug-Stud..... 134
- Stud..... 134
- Tee..... 604
- Terminal..... 141
- Three-Way..... 132
- Two-Way..... 131

Constant Current Regulating Transformers.....1111

Construction of Cutter Multiple Streethoods....1150

Construction of Cutter Series Streethoods.....1132

Contact-Insulators, Wooden 890

Contact-Type Carbon Circuit-Breakers..... 271

Control H L.....1439
- Type C, D-C.....1420
- Type F, A-C.....1424
- Elevator.....1426

Control Apparatus.....1294

Control Desks..... 550

Control Equipment For Enameling Ovens.....1297

Control Mechanisms for Rheostats..... 618

Control Panels.....1118
- For Regulating Transformers.....1112
- Krantz Safety Auto-Lock..... 174
- Regulator.....1119

Control Pedestals..... 548

Control Relay..... 567

Control Switches, Type CS 563
- Type 449–A.....1087
- Type 494.....1085
- Type 495.....1085
- Type 543–A.....1087

Controllers.....1413-1418
- Type E.....1426
- Type FA.....1423
- Type RF.....1423

Converters, Synchronous..1429

Cooking Utensils.....1287

Cool-Breeze-Anywhere....1244

Cooper-Hewitt Rectifiers..1111

Copper and Aluminum Compared.....1004

Copper for Bus-Bars..... 624

Copper Terminals..... 605

Copper Tube Connectors.. 604

Copper Tubing for Wiring Arresters..... 37

GENERAL INDEX—Continued

	Page
Corner Bayonets	968
Correct Illumination Interior	1216
Counters, Cycle	724
Pocket	1000
Couplings, Nuttall Flexible	1436
Cover plates, Remote-Control	394
Cozy Glow Radiators	1258
Crane Motors	1409
Crest-Voltmeter Outfits	707–802
Crooks, Driveway	1206
Crooks, Entrance	1208
Interurban	1207
Lawn	1208
Parkwith Hoods	1206
Platform	1208
Street	1205
Urban	1207
Village	1205
Cross-Arms	963
Cutter	1169
Cross Arm Braces, Angle	956
Cross Arm Saddles	970
Crossings	931
Adjustable, Type KD	899
Adjustable, Metallic	898
Ridig Insulated	899
Ridig Metallic	897
Cross Span Overhead Construction	840
Cross Span Steady Hangers	927
Crow Bars	1002
Cups, Oil Testing	803
Curling Irons	1256
Current Transformer,	
Portable	742
Type A	725
Type FB	732
Type FS	732
Type FR	734
Type KA	726
Type KB	728
Type KC	730
Type KR	733
Type MA	727
Type MB	729
Type MC	731
Type OA	735
Type OB	736
Type OC	737
Curve Ears Type F	881
Curve Hangers	928
Curve Overhead Construction	840
Cutout Boxes	122
Made to Order	123
Stock	122
Type L	126
Cutout Hangers and Reflectors	1183
Cutout Knife Switches	1081
Cutout Pulleys	1166
Cutout Switches	391
Cutter, Multiple Street-hood Bodies	1153
Cutter Steel Service	122
Cutter Toggle Bolts	129
Cycle Counters	724
D	
Data Blank For Overhead Construction	1010
Data Sheet For Voltage Regulators	537–540
Data, Wire and Cable	105
Dead Front, Safety Fuse Panels	171
Deflection Angle of Trolley Wire	912
Dehydrating of Insulating Oil	813
Demand Meters, Watthour	630
Desk and Bracket 10-inch Fans	1232
16-inch fans	1234
Desks, Control	550
Details for Oil Circuit-Breaker	394
Details of Desk and Bracket Fans	1236
Detectors, Switchboard Electrostatic Ground	656
Development of Safety Apparatus	145
Diagram of Connections for Carbon Circuit-Breakers	241
Dial Switch	665
Diameter of Stranded Cable and Solid Wire	143
Digging Bars	1002
Direct Current Switchboard Panels	519
Direct-Trip Attachments	389
Discharge Resistors	36
Disc Immersion Heaters	1334
Disconnecting Switches	215
Safety Mine	155
Selector Type	227
Type M	219–225
Type O	220–225
Type P	221–227
Disc Stoves	1255
Distribution Transformers	745
Drill, Electric	990
Hand Operated	991
Drilling Machines	992
Drilling Plans	289
Drive Crooks	1206
Driving Journal Box	1417
Drop Forge Eye Bolts	958
Drop Forge Turnbuckles	976
Drum Controllers	1423
Drum Reverse Switches	1425
Drum-Type Switches	230
Drying and Purifying, Oil	808
Dry Type Glue Pots	1331
E	
Ears, Splicing	888
Steady Strain	921
Trolley Type E	873
Trolley Type EL-1	875
Trolley Type F	879
Trolley Type FP	879
Trolley Type G	876
Trolley Westinghouse Composition	873
Efficient Illumination with Cutter Multiple Street-hoods	1151
Cutter Series Street-hoods	1133
Elbows	133
Electric Mechanisms	72
Electrical Operating Mechanisms	422
Electrical Speed Indicators	701
Electrical Heated Hot Tables	1327
Electrically Operated Carbon Circuit-Breaker	271
Electrolyte Type D	37
Electrolytic Lightning Arresters	8
Type AL	35
Type AK	25
Electrostatic Glow Meter	658
Elevator Control	1426
Emergency Splicing Sleeves	887
Enclosed Auto-Lock Brush Switches	151
Enclosed Cartridge Fuses	60
Enclosed Fuse Blocks	201
Energy Required for Heating Buildings	1336
Entrance Crooks	1208
Entrance Switches, Full-Safety	149
Equalizers	140
Equalizer Contacts	267
Equalizer Pedestals	556
Equipments for Wood Working Lathes	1407
Exciter and Voltage Regulator Panels,	
Type ED	524
Type JD	524
Expansion Bolts	869
Expansion Joints, Nuttall	1436
Expulsion—Type Fuse Blocks	69–205
Extension Arms	917
F	
Factory Sewing-Machine Motors	1375
Facts about Lightning	1
Fan-Motor Oil and Grease	1243
Fans, Ceiling 56-inch	1238
Desk and Bracket, 10-inch	1232
Desk and Bracket, 16-inch	1234

GENERAL INDEX—Continued

Page

Fans,
Exhaust 1248
Gyrating 1237
Railway-Coach 1241
Westinghouse 1229
Westinghouse-Ventura 1370
Whirlwind, 8-inch 1230
Faradoid 1033–1059
Farm Unit, Electric 1385
Fault Localizers, Portable. 703
Feed Wire Insulators 869
Feeder Ear, Type E 874
Type F 882
Type FP 881
Feeder Overhead Construction 844
Feeder Panels 458
For Mines 472
Type JB 513
Type KD 482
With Circuit Breaker Protection 480
With Fuse Protection. 480
Feeder Sections 488
Feeder Suspensions 872
Feeder Tap Insulators 852
Feeder Tap Support 917
Field Discharge Circuit-Breakers 272
Field Switches 221
Film Socket 1131
Filter Paper 811
Filtering of Insulating Oil .. 913
Fittings for Pierce Forged Steel Pins 970
Fittings, Lightning Arresters 23
Fixtures, Bracket 1181
Cutter Sol-Lux 1194
Type CI 1123
Vapor Proof 1179
Flame Carbon Arc Lamps. 1107
Flange, Pipe 612
Flexible Approaches 894
Flexible Couplings 1436
Float Switches 1425
Flood Lighting Projectors 1184-1185
Floor Boxes, Krantz 194
Krantz Gem 198
Floor Braces 612
Floor Bushing, Condensor Type 945
Floor Tubes, Porcelain 1072
Foot Warmer 1320
Fork Bolts, Insulated 941
Forks, Raising 1003
Frames, Switchboard 572
Trip-Magnet 387
Frankel Solderless Connectors 130
Franklin Mazda Lamps ... 1210
Frequency Meters, Switchboard 652
Friction Type, Tape 836

Page

Frogs, Trolley Detroit 891
Full Safety Entrance Switches 149
Fuse Blocks 64–65
Expulsion Type 205
For Instrument Circuit 201
High Voltage 207
Switchboard Type 203
Transformer 66
With Cast Iron Bases. 203
With Insulating Bases 64–65
Fuse Boxes, Auxiliary Circuit 1080
Expulsion Type 68
Railway 1075
Transformer 66
Type OD, Safety First. 69
Fused Circuit-Breakers 209
Fuse Holders 64–65
Without Bases 65
Fuse Panels, Type F, Krantz 170
Type F, Dead Front, Krantz 171
Fuse Ribbon 59
Alloy 59
Fuse Type Lightning Arresters 22
Fuse Wire 59
Alloy 59
Fuses, Application-Data ... 117
Horn Gap 435
Link 59
Railway 1075

G

Gaps, Impulse 31
Safety Spark 21
Sphere 35
Gate Post Newels 1202
Gathering Locomotives 1414
Gears, Angle 990
Nuttall Railway 1106
Gem Floor Boxes 198
Generator and Feeder Panels 486
Generator Panels,
For Battery Charging. 491
For Control of Generators 484
For Mines 467
Type KD 486
With Circuit-Breaker Protection 456
Generator Voltage Regulators 527
Generators Sections 502
Generators Units 1433
Generators, Alternating-Current 1434
Magneto 702
Type CD 1377
Type SK 1387
Giant Strain Insulators 939
Globe Strain Insulators 940
Globes 1202
Glow Meters 658

Page

Glue Pots 1331
Graphic Frequency Meters. 671
Graphic Instruments, Type M 674
Type U 679
Graphic Power Factor Meters 672
Graphic Wattmeters 671
Type M 673
Grease, Fan-Motor 1243
Grinder, Portable Electric. 993
Grinding Motors 1380
Grips, Chicago Wire 999
"Quick Samson" Wire 999
Ground Connections 2
Ground Pipes 962
Ground Rods 962
Ground Wire Bayonets 965
Ground Wire Clamps 968
Ground Wires, Overhead .. 1016
Grounding Tap Connectors 137
Guy Hooks 962
Guy Rods 960
Gyrating Fans 1237

H

Hack-Saw Frame and Blades 997
Half-Strained Ear Type E. 874
Type F-4 883
Type F-6 883
Hand Closing Handles 396
Handle and Coverplate for Oil Circuit-Breakers 300
Handles Hand Closing 396
Spade for Knife Switches 114
Handling of Insulating Oil .. 813
Hand Operated Drill 991
Hand Tools for Installing Twin-Stud Terminal Bonds 993
Hanger Clamps 610
Hanger Tools, Cross Span. 995
Hangers, Anchor 926
Automatic Cutout 1183
Catenary 922–925
Catenary Type NF ... 922
Cross-Span 921
Cross-Span Steady 927
Curve 928
Flexible Anchor Type FC 926
Flexible Catenary Type BG 923
Flexible Catenary Type B-3 924
Flexible Catenary Type FE 924
Flexible Catenary Type GF 925
Flexible Catenary Type FS 925
Flexible Pull-Off Type FC 926
Messenger 921

GENERAL INDEX—Continued

Page

Hangers
Pull-Off 926
Rigid Catenary Type B 923
Type SP 929
Harmonic Analyzers 704
Haulage Trolley, ... 1417
Headstock Equipments for Wood Working Lathes .. 1407
Heaters, Air Type D 1259
Bayonet Immersion ... 1323
Bayonet Immersion for Domestic Use 1288
Disc Immersion 1334
Oven Type C 1295
Steel Clad 1324
Water 1263, 1288, 1323
Heating Equipment for Ovens 1291
Heating Plate 1330
Helpful Cooking Utensils ... 1287
High-Voltage Equipment .. 798
High-Voltage Fuse Blocks. 207
High-Voltage Fuse Circuit-Breaker 209
High-Voltage Measuring Devices 706
High-Voltage Straight-Line Suspensions 855
Holders, Card 621
Fuse 64–65
Without Bases 65
Sol-Lux Industrial Lighting 1175
Hooks, Cant 1003
Guy 962
Swivel Carrying 1003
Horizontal Pipe Suspensions 863
Horn Gap Arresters 425
Horn Gap Choke Coil 425
Horn Gap Fuses 435
Horn Gap Switches 403
Hot Plates 1254–1286
Hot Tables, Electrically Heated 1327
Household Irons
Type E 1247
Type M 1246

I

I-Beam Clamps 610–864
I-Beam Hanger Clamp 610
Idler Brackets 617
Ignition, Type SC 1442
Immersion Heaters, Bayonets 1322
Disc 1324
For Domestic Use 1288
Impulse Gaps 31
Incoming Line Panels 471
Indicators, Electrical Speed 701
Temperature 663
Induction Feeder, Voltage Regulators 779
Induction Motor Panels ... 468

Page

Induction Motors, Squirrel-Cage 1398
Wound-Rotor 1405
Industrial Haulage Trolleys 1417
Industrial Heating Plate ... 1330
Industrial Lighting Reflectors 1172
Industrial Reflectors 1108
Industrial Trolleys 1105
Instruction For Ordering Carbon Circuit-Breaker .. 248
Instructions for Ordering Oil Circuit-Breakers 314
Instrument Posts 560
Instruments, Precision 697
Type AW, Switchboard 643
Type BI, Automobile .. 639
Type BX, ... 640
Type EW, Automobile. 642
Type FW 644
Type GL and GM Switchboard 660
Type M, Switchboard Graphic 668
Type PC and PD, Portable 689
Type PL, Portable 684
Type PM, Portable ... 694
Type PR 694–695
Type PW, Portable ... 682
Type SL 645
Type SM 649
Type U, Graphic 679
Instruments Switches 230
Drum Type 230
Plug Type 236
For Ground Detector Circuits 237
For Synchronizing Circuits 238
For Voltmeter Circuits 236
Push-Button Type 239
Insulated Bolts 621
Insulated Crossings, Rigid .. 899
Adjustable 899
Insulated Fork Bolts 941
Insulated Middle Supports. 852
Insulated Turnbuckles 940
Insulation Testing Equipments 793
Portable Bench Type. 794
Portable Carriage Type 795
Portable Truck Type .. 796
High Capacity Type ... 797
Insulating and Soldering Compounds 829
Insulating Oils 832
Dehydrating 913
Filtering 913
Handling 913
Storage 913
Testing 913
Insulation, Mica 815
Moulded 853
Insulators 1169
Armored Feeder 870
Bus-Type 450
Cap and Cone 854
Circuit-Break 1068

Page

Insulators
Coke Oven Type 855
Faradoid 1033–1059
Feeder Wire 869
Feeder Tap 852
Giant Strain 939
Globe Strain 940
Messenger 918
Mine Section 901
Pillar 943
Porcelain 1011
Porcelain Pin-Type ... 1023
Porcelain Strain 1067
Porcelain Suspension Type 1060
Section 931
Section Automatic 903
Section Type HM 904
Section Type HR and HR–2 899
Section Type KB 900
Spool Type Strain 941
Strain Brooklyn 942
Suspension Strain 1066
Wooden Contact 890
Wood Strain 935
Interlocking Attachments .. 396
Internal Lightning 1
Interurban Crooks 1207
Inverse-Time-Limit Attachments 389
Irons, Clinching 999
Curling 1256
Household Type E 1247
Household Type M ... 1246
Laundry, Type E 1247
Type M 1246
Tailors 1335
Three-Pound 1245

J

Jet Condensors 1431
Joints, Nuttall Expansion .. 1436
Journal Box, Driving 1417
Jumpers, Bus-Line 1093
Train Line 1095
Junction Boxes 1088
Junior Ornamental Tops ... 1197
Jupiter Cutout Pulleys 1166

K

Knife Switches 72
Application Data 117
Main Cutout 1081
Motor-Starting 211
Type A 72
Type C 73
Knives, Cable Splitting 997
Cable Stripping 996
Draw 997
Knuckle-Joint Connectors. 121

L

Laboratory Instruments ... 687
Ladles, Pouring 1000
Lag Screws 958
Lamp Accessories, Arc 113
Lamp Sockets, Shades and Brackets 571

GENERAL INDEX—Continued

Page

Lamps, Arc, Type H....1107
Arc, Metallic Flame Series....1109
Franklin Mazda....1210
Mazda....1209
Mazda C....1211
Mazda for Automobiles 1214
Mazda for Flashlights.1215
Mazda for Rural Lighting....1212
Mazda for Train Lighting Service....1213
Multiple A-C....1108
Multiple D–C....1108
Multiple Series....1108
Series....1108
Large Oil Circuit-Breakers. 397
Large Steam Turbine Generator Units....1433
Laundry Irons Type E....1247
Type M....1246
Lawn Crooks....1208
Leads for Use with Ammeter and Shunts.... 683
Lectroseal Transformer Oil. 832
Leg Straps....1000
Lighting Equipment 1180–1442
Lighting Fixtures....1173
Lighting Holders....1175
Lighting Reflectors.... 1172–1174–1175
Lighting Systems with Cutter Streethoods....1130
Lighting, Mazda Street....1117
Protective....1128
Railway-Yard....1129
Lightning, Arresters.... 1
Direct-Current.... 4
Fittings.... 23
Fuse Type.... 22
Horn Gap.... 425
Low Equivalent.... 19
Series Lighting Circuit 9
Some Facts About.... 1
Spark Gap and Low Equivalent.... 11
Type A Electrolytic... 8
Type AK....25–34
Type AL....25–35
Type C.... 13
Type CR.... 14
Type DL.... 430
Type DLR.... 430
Type G.... 15
Type K–3.... 6
Type M.... 441
Type M....5–12
Type MP.... 432
Type R.... 437
Type RC.... 437
Type RCR.... 439
Type S....17–434
Type W.... 16
Type WB.... 426
Type WC.... 426
Type WBR.... 426
Type WCR.... 426
Lightning, Atmospheric... 1
Lightning, Internal.... .. 1
Lights, Sign....1182

Page

Limiting Resistors for Potential Transformer Fuses 204
Line Fittings, Transmission. 947
Line Junction Boxes....1088
Line Material, Pole....1171
Line Sections.... 503
Line Section Switches.... 904
Linemen's Tools.... 995
Link Fuses.... 59
Localizers, Portable Fault.. 703
Lock Washers.... 959
Locomotives, Baldwin-Westinghouse....1441
Gathering....1414
Traction Reel....1416
Loom Motors....1408
Low Equivalent Lightning Arresters....11–19
Lugs, Angle Connectors.... 138
Back Connector.... 136
Front Connector.... 136
Right Angles.... 138
Service Box.... 135
Swivel.... 137
Luminous Radiators....1260
Lucsolite Fixtures....1123

M

Machine Bolts.... 957
Machines, Drilling.... 992
Magnet-Operated Brakes..1427
Magneto Generators.... 702
Magneto Pulleys.... 702
Main Cut-Out Knife Switches....1081
Mantel or Flush Type Luminous Radiators....1260
Marine Propelling Machinery....1435
Mast Arms....1162
McCandless-Westinghouse Mazda Auto Lights....1214
Flush Lights....1215
Measuring Devices, High Voltage.... 706
Mechanical Feeder Clamps. 885
Mechanical Interlocking Attachments.... 396
Mechanical Stresses On Bus-Bars.... 581
Mechanism, Electric.... 272
Electrical Operating.... 422
Melting Pots....1000
Mercury Rectifier Outfits..1217
Messenger, Cable....1007
Messenger Hangers....921
Messenger Insulators.... 918
Type J.... 918
Type JC.... 918
Type MB.... 919
Metallic-Flame Series Arc Lamps....1109
Metal Switchboard Caps.. 621
Metering Equipments, Outdoor.... 700

Page

Metering Panel Boards, Krantz.... 190
Meter Houses, Type M.... 546
Meter Panels.... 542
Meter Sections, Amperehour 504
Meter Swinging Brackets.. 620
Meter Swivel Brackets.... 619
Meters, Electrostatic Glow. 658
For Measuring....1444
For Use With Transformers.... 667
Graphic Frequency... 671
Graphic Power Factor. 672
Polyphase with Transformers.... 628
Portable Standard Watthour.... 637
Prepayment Watthour 629
Self-Contained.... 667
Watthour, Type CW–6 636
Type OA....625–666
Type RO, Demand 630
Switchboard Frequency 652
Switchboard Power Factor.... 653
Switchboard Reactive Factor.... 654
Methods of Applying Westinghouse Suspensions in Mines.... 864
Methods of Operation of Series of Distribution Systems....1130
Metropolitan Newels....1203
Mica Insulation.... 815
Micarta.... 817
Micarta Terminal Insulating Tubes.... 391
Middle Supports.... 852
Mill Motors....1409
Mine Clamps.... 884
Mine Disconnecting Switches.... 155
Mine Haulage Trolleys....1417
Mine Locomotives, Baldwin-Westinghouse 1410
Battery....1410
Trolley and Storage...1410
Mine Motors, No. 900....1411
Mine Overhead Construction.... 845
Mine Section-Insulators with Switch.... 901
Mine Suspension Type B.. 861
Modern Street Lighting Systems....1130
Moisture Absorption of Porcelain Insulators....1015
Monkey Wrenches.... 996
Motor Accessories, Small..1384
Motor Connection Box....1098
Motor-Generators, Small..1382
Battery Charging....1393
For Motion Picture Machines....1393
Synchronous....1429

Page

Motor-Starting Knife Switches..... 211
Motor Starting Oil Circuit-Breakers..... 341
Motor Starting Switches, Safety..... 146
Type A..... 115
Type C..... 115
Motors, Buffing.....1380
Crane.....1409
Factory Sewing Machines .1375
Grinding.....1380
Loom.....1408
Mill.....1409
Mine No. 900.....1411
Polishing.....1380
Railway.....1437
Sew.....1372
Synchronous.....1406
Type AR.....1349
Type CA.....1341–1345
Type CAH.....1346
Type CD.....1361
Type CDH.....1367
Type CS Squirrel-Cage Induction.....1398
Type CSA.....1355
Type CW, Small.....1358
Type SK, Commutating Pole.....1387
Wound-Rotor Induction.....1405
Moulded Insulation..... 853
Mounting Bolts..... 393
Mounting Brackets..... 609
Mounting Brackets, Special 392
Universal..... 607
Mounting Clamp Brackets 616
Moving-Coil Regulators and Control Panels.....1118
Multiple Lamps A. C.....1108
Multiple Lamps D. C. ...1108
Multiple Series Lamps D.C.1108
Multiple Streethood Bodies.1152
Multiple Streethoods.....1150
Multiple Suspension Streethoods.....1156
Multipole Electrically Operated Carbon Circuit-Breakers..... 272
Multipole Manually Operated Carbon Circuit-Breakers..... 272
Multipole Streethood Bodies Cutter.....1153

N

Newels, Bridge.....1202
Commerce.....1203
Gate Post.....1202
Metropolitan.....1203
Ornamental.....1202
Nickel Silver Wire..... 59
Non-Automatic and Automatic Transformer-Trip Oil Circuit-Breakers..... 293
Nuts, Fancy Hexagon..... 621
For Terminals..... 605

Page

Nuttall Railway and Industrial Trolleys.....1105

O

Oil Barrels..... 834
Oil Circuit-Breaker Accessories..... 386
Oil Circuit-Breakers Application of..... 290
Automatic Series-Trip. 293
Construction..... 299
Current Rating..... 295
Current Temperature. 295
Details and Accessories 353
Electric Operation.... 296
General Information.. 295
Handle and Cover Plate 300
Instruction for Order.. 314
Large..... 397
Methods of Operation. 295
Methods of Tripping.. 297
Non-Automatic and Automatic Transformer-Trip..... 293
Terminal Insulation... 300
Tripping Attachments. 298
Tripping Combinations 299
Type of Mounting.... 300
Type B..... 397
Type C..... 399
Type CO..... 401
Type D..... 318
Type E..... 398
Type F–1..... 355
Type F–2..... 357
Type F–3..... 364
Type G..... 401
Type I..... 315
Type O..... 400
Oil Drying and Purifying Outfits..... 808
Oil, Fan-Motor.....1243
Insulating..... 832
Switch..... 834
Oil Testing Cup..... 803
Omission Allowances..... 754
Optional Equipment..... 468
Ore-Mine Switches, Safety 156
Ornamental Brackets.....1204
Ornamental Newels.....1202
Ornamental Posts.....1199
Ornamental Posts.....1187
Ornamental Street-Lighting Fixtures.....1193
Ornamental Street-Lighting.....1186
Ornamental Tops, Cutter Junior.....1197
Ornamental Tops, Cutter Senior.....1196
Outdoor Metering Equipments..... 700
Outdoor Service Foot Warmer.....1320
Outdoor Substations..... 443
Outdoor Switching and Metering Equipments. 543
Outdoor Type for Platform Mounting..... 785

Page

Outfits, Crest-Voltmeter... 707
For Use with Embedded Thermo-Couples 664
Oil Drying and Purifying808
Portable Testing Type PR..... 696
Ovens Type C.....1295
Ovens, For Baking Railway-Motor Armatures.....1301
Standardized.....1304
Type K-1.....1305
Type K-2.....1305
Type K-3.....1306
Type K-4.....1306
Type K-5.....1307
Type L-1.....1308
Type L-2.....1308
Type L-3.....1310
Type L-4.....1311
Type M-1.....1312
Type M-2.....1313
Type M-3.....1314
Type N-1.....1315
Type N-2.....1315
Type N-3.....1316
Type O-1.....1317
Type O-2.....1317
Type P-1.....1318
Type P-2.....1319
Type P-3.....1319
Overhead Construction.... 837
Overhead Ground Wires...1016
Overload Relays, Type CB. 714
Type CO..... 709
Type TO..... 720

P

Pads, Warming.....1257
Panel Boards, Krantz Metering..... 190
Krantz Railway-Type Safety..... 172
Krantz Straightline Types B and BP... 178
Safety Type S..... 157
Type S..... 163
Panel Outlets..... 484
Panel Swinging Brackets... 620
Panels, Arc Welding..... 482
Battery Charging Type KD..... 489
Battery Charging Type SD..... 496
Cents-Per-Hour Meter. 542
Control.....1118
Control, Krantz Safety Auto-Lock..... 174
Feeder..... 458
Feeder Type JB..... 513
Feeder Type KD..... 486
For Battery Charging. 491
For C. C. Regulating Transformers.....1112
Fuse, Type F Dead-Front Safety..... 171
Fuse, Type F Safety... 170
Generator.....456–484
Generator Type KD... 486
Incoming Line..... 471
Induction Motor..... 468
Marble..... 577

GENERAL INDEX—Continued

Page

Panels,
- Regulator Control 1119
- Safety Type C..... 167
- Slate..... 578
- Switchboard..... 519
- Switchboard Type EA. 520
- Switchboard Type EB. 521
- Switchboard Type EC. 522
- Switchboard Type EE. 523
- Switchboard Type EH. 522
- Switchboard Type GD. 518
- Switchboard Type JA. 505
- Switchboard Type JB. 509
- Switchboard Type JD. 455
- Synchronous Converter Switchboard..... 525
- Synchronous Motor... 469
- Voltage Regulator.... 524

Panels with Circuit-Breaker Protection..... 476

Panels with Fuse Generator Switch..... 476

Paper, Filter..... 811
- For Use with Type N Graphic Instruments 676
- Treated..... 824
- Untreated..... 826

Park Crooks With Hoods..1206

Part for Bracket Suspension Series Streethoods....1142

Parts for Cutter Brackets..1145

Parts for Cutter Ornamental Posts.....1198

Pedestals, Control..... 548
- Equalizer..... 556
- Rheostat..... 558
- Signal..... 559

Percolators, Coffee.....1248

Pike Poles.....1002

Pillar Insulators..... 943

Pin-Type Strain Insulators, Porcelain.....1069

Pins, Channel..... 994
- For Railway Feeders.. 976
- For Steel Arms..... 972

Pins for Wood Arms..... 971
- Pipe..... 975
- Pole Top..... 975
- Short Shank Western Union..... 974
- Standard Western Union..... 975
- Wood Top..... 974

Pin-Type Insulators, Porcelain.....1023

Pipe Brace Clamps..... 613

Pipe Brackets..... 611

Pipe Bracket Suspension... 863

Pipe Cross Clamps..... 615

Pipe Ends..... 612

Pipe End Clamps..... 611

Pipe Flange..... 612

Pipe Frame Mounting Brace.....612

Pipe Mounting Brackets... 611

Pipe Pins..... 975

Pipe Saddle Clamps..... 611

Page

Pipe Suspension..... 863

Pipes, Ground..... 962

Planer-Motor Equipments.1392

Plates, Hot.....1254–1286
- Industrial Heating....1330
- Strain..... 961
- Strain Malleable Iron 878

Platform Crooks.....1208

Pliers, Gas..... 998
- Side Cutting..... 997

Plugs, Charging..... 119
- Service Box..... 135

Plug Type Fuse Blocks.... 66

Plug Type Instruments Switches..... 236

Pocket Counter.....1000

Points of Importance in Selecting and Applying Small Motors.....1339

Pole Climbers.....1000

Pole Line Material.....1171

Pole Shims..... 961

Pole Steps for Tubular Steel Pole..... 961

Pole Steps for Wood Pole 961

Pole Supports.....1003

Pole Top Pins..... 975

Pole Top Ridge Iron..... 976

Poles, Pike.....1002

Polishing Motors.....1380

Polyphase Meters..... 628

Porcelain Floor Tubes.....1072

Porcelain Insulators.....1011

Porcelain-Lined Conduit Bushings..... 200

Porcelain-Pin Type Insulators.....1023

Porcelain Pin-Type Strain..1069

Porcelain Strain Insulators.1067

Porcelain Suspension Type Insulators.....1060

Porcelain Wall Bushings...1070

Porcelain Wall Tubes.....1071

Portable Ammeters..... 694

Portable Current Transformers..... 742

Portable Electric Grinder.. 993

Portable Fault Localizers.. 703

Portable Graphic Instruments..... 664

Portable Instruments Type PC..... 689
- Type PD..... 689
- Type PL..... 684
- Type PW..... 682

Portable Laboratory Instruments..... 687

Portable Potentiometers... 699

Portable Shunts..... 688

Portable Standard Watthour Meters..... 637

Portable Testing Outfits... 696

Portable Voltage Transformers..... 744

Page

Post Hole Spoons.....1002

Post Type Relays..... 423

Posts, Binding..... 141
- Cutter Ornamental....1199
- Instruments..... 560
- Ornamental.....1187
- Terminal..... 622
- Traffic.....1203

Potentiometers, Portable.. 699

Pots, Glue.....1331
- Melting.....1000
- Solder.....1332

Pouring Ladles.....1000

Power Stand.....1386

Power Transformers.....1432

Precision Instruments..... 697

Prepayment Watthours Meters..... 629

Projectors, Flood-Lighting. 1184–1185

Propelling Machinery.....1435

Protecting Armor Trolley.. 890

Protective Lighting.....1128

Pull-Off For Pantagraph-Trolley Operation 928

Pull-Off Hangers..... 926

Pulleys Cutter Cut-Out....1166
- Magneto..... 702

Purifying Outfits, Oil..... 808

Push-Button Stations.....1425

Push-Button-Type Switches..... 239

R

Radiators, Cozy Glow.....1258
- Mantel or Flush-Type Luminous.....1260

Rail Bonds..... 977
- Concealed..... 983
- Solder..... 986

Rail Bond Terminal..... 978

Railway Car-Type Circuit-Breakers.....1073

Railway-Coach Fans.....1241

Railway Fuse Boxes and Fuses.....1075

Railway Gears.....1106

Railway Motors.....1437

Railway Trolleys.....1105

Railway Type Switches....1082

Railway-Yard-Lighting....1129

Ranges, Automatic Electric.1267
- Type M-1.....1281
- Type 2-19-B-Combination and Electric1279
- Type 2-19-B-Half Automatic Electric....1277
- Type 2-19-B-Semi-Automatic Electric....1278
- Type 3-19-B- Automatic Electric.....1272
- Type 3-19-B- Combination Gas and Elec..1274
- Type 3-19-B- Double Combination Gas and Elec.....1276

GENERAL INDEX—Continued

Page

Ranges,
Type 3-19-B- Double Elec....1275
Type 3-19-B- Semi-Automatic Elec....1273
Type 515....1284
Reactance Coils....1122
Reactance-Coil Regulator Outfits....1122
Reactance-Coil Regulator Outfits For Mazda Street Series Lamps. 1121
Receptacles Bus-Line....1093
Charging.... 119
Train-Line....1095
Recorders, Time....1099
Recording Demand Watt-hour Meters.... 633
Rectifier Accessories....1227
Rectifier Bulbs and Renewals....1228
Rectifier Outfits, Type AA.. 1221
Type AE....1222
Type AL....1225
Type AN....1221
Type AT....1224
Type E....1223
Type W....1220
Type WL....1225
Rectifiers, Cooper-Hewitt.. 1111
Rectifiers Outfits, Mercury. 1217
Reducers.... 132
Reels, Conductor-Cable... 1414
Reflecto-Cap-Diffusers.... 1178
Reflectors Cutout....1183
Industrial....1108
Lighting....1172
Sol-Lux Industrial Lighting....1174
Regent Film Socket....1131
Regulating Transformers For Primary and Secondary Circuits....1119
Rectifier C. C....1111
Regulator Control Panels.. 1119
Regulator Outfits For Mazda Street Series Lamps 1121
Reactance Coils....1122
Regulator Panels, Voltage Types JD and ED.... 524
Regulators, Generator Voltage.... 527
Induction Feeder-Voltage.... 779
Instructions For Ordering.... 783
Moving Coil....1118
Relays, Control.... 567
Post Type.... 423
Secondary.... 781
Transfer.... 718
Overload Type CB... 714
Overload Type CO.... 709
Reverse-Phase.... 717
Reverse-Power.... 709
Temperature.... 719
Voltage.... 716
Type D.... 721
Type K M.... 722
Type T O Overload... 720

Page

Remote-Control Bell-Crank Attachments.... 395
Remote-Control Carbon Circuit-Breaker.... 271
Remote-Control Coverplates 394
Remote-Control Details For Oil Circuit-Breakers... 394
Repair Parts....1338
Repair Parts For Mine Section Insulator.... 902
Reset Switches, Type 449-A 1087
Resistors, Battery Charging 504
Charge and Discharge. 36
For Railway Service...1090
For Voltmeters, Watt-meters, and Three-Phase Power Factor. 692
Unbalancing.... 37
Reverse-Phase Relays, Type C P....1717
Reverse-Power Relays, Type C R.... 709
Reversing Planer - Motor Equipments....1392
Rheostats, D-C....1418
Rheostat Pedestals.... 558
Ribbon, Alloy Fuse.... 59
Fuse.... 59
Rico Coasting Time Recorders....1099
Ridge Iron, Pole-Top 976
Rifles, Sporting.... .1443
Rigid Insulated Crossings.. 899
Rods, Anchor or Guy... . 960
Ground.... 962
Rolled Steel Guy Clamps . 960
Roof Bushings, Condense Type.... 944
Round Plate Washers.... 959

S

Saddles, Cross-Arm.... 970
Safety Apparatus, Development of.... 145
Safety Coils....1125
Safety Enclosed Auto-Lock Brush Switches, Krantz 151
Safety-First Fuse Boxes.... 69
Safety Fuse Panels, Type F 170
Safety Fuse Panels, Type F Dead-Front.... 171
Safety Mine Disconnecting Switches.... 155
Safety Motor Starting Switches, Type W K-100.... 146
Safety Ore-Mine Switches.... 156
Safety Panels, Krantz Type C.... 167
Safety Panel Boards, Railway Type.... 172
Type S.... 157
Safety Spark Gaps.... 21
Safety Straps....1000
Schaper Forged Guy Clamps 960

Page

Screws, Lag.... 958
Secondary Relays.... 781
Section Insulators.... 931
Automatic.... 903
For Mines.... 901
Type H M.... 904
Type H R.... 899
Type H R-2.... 899
Type H S-2.... 933
Type H S-3.... 933
Type K B....900–932
Type K C-2.... 932
Type K D.... 899
Section Switches, Line.... 904
Self-Contained Meters.... 667
Senior Ornamental Tops...1196
Series Lamps, A.C. 1108
Series Lighting Circuit Lightning Arresters... 9
Series-Trip Oil Circuit-Breakers.... ... 293
Service Box Lugs.... 135
Service Box Plugs.... 135
Service Boxes.... 128
Steel.... 122
Service Switches.... 128
Sew-Motors....1372
Sewing-Machine Motors, Factory....1375
Shades, Lamp.... 571
Sherardizing.... 353
Shims, Pole.... 961
Short-Circuit Current Factors.... 292
Shovels, Hickory or Ash Handles....1001
Shunt Lead Holders.... 617
Shunt Supporting Brackets. 619
Shunt-Trip Cut-Out Switches.... 391
Shunts For D. C. Ammeters Type G.... 661
Portable Type P L.... 688
Use with P W Millivoltmeters.... 683
Signal and Shunt-Trip Cut-Out Switches.... 391
Signal-Contact Attachments Bell-Alarm.... 391
Signal Pedestals.... 559
Signal Switching Sets.... 559
Sign Lights, Sol-Lux....1182
Single Bo-Arrow Arms.... 966
Sleeves, Copper Bonding... 994
Splicing.... 887
Small Motor Accessories...1384
Small Motor-Generators...1382
Small Turbines For All Needs....1428
Snatch Blocks....1001
Socket Systems, Adjuster..1120
Socket Terminals.... 988
Sockets, Cutter Streethood.1144
Lamp.... 571

GENERAL INDEX—Continued

Page

Solder Pots....1332
Soldered Rail Bonds.... 986
Soldering Compounds.... 829
Solderless Connectors, Frankel.... 130
Solders....1337
Some Facts about Lightning.... 1
Spacing Bolts.... 958
Spade Handles For Knife Switches.... 114
Spanner and Wrench.... 142
Spark-Gap and Low Equivalent Lightning Arresters.... 11
Spark Gaps, Safety.... 21
Special Mounting Brackets. 392
Specifications For Wood Poles....1009
Speed Indicators, Electrical 701
Sphere Gaps, Type AK.... 35
Spherical Spark Gaps.... 801
Splicers, Trolley, Type U Trolley Wire.... 886
Splicing Clamps.... 998
Splicing Compound.... 836
Splicing Ears.... 888
Splicing Sleeves.... 887
Trolley Wire.... 142
Spool-Type Strain Insulators.... 941
Spoons, Post-Hole....1002
Square Plate Washers.... 959
Squirrel-Cage Induction Motors Type CS....1398
Stand Electric Power....1386
Standardization of Distribution Transformer.... 773
Standardized Electric Ovens1304
Standard Resistors for Railway Service....1090
Standard Watthour Meters, Portable.... 637
Starters for Squirrel-Cage Induction Motors....1422
Starting Equipment....1442
Steady Strains.... 920
Steady Strain Ears.... 921
Steady Strain Suspension.. 921
Steam Turbine Generator Units....1433
Steel Clad Heaters....1324
Steel Service Boxes.... 122
Steel Studs Sherardized.... 862
Steel Tackle Blocks....1001
Steel Towers and Outdoor Substations.... 443
Steel Trolley Wire....1007
Stillson Wrench.... 996
Stock Cut-Out Boxes.... 122
Stokers, Chain Grate....1430
Roney....1430
Underfeed....1430

Page

Stops for Type A Knife Switches.... 114
Storage of Insulating Oil... 813
Stoves, Disc....1255
Table....1252
Toaster....1251
Straight Line Ear Type F-3. 879
Type F-4.... 880
Type F-6.... 880
Straight Series Systems with Regulating for Transformer and Cutter Regent Film Socket 1131
Strain Ear, Type E.... 874
Type F.... 883
Strain Insulators, Brooklyn 942
Giant.... 939
Globe.... 940
Porcelain....1067
Porcelain Pin Type...1069
Spool Type.... 941
Suspension....1066
Wood.... 935
Strain Plates.... 961
Malleable Iron.... 878
Strain Yokes.... 954
Straps, Leg....1000
Safety....1000
Street Crooks....1205
Streethood Bodies, Cutter, Adjuster-Socket....1147
Multiple....1152
Series....1134
Streethood Brackets.1136, 1154
Streethood Sockets....1144
Streethoods, Advantages of 1132
Construction of Cutter
Cutter Multiple....1150
Series....1132
Cutter Series Suspension....1138
Suspension....1156
Street-Lighting Fixtures, Ornamental....1193
Street-Lighting, Mazda....1117
Street-Lighting Systems, Ornamental....1186
Street-Lighting Systems with Cutter Streethoods....1130
Studs, Sherardized.... 862
Sub-Panels for Battery Charging.... 492
For Motor Starting... 494
Sub-Stations, Outdoor.... 443
Supply Parts for Safety Panel Boards.... 166
Supports, Bus-Bar Type P 585
Feeder Tap.... 917
Insulated Middle.... 852
Pole....1003
Surface Condensers....1431
Suspension Details of Gyrating and Ceiling Fans..1239
Suspension Strain Insulators 1066

Page

Suspension Streethood, Cutter Multiple....1156
Cutter Series....1138
Suspension Type Insulators 1060
Suspension Strain Clamps.. 947
Suspensions Ceiling and Mine.... 859
Double Curve.... 857
Feeder.... 872
For Double Trolley Wire.... 858
High-Voltage Straight Line.... 853
Horizontal Pipe.... 863
Mine, Type B.... 861
Pipe Bracket, Type B. 863
Single Curve.... 857
Steady Strain.... 921
Suspensions, Strain.... 857
Type A.... 856
Type B.... 860
Type B Pipe Bracket.. 863
Type B Pipe.... 863
Type C.... 865
Type D.... 868
Vertical Type.... 863
Suspension Wire Clamps... 953
Type AD.... 953
Type FR.... 951
Swan Necks....1207
Switchboard Ammeters and Voltmeters Type GL.. 660
Type GM.... 660
Type SL.... 645
Switchboard Details.... 579
Switchboard Ground Detectors and Voltmeters 656
Switchboard Frames.... 572
Switchboard Frequency Meters.... 652
Switchboard Graphic Instruments.... 668
Switchboard Instruments Type AW.... 643
Type FW.... 644
Switchboard Mountings for Rheostats.... 618
Switchboard Power Factor Meters.... 653
Switchboard Reactive Factor Meters.... 654
Switchboard Synchronoscope.... 655
Switchboard Type Fuse Blocks.... 203
Switchboard Panels D. C... 519
Type EA.... 520
Type EB.... 521
Type EC.... 522
Type EE.... 523
Type EH.... 522
Type GC Synchronous Converters.... 525
Type GE Synchronous Converters.... 525
Type GD.... 518

Page

Switchboard Panels Type JA..... 505
Type JB..... 509
Type JD..... 455
Type JD Three Wire 477
Switchboard For Mines
Type JD..... 462
General..... 451
Safety..... 177
Theatre Safety..... 176
Westinghouse..... 451
Switch Dials..... 665
Switching Equipment and Automatic Protection. 463
Switch Oil H-F..... 834
15-F Special..... 834
Switches, Application Data 117
Automatic Time.....1280
Burke Horn Gap..... 403
Canopy.....1082
Control Type CS..... 563
Switches, Control Type 449-A.....1087
Control Type 494.....1085
Control Type 495.....1085
Control Type 543-A.1087
Disconnecting..... 215
Disconnecting Type M, O, P..... 225
Drum Reverse.....1425
Drum Type..... 230
Field Type A..... 212
Float.....1425
Full-Safety Entrance.. 149
Horn Gap Type AA... 418
Horn Gap Type AC... 421
Horn Gap Type B.... 404
Horn Gap Type IB... 408
Horn Gap Type C.... 413
Horn Gap Type V.... 415
Instruments..... 230
Knife..... 72
Knife, Motor Starter.. 211
Line-Section..... 904
Main Cutout Knife...1081
Motor Starter Type A and C..... 115
Push-Button Type.... 239
Railway Type.....1082
Reset.....1087
Safety Mine Disconnecting..... 155
Safety Motor Starting. 146
Safety Oil-Mine..... 156
Service..... 128
Signal and Shunt-Trip Cutout..... 391
Type A Front-Connected..... 72
Type A Front-Connected..... 74
Type A Rear-Connected..... 72
Type C Front-Connected.....73–85
Switching Sets, Signal..... 559
Swivel Brackets for Meters. 619
Swivel Carrying Hooks....1003
Swivel Lugs..... 137
Synchronoscope, Switchboard..... 655

Page

Synchronous Converter....1429
Synchronous Converter Panels..... 471
Synchronous Converter Switchboard Panel.... 525
Synchronous Motors.....1406
Synchronous Motor-Generators.....1429
Synchronous Motor-Panels. 469
Systems with Cutter Streethoods.....1130

T

Table Stoves.....1252
Tailors' Irons.....1335
Tamping Bars.....1002
Tap Insulators Feeder..... 852
Tap Support, Feeder..... 917
Tapes.....836
Cable..... 836
Friction..... 836
Splicing Compound... 836
Taps, Cable..... 139
Tee Connectors..... 604
Telephone and Feeder Overhead Construction.... 844
Temperature Indicators... 663
Temperature Relays..... 719
Terminal Connectors..... 141
Terminal Contact Nuts.... 605
Terminal-Insulating Tubes Micarta..... 391
Terminal Posts for Switchboard Small Wiring... 622
Terminals, Bus-Bar..... 603
Copper..... 605
Rail Bond..... 978
Socket..... 988
Testing Cup, Oil..... 803
Testing Insulators.....1013
Testing Insulating Oil..... 813
Testing Outfits..... 696
Theatre Switchboard..... 176
Thimbles, Drawn Steel Separable..... 970
Wire-Rope..... 960
Through Bolts..... 957
Time Constants of Exciters. 539
Time Recorders.....1099
Time Switches.....1280
Toaster Stoves.....1251
Toaster, Turnover.....1250
Toggle Bolts..... 129
Tongs, Type A..... 995
Tool Belts.....1000
Tools and Appliances, Bonding..... 989
Tools, Commutator.....1104
Linemen's..... 995
Totalizing Graphic Wattmeters..... 673
Towers, Steel..... 443
Traction Reel Locomotives 1416

Page

Traffic Posts.....1203
Train Line Junction Boxes. 1088
Train Line Receptacles and Jumpers.....1095
Transfer Relays, Type BT.. 718
Transformer Characteristics 292
Transformer Fuse Blocks and Boxes..... 66
Transformer-Trip Oil Circuit Breakers, Automatic..... 293
Non-Automatic..... 293
Transformers, Auto-Current for A-C Series Lamps 1108
Current..... 725
Distribution..... 745
Distribution, Instruction for Ordering....754
Dry-Type Indoor..... 739
For Adjuster Socket System.....1120
For A. C. Series Lamps 1108
For Control Circuit... 781
Oil Insulated.....737–739
Transformers, Power.....1432
Portable Current..... 742
Portable Voltage..... 734
Rectifier CC Regulating.....1111
Regulating.....1119
Semi-Portable..... 739
Voltage..... 738
Transmission Line Fittings. 946
Transmission Lines, Wood Pole Construction....1018
Trays for Coffee Percolators1249
Treated Cloth and Paper 824
Trip Coils..... 388
Trip-Magnet Frames..... 387
Trolley Brackets Broadway 1199
Trolley Ears Type E..... 873
Type EL-1..... 875
Type F..... 879
Type G..... 876
Westinghouse Composition..... 873
Trolley Frogs, Bronze..... 893
Detroit..... 891
Type DR..... 892
Type MK..... 895
Type RF..... 896
Type W..... 896
Trolley, Mine and Industrial Haulage.....1417
Nuttall Railway and Industrial.....1105
Trolley Protecting Armor.. 890
Trolley-Wire Chucks..... 890
Trolley-Wire Splicers...866–889
Trolley-Wire Splicing Sleeves142
Trolley-Wire Steel.....1007
Truing Device, Commutator.....1104
Tubes, Micarta Terminal-Insulating..... 391
Porcelain Floor.....1072
Porcelain Wall.....1071

GENERAL INDEX—Continued

Page

Turbines for All Needs....1428
Turbine Generator Units..1433
Turnbuckles, Drop Forged. 976
Insulated Type TC... 940
Turnover Toaster.....1250
Twin Terminal Bonds..... 987
Types of Overhead Construction..... 837
Typical Circuit-Breakers and Bus Structures.... 311
Typical Data of Complete Sets of Resistors.....1092

U

Unbalancing Resistors..... 37
Uninsulated Bolts..... 621
Universal Cross-Arm List.. 964
Universal Mounting Brackets..... 607
Untreated Cloth and Paper. 826
Urban Crooks.....1207
Utensils, Helpful Cooking..1287

V

Vapor Proof Fixtures.....1179
Vehicle Charing Panels.... 494
Ventilators.....1202
Ventura Electric Fans.....1370
Vertical Pipe Suspensions.. 863
Village Crooks.....1205
Voltage Measuring Devices 801
Voltage Regulator Panels.. 524

Page

Voltage Regulators..... 527
Voltage Relays..... 716
Voltage Transformers. ... 738
Portable..... 744
Voltmeters, Automobile... 642
Switchboard Type TG. 656
Switchboard Type GL and GM..... 660
Switchboard Type SL.. 645
Switchboard Type SM. 649

W

Wall Brace..... 612
Wall Bushing Condensor Type..... 645
Porcelain.....1070
Wall Tubes, Porcelain.....1071
Warmers, Chocolate.....1333
Warming Pads.....1257
Washers, Beveled..... 621
Centering..... 970
Lock..... 959
Round-Plate..... 959
Square-Plate..... 959
Water Heater. 1263, 1288, 1323
Water Heating.....1322
Watthour Demand Meter.. 630
Watthour Meters Demand. 630
Portable Standard.... 637
Prepayment..... 629
Recording-Demand... 633
Type CW-6..... 636
Type OA.....625 and 666

Page

Wattmeters, Graphic BC.. 671
Switchboard Type SM. 649
Totalizing Graphic Type M..... 673
Wearing Plates for Trolley Frogs and Crossings... 894
Welding Equipments, Arc..1395
Welding Panels, Outlet.... 484
Whirlwind 8-inch Fans....1230
Why I Use Westinghouse Appliances.....1266
Wire and Cable Data.....1005
Wire, Alloy-Fuse..... 59
Aluminum..... 59
Fuse..... 59
Nickel Silver..... 59
Trolley Steel.....1007
Wire Grips, Chicago..... 999
"Quick Samson"..... 999
Wire Rope Plants..... 959
Wire Rope Thimbles..... 960
Wire Splicers Trolley..... 889
Wood Pole Specifications..1009
Wood Strain Insulators.... 935
Wound-Rotor Induction Motors.....1405
Wrenches..... 142
Wrenches, Monkey..... 996
Steel CombinationLag-Screw..... 995
Steel Lag Screw..... 995
Stilson..... 996
Type BF..... 995
Type HB..... 995

Disc
& Gen
Index

Lightn'g
Arrest-
ers

SOME FACTS ABOUT LIGHTNING

Lightning, from the protective standpoint, is a term used to cover all kinds of disturbances in electrical transmission systems that take the form of high voltage. There are two kinds of lightning, viz: that due to atmospheric lightning, and that due to internal disturbances in the line itself. Lightning arresters are designed to take care of atmospheric lightning and those internal surges that are transient in nature, but not those that are continuous.

Atmospheric Lightning

1. **Cause**—Atmospheric lightning is due to discharges that occur between two oppositely charged clouds or between a cloud and the earth.

2. **Direct Strokes**—When a discharge from a cloud strikes an electrical conductor directly it almost always breaks down the insulation at or very near that point. It rarely travels along a transmission line far enough to reach an arrester and if it did it would probably destroy any type of arrester except possibly an electrolytic one. Arresters are not designed, therefore, to handle direct lightning strokes. It is usually the line insulators rather than the station apparatus that are injured by these direct strokes and they are best protected by overhead ground wires well and frequently grounded rather than by arresters.

3. **Induced Strokes**—By far the greater number of disturbances in transmission systems due to atmospheric lightning are induced therein by discharges between clouds overhead or between a cloud and the earth in the vicinity.

(a) The frequency of disturbances due to atmospheric lightning is always very high, i.e., hundreds of thousands of cycles per second. This is because there is little or no induction in the atmospheric discharge path.

(b) The voltage of induced disturbances varies all the way from very high values where the atmospheric discharge occurs close to the line, to a mere ripple in the case of discharges at a great distance. The energy is in almost all cases small, although the rate of energy is very high while it lasts. Both the voltage and the energy of an induced surge are reduced the farther it travels along a line.

(c) A surge induced by atmospheric lightning causes damage either because of its high voltage which punctures the insulation to ground or because of its high frequency which builds up a high voltage across the end turns of the first inductive winding it strikes, thus causing a breakdown between turns. In either case the power current follows through the puncture and a short-circuit or an internal surge is started that may cause great damage.

Internal Lightning

Internal surges are caused by any change in the load conditions. They may be either transient or continuous.

Transient surges are caused by sudden changes of load such as are occasioned by switching, the operation of circuit-breakers, etc. They are usually comparatively unimportant but may be quite severe where a very heavy current is broken suddenly.

Continuous surges are caused by arcing grounds which result in oscillations of great power at a frequency usually a few thousand cycles per second. This frequency is inherent in the line and is determined by the capacity resistance and inductance of the line. These are very destructive and frequently result from breakdowns of insulation caused by induced lightning. Lightning arresters (except the electrolytic for a limited time) cannot handle continuous discharges such as these without being destroyed by overheating. Arresters do protect against arcing grounds, however, by protecting against the induced surges that are their primary cause in so many cases.

On a transmission line another cause of trouble that results in a continuous high voltage is a displaced neutral due to a ground on one phase of an ungrounded neutral system. This raises the voltage of the other phases above ground abnormally. In the case of transformers of high ratio this effect may appear even on the opposite side of the transformer and cause arresters to discharge continuously and be destroyed without apparent cause, inasmuch as the ground may exist a great distance away and on a different circuit.

Lightning Arresters

The arresters described in this catalogue are designed to take care of atmospheric lightning and transient internal surges but not of continuous surges.

GROUND CONNECTIONS

FIG. 1—GROUND POINT AND CAP

Importance of Good Ground—Too much importance cannot be attached to the making of proper ground connections. These should be as short and straight as possible. A poor contact will render ineffective every effort made with choke coils and lightning arresters to divert the static electricity into the earth. It is important, therefore, not only to construct a good ground, but in doing so to appreciate thoroughly the necessity of avoiding unfavorable natural conditions. Many lightning arrester troubles are traceable directly to poor ground connections.

Connection to Existing Grounds—Direct connection to an underground pipe system (such as a city water main), furnishes excellent ground, because of the great surface of pipe in contact with the moist earth and the maximum number of alternative paths for the discharge. A supplementary ground line should always be connected to the structural steel framework of the station, and to any nearby trolley rails. In water-power plants the ground should always include a connection to the pipe line or penstock and to the case or frame of the apparatus to be protected.

Methods For Making Lightning Arrester Grounds

A. **Buried Plate**—A good ground connection for a bank of station arresters may be made as detailed in Fig. 2, in the following manner:

First, dig a hole four feet square as near the arrester as possible until permanently damp earth has been reached.

Second, cover the bottom of this hole to a depth of two feet with crushed coke or charcoal (about pea size).

Third, over this lay 10 square feet of tinned copper plate.

Fourth, solder or rivet the ground wire, perferably No. 0 copper, securely across the entire length of the ground plate.

Fifth, cover the ground plate with two feet of crushed coke or charcoal.

Sixth, fill the hole with earth, with plenty of common salt sprinkled in it, using running water to settle it.

The method given above of making a ground connection is simple and has been found to give excellent results, and yet if not made in proper soil it will prove of little value.

B. **Iron Pipe Ground**—A ground that is simple and very effective may be obtained by driving galvanized-iron pipe into the earth. The pipes should each have a galvanized-iron point and a brass cap with a lug for soldering, (see Fig. 1) malleable point, Style No. 157169, and brass cap Style No. 157170. Three-quarter-inch pipe is sufficiently large for this purpose. The pipes should be 8 to 10 feet long and should be driven into earth until about 6 inches is exposed. For station arresters a multiple-pipe ground should be used, the pipes spaced approximately 8 to 10 feet apart. An arrangement of 7 pipes in parallel is very good for this pur-

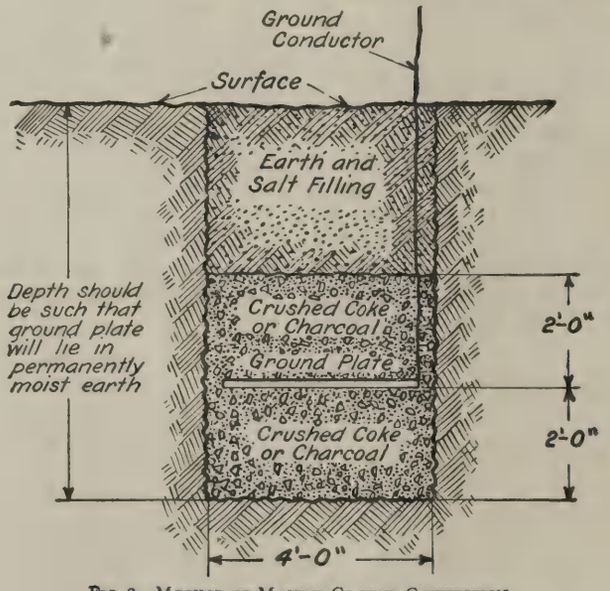


FIG. 2—METHOD OF MAKING GROUND CONNECTION

GROUND CONNECTIONS—Continued

pose; they may be arranged as shown in Fig. 3, an arrangement which is economical in space and wire. A single-pipe ground or any pipe of a group should have a resistance to an adjacent water pipe of not more than 15 to 30 ohms; two pipes in parallel not more than 7½ to 15 ohms; three pipes in parallel not more than 5 to 10 ohms; etc.

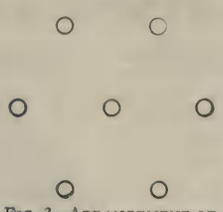


FIG. 3—ARRANGEMENT OF MULTIPLE PIPE GROUND

Sprinkle plenty of salt on the surface of the earth about points when pipes are driven. Sea water when available is admirably adapted for keeping the ground damp.

C. An excellent and conveniently made ground may be effected by utilization of a large, old iron casting, fitted with a riveted copper strap and buried in damp earth. A few pounds of common salt thrown around the ground terminal (before covering) helps to maintain a moist condition of the soil.

D. Other methods of making grounds may be mentioned. A good one can be made by unlaying the strands of a 500,000 circular mil copper cable for one foot or more from the end, and spreading the ends of the strands to form a flat circle. This end is then buried as prescribed for the copper plate. **Wrought iron pipes** driven deep in moist earth, and heavy copper ribbon so disposed and laid in coke or charcoal as to give a surface corresponding to the copper plate have been used with good results, but the necessity for locating in damp soil applies in each instance.

Proper Soil for Ground—The above method of making a ground connection is simple and cheap and has been found to be very effective; yet if it is not made in proper soil it will prove of little value. Clay even when wet, rock, sand, gravel, dry earth, and pure water are **not** suitable materials in which to place a lightning-arrester ground. Rich soil is the best. This soil should be damp and should contain some solution of acid, alkali, or salt; salt water is excellent for this purpose. When pipe grounds are driven, salt water should be poured around the pipes. As mentioned above, sea water when available is well suited for this purpose.

To replace the salt solution washed out of the soil, sprinkle plenty of crystal salt or common salt around the pipe, or better yet, place it in moist earth around the pipes just beneath the surface.

Grounding in Streams—When a mountain stream is conveniently near it is not uncommon to throw the ground plate into the stream. The practice results in poor contact, owing to the high resistance of pure water and the rocky bottom of the stream.

Ground Conductor—For the conductor between the arrester and the ground connection, either strap copper or copper tubing should be used. It is important that a conductor having the greatest possible superficial area be used, inasmuch as high frequency discharges are carried almost wholly on the surface of their conductor. Strap copper having a section say $\frac{1}{32}$ inch by 1½ inch makes a good conductor for the average condition. Such a ground conductor may be fastened directly to the station structure with wood-screws.

Do not run the ground lead of a lightning arrester in an iron pipe because the choking effect of the pipe at the high frequency of lightning will limit the freedom of discharge. The ground connection of a lightning arrester should be run as direct as possible, avoiding unnecessary bends or loops to reduce to a minimum the inductance of the circuit.

Record of Ground—When an earth connection is arranged it is an excellent plan to make an accurate record of its location, construction, and condition, so that later it may be easily accessible for inspection. Earth connections or "grounds" should be periodically examined, and tested for resistance at least once a year to ascertain their condition.

Inspection—The ground connection should be inspected from time to time and the resistance and earth connection tested for open circuits.

DIRECT-CURRENT LIGHTNING ARRESTERS

FOR RAILWAY AND LIGHTING CIRCUITS

For direct-current service, lightning arresters are required for comparatively low voltages, but of high discharge capacity. The most satisfactory arresters, in order to adequately protect motors, generators and rotaries, must have the ability to discharge static at the lowest possible voltage rise above normal operating voltage, without danger of the generator current following and destroying the arrester. In general direct-current arresters are of two kinds; first, those which allow the generator current to follow a discharge when normal voltage is established and then disrupt it; and, second, those in which the generator current does not follow a static discharge. The latter type requires no resistance in the static discharge path, as in the case of the first type, to limit the generator current, and, provides the greatest freedom for discharge of static and the lowest voltage discharge point. The Westinghouse direct-current arresters here listed are all of the second type, requiring no series resistance, and each represents, therefore, in its own field of application, the maximum protection possible.

Application

These arresters are arranged for mounting on cars (either on the roof or under the body), on poles, walls, and in stations. Car and pole type arresters are supplied for all voltages up to 1500, and station arresters for all voltages up to 2450.

For car mounting under all ordinary conditions the type MP arrester may be used up to 750 volts, with one or two arresters mounted on each car. These are provided for open or conduit wiring. Under severe conditions up to 750 volts, or where these or other arresters have given inadequate protection, and in all cases above 750 volts up to 1500 volts, the type K-3 arrester should be applied on cars, and will give the maximum protection possible. Car arresters should be provided in every case, as with the car in a position between two line arresters the impedance to the nearest arrester may very well be greater than through the car to ground by puncturing the insulation of apparatus on the car.

For pole mounting in addition to arresters on the cars, auxiliary protection should be supplied in the form of line arresters mounted about five to the mile. These arresters discharge static from the line, and relieve the car arresters from excessive duty, so that complete protection is more nearly assured to the apparatus on the car. The types MP and K-3 arresters, line mounting form, are used for this purpose, according to voltage or severity of conditions.

For mine haulage systems the line mounting types MP and K-3 arresters are used where the line and trolley run above ground, thus protecting the locomotives.

For power motors and other apparatus on the receiving end of direct-current circuits the wall mounting type MP or the wall or car mounting type K-3 arresters are used, thus offering three degrees of protection, according to the requirements of the installation or the allowable investment.

For station protection of generators, rotary converters and switchboards the type K-3 car mounting form of arrester affords adequate protection to small or medium sized stations. For maximum protection the type A electrolytic arrester should be used. It is unlimited in its application, and has greater discharge capacity than any other arrester offered for this purpose. One arrester should be installed in the station (or if the type K-3 is used it may be placed immediately outside) on each incoming line, and no additional arresters are required at the generator. Where only the generator or rotary converter is to be protected one set of arresters should be installed between each machine and the bus-bar.

For rotary converters—In addition to the protection of the machine from static disturbances in the manner above indicated, the type K-3 arrester may be used for special protection as follows:

Where the alternating-current side of a converter is supplied through a transformer of high primary voltage, there is often a tendency to flashover and break down, due to the condition that the transformer represents a condenser of considerable capacity in series with the rotary converter, which is a condenser of less capacity, and this distributes the voltage in an inverse ratio to the capacity; i. e., the rotary converter is subjected to high voltage strains, although not so well insulated as the transformer which is subjected to the lower voltage strain. By placing an additional condenser in multiple with the rotary, thus increasing the capacity, the voltage strain is better distributed, resulting in the more highly insulated transformer taking the greater strain. A one-microfarad condenser, such as the car mounting form type K-3 arrester, with the spark-gap short-circuited, will excellently answer the purpose. One condenser should be connected between each lead and ground on the alternating-current side of 600-volt direct-current rotary converters, and two condensers in the case of 1200 or 1500-volt rotaries.

To prevent flashovers on the direct-current commutator of a rotary converter arising from sudden overloads or short-circuits on the line near the station, the K-3 car mounting form of arrester may be used, and should be connected with the gap short-circuited, directly across the direct-current brushes inside the fields. The type A electrolytic arrester with charging gap short-circuited may be similarly used, but the condenser arrester should be satisfactory under the majority of conditions.

DIRECT-CURRENT LIGHTNING ARRESTERS—Continued

TYPE MP LIGHTNING ARRESTERS

100 to 750 Volts Direct or Alternating Current
For Car, Line, and Station Use

STYLE NO. 47417
FOR CAR MOUNTING

STYLE NO. 154297
FOR POLE MOUNTING

Description—These arresters are provided for use on voltages from 100 to 750, alternating or direct current. They are especially adapted, however, for protection of direct-current railway motors or power motors, and are arranged for mounting on either car, pole, or wall.

The type MP (or multipath) arrester consists of ground and gauged particles of carborundum held together by a binding compound, and shaped in the form of a disc, with metal plate terminals at each side of the disc. The binding compound is a dielectric, and is broken down between particles in the operation of these arresters so that this carborundum block consists of many arcing paths between the particles of carborundum. At a rise in voltage above normal, due to a static charge on the line, these gaps break down and provide a free discharge path to ground. Upon the voltage dropping to normal the arcs are broken, since they are so finely divided that they cannot be maintained at normal voltage and the size of the block is such as to carry off all discharges without heating. Since no generator current can follow the static discharge there is no noticeable surge such as caused by arresters which allow the power circuit to flow to ground and then disrupt it by mechanical means or magnetic blowout.

For voltages up to 400 the carborundum is used without additional gap. For voltages from 400 to 750 the arrester includes a single small gap between broad metal points in series with the carborundum block. Both arresters discharge at a lower rise above normal voltages than is possible with any other form of arrester, except the condenser and the electrolytic.

The only impedance to a static discharge in the MP arrester is the resistance of the arcs. This arrester has, therefore, the lowest equivalent gap and the maximum discharge capacity of any similar service, except the condenser and electrolytic types. The large diameter of the block gives a large cross-section of discharge path and a corresponding freedom of discharge.

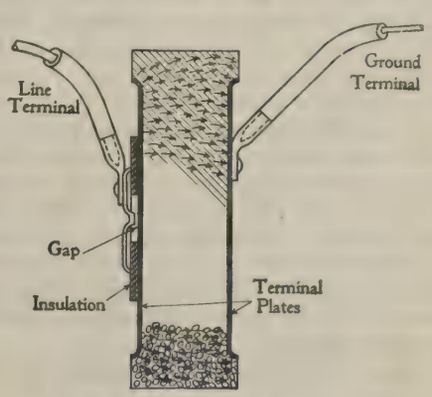
These arresters are contained in cast-iron boxes, which are practically unbreakable, and they are light in weight, small in size, and convenient, therefore, for handling and mounting. One-half of the casting can easily be removed, making access to the arrester easy for inspection or repairs. They are waterproof against rain or splashing of water from car wheels.

Mounting—Type MP arresters are furnished in three forms of mounting, as follows:

In the car mounting form for open wiring, the mounting lugs are on the top half of the casting, so that the arrester can be mounted on a floor sill. The bottom half can be opened for inspection.

When the arrester is mounted on the car roof a clearance of 4 inches is required for the removal of the lower half of the casting for inspection. If sufficient clearance can not be secured for the use of arrester Style No. 47417, arrester Style No. 154297 (for voltage 400 to 750) should be used. Both of the foregoing arresters are to be mounted in a vertical position.

For line and wall mounting the arrester is supplied similar to the car mounting form, except with the mounting lug on the bottom half of the casting. The upper half can be removed for inspection.



DISCHARGE PATHS IN TYPE MP ARRESTERS

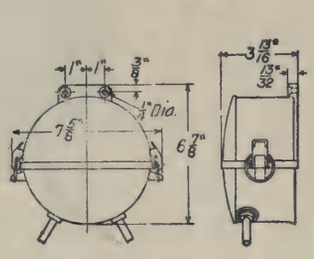
DIRECT-CURRENT LIGHTNING ARRESTERS—Continued

PRICES—TYPE MP ARRESTERS

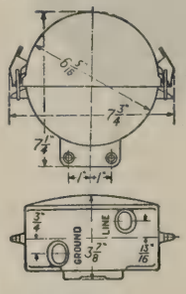
The style numbers and list prices include the arresters complete and ready for installation.

Volts	Mounting	Approx. Wt., Lbs. Net	Boxed	Style No.	List Price Each
100 to 400	On wall or pole	7½	9	230110	$8 75
100 to 400	On cars	7½	9	269573	8 75
400 to 750	On wall or pole	7½	9	154297	8 75
400 to 750	On cars	7½	9	47417	8 75
Carborundum block, for use in any of above arresters				247950	1 25

Order by Style Number



STYLE NO. 47417
STYLE NO. 269573



STYLE NO. 154297
STYLE NO. 230110

These dimensions are for reference only. For official dimensions apply to nearest district office.

TYPE K-3 LIGHTNING ARRESTERS

For Voltages Up to 1500

TYPE K-3 WITHOUT SPARK GAP OR RESISTANCE

Application—The type K-3 is for line, car, and station protection on direct-current circuits of 750 or 1500 volts. It is especially applicable for protection of direct-current railway and power motors, and for direct-current generators and rotary converters. When properly connected it is also valuable in preventing flash-overs on the commutator of rotary converters.

The type K-3 can be made extremely sensitive and after installation requires no attention except inspection. It handles only transient energy on the line, and does not allow passage of any power current. Thus this arrester does not cause any surges on the line, as do arresters that have to break heavy power arcs after each discharge. About five arresters per mile are recommended for line protection and one or two to each car. It can be mounted on top or under the car.

This type of arrester should be used where local conditions are so severe that higher degree of protection is justified than can be obtained with the lower-priced type MP arrester. The type K-3 arrester is equal in protective ability to an electrolytic arrester of the car-type in first-class condition, but is without any of the inconveniences of the electrolytic type for car service, and requires very little maintenance expense.

The type K-3 arresters are very effective for the protection of direct-current apparatus in stations of small to medium capacity and for direct-current lighting or power-circuit installations. For such application this arrester is only exceeded in protective value by the large size Westinghouse type A electrolytic arresters.

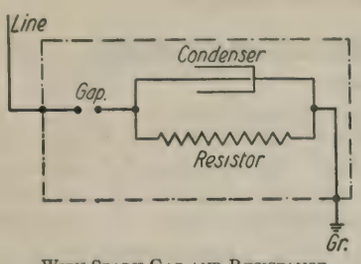
TYPE K-3 WITH SPARK GAP AND RESISTANCE, SHOWING ACCESSIBILITY OF SPARK-GAP CHAMBER FOR INSPECTION

Construction—The type K-3 arrester is of the condenser type and is supplied in two forms: One form consists of a condenser alone; the other consists of a condenser in series with a spark-gap, the condenser being shunted by a high resistance. (See diagrams of connections.)

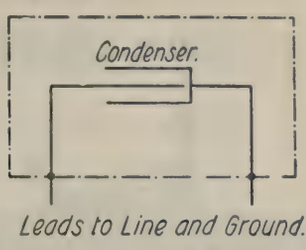
The condenser is of the flat plate unit-form, which, in case of burnout, is easily exchanged without the necessity of dismounting the arrester. The condensers in all the type K-3 arresters have a capacitance of one microfarad, which is equivalent in capacity to 100 miles of average line.

In the arrester without gap the condenser is connected directly across from line to ground, whether mounted on pole or car. Direct current cannot pass through a condenser, and there is, therefore, no leakage. The condenser is charged to normal

DIRECT-CURRENT LIGHTNING ARRESTERS—Continued



With Spark Gap and Resistance



Without Spark Gap or Resistance

Connections of Type K-3 Resistance

voltage, but as soon as static surges appear the condenser discharges these surges at any voltage above normal. The use of the arrester without gap is important in the protection of apparatus having weakened insulation. Many railway cars are operating with motors that will not stand a breakdown test at the voltage necessary to bridge an arrester gap, but with this type of arrester they are given protection.

In the arrester with gap the principal differences are that the condenser is always discharged and, therefore, affords a slightly increased capacity for discharge of any static wave of great volume. The use of the gap also provides a means for testing the operation of the arrester by the use of tell-tale papers and provides an easy way to make and break the circuit for testing the condenser. This arrester may be used with the gap short-circuited inasmuch as the resistance shunting the condenser is of such high value that only a negligible amount of direct current can flow and no heating results.

General—The arrester is mounted in a rectangular cast-iron box with a waterproof cover. The spark-gap chamber of the form having spark-gap is accessible by removing a small separate cover. The arrester can be easily mounted underneath the car or on the roof of the car, and is suitable for mounting in any position on car, pole, or wall.

Testing—The only way in which the type K-3 arresters can fail is by the open-circuiting or short-circuiting of the condenser.

An **open circuit** is extremely improbable, but can be determined by charging and discharging the condenser and observing the spark. In the gap-form of arrester with the gap open the condenser is kept discharged by the resistance and upon closing and opening the gap a spark of considerable intensity can be observed. In case the condenser is open-circuited and the resistance only in circuit, the spark will be very faint. In the type of arrester without gap or resistance the static spark through the condenser can only be observed upon making the circuit after breaking it and discharging the condenser. For this purpose the circuit should be opened between line and arrester, and the line lead from the arrester should be touched to any convenient ground thus short-circuiting the condenser and discharging it. With the condenser discharged the circuit to the line should be closed and the spark observed.

If the condenser has failed and has **short-circuited** it will have blown the fuse or if no fuse is provided it will have burned off a lead or opened the car breaker.

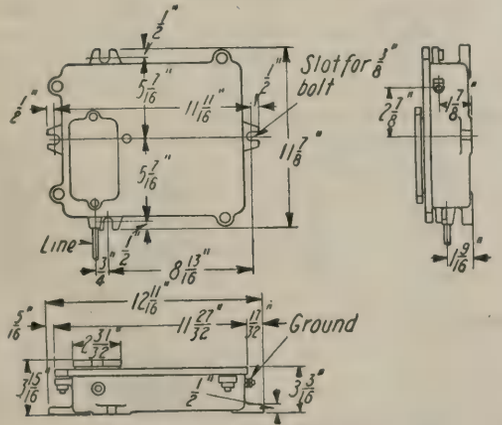
PRICES—Type K-3 Lightning Arresters

Style number and list price include the arrester complete as described, ready for installation.

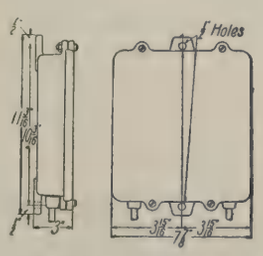
Volts	Description	Approx. Wt., Lb. Net	Approx. Wt., Lb. Boxed	Style No.	List Price
100– 750	Without gap or resistance	23	42	256368	$27 50
750–1500	Without gap or resistance	23	42	256369	37 50
100– 750	With gap and resistance	26	45	256371	51 50
750–1500	With gap and resistance	26	45	256372	61 00

Order by Style Number

OUTLINE DIMENSIONS



With Gap and Resistance



Without Gap or Resistance

DIRECT-CURRENT LIGHTNING ARRESTERS—Continued

TYPE A ELECTROLYTIC LIGHTNING ARRESTERS

For Voltages Up to 2450

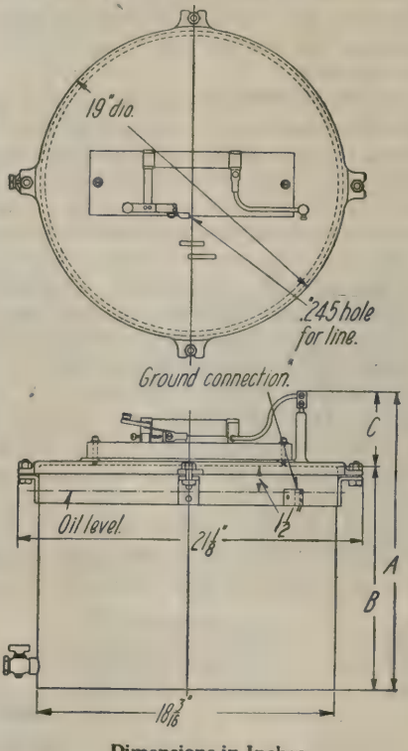
Description—These arresters are for use in generating stations or substations up to 2450 volts, and are provided for indoor mounting only. While listed for direct current use, the present form of arrester with spark gap may be used for low-voltage alternating-current installations, in which case the maximum voltage rating for each arrester should be reduced 10 per cent from that given.

The type A electrolytic arrester is entirely similar in construction to the type AK arresters for higher voltages, alternating current, described elsewhere, except that no charging resistance is required. The same aluminum trays are used, and these trays are mounted in an iron tank of ample strength, and of such size as to provide sufficient oil for cooling purposes under all possible operating conditions. The size of aluminum plate exposed to electrolyte is twice that of any other alternating-current aluminum arrester, and several times that of any other direct-current aluminum arrester, therefore this type A arrester exceeds in discharge capacity any other arrester for similar service. It is not limited like competing types to any particular kilowatt capacity of circuit.

The type A arrester is provided with a fuse mounted on top of a tank, and with a gap for insulating the arrester from the line. This gap can be easily short-circuited for the purpose of charging the arrester, which operation should be performed once a day. The arrester can be operated on direct current with the gap closed, but in this case the leakage current disintegrates the aluminum trays and the electrolyte, giving them a much shorter life than when a gap is used.

In addition to the daily charging of the arrester, it is necessary to inspect the condition of plate and replace the electrolyte about once a year. If the arrester is used with gap short-circuited, this period should be reduced to once in six months.

Outline Dimensions



Dimensions in Inches

No. of Trays	A	B	C
2 to 4	15¾	11¼	4½
5 to [illegible]	17½	13	4½

Prices

The style number and list prices include the arrester complete and ready for installation.

Voltage	No. of Trays	Electrolyte†	Gals. of Oil	Approx. W. Lbs.‡ Net.	Approx. W. Lbs.‡ Boxed	Style No.	List Price Each
0– 350	2	1	9	42	72	201555	[illegible] 75 00
350– 700	3	2	9	42	72	120830	79 00
700–1150	4	3	9	42	72	201556	83 50
1150–1400	5	4	13	42	83	201557	88 00
1400–1750	6	5	13	42	83	201558	92 00
1750–2100	7	6	13	42	83	165047	96 00
2100–2450	8	7	13	42	83	201559	100 00

Accessories

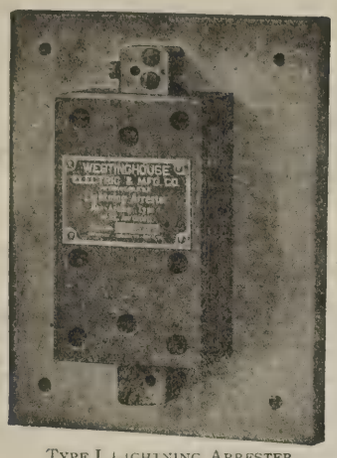
Cup for filling trays	125412	*
Aluminum tray (treated) without connection lug	229147	*
Aluminum tray (treated) with connection lug	229148	*
Type D electrolyte (8-ounce bottle)	141539	$0 50

*See prices of same style number listed under "Types AK and AL Lightning Arresters."
†Number of bottles of electrolyte style No. 141539.
‡Weights do not include oil or electrolyte. Net weight of oil, 7½ lbs. per gal.; shipping weight, 9 lbs. per gal.

Order by Style Number

SERIES LIGHTING CIRCUIT LIGHTNING ARRESTERS

FOR DIRECT-CURRENT AND ALTERNATING-CURRENT CIRCUITS



TYPE I LIGHTNING ARRESTER

TYPE J LIGHTNING ARRESTER

These arresters are for use on direct and alternating current series arc and Mazda lighting circuits.

Types I and J arresters are for **direct current** only. The type I arrester is mounted on a marble base for station use. The type J arrester is enclosed in a weatherproof box for outdoor use. They consist of two metal electrodes mounted on a lignum vitae block, flush with its surface. Charred or carbonized grooves between the electrodes provide a ready path for the discharge, while other grooves at right angles to the discharge path provide a vent for the discharge gases. A second block fitting closely over this mounting block so confines the gases produced by the discharge that they develop a very high pressure and are, accordingly, expelled violently through the grooves. As these grooves are at right angles to the normal discharge path the expulsion of the gases almost instantly disrupts the arc and stops the discharge. The absence of series resistance gives these resistors great freedom of discharge and increases their protective value, while the expulsion of the gases disrupts the arc so quickly that the discharge produces practically no visible effect on the operation of the lamps, as there is no time for movement of regulator of a rectified system, or of the regulating device of a brush arc machine. This makes these arresters much superior to the horn-gap type, inasmuch as the latter require the use of series resistance which considerably reduces their protective value, while the long time required for the arc to rise on the horns before breaking causes the regulator coils to move and seriously reduce the current through the arc lamps, in some cases interrupting the service.

Applications of Types I and J Arresters—When the maximum generated voltage at the arc lamp-circuit terminals or the brush arc machine or Cooper Hewitt constant-current regulator does not exceed the voltage given in the table below use the corresponding combination of arresters.

Max. Gen. Voltage	Combination of Arresters
4000 Volts	2 arresters connected as in Fig. B
7000 Volts	3 arresters connected as in Fig. C
10000 Volts	4 arresters connected as in Fig. D

Type C arresters are for **alternating-current** circuits only. They are provided for both indoor and outdoor mounting. The arrester for outdoor mounting is the standard style used on alternating-current lighting and power distribution lines, and is enclosed in a cast-iron box which is excellently weatherproof. The indoor arrester consists of a standard type C spark-gap unit mounted on a marble base so as to provide the necessary insulation.

The type C arrester consists of six spark gaps between knurled non-arcing metal cylinders and has no resistance in series with the gaps. It is especially applicable to alternating-current constant-current circuits, since the use of the non-arcing metal gaps disrupts the generator current which follows a static discharge, at the zero point of the first half cycle. While this arrester is limited in the capacity of the circuit upon which it can be applied when used on power lines, it is unlimited in its application to series lighting circuits, owing to the constant-current characteristics of the circuit. The elimination of the series resistance, therefore, makes this not only the simplest form of arrester, but an ideal one for the service.

SERIES LIGHTING CIRCUIT LIGHTNING ARRESTERS—Continued

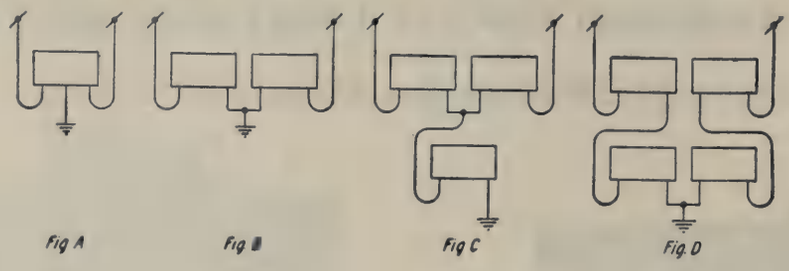


Fig A Fig B Fig C Fig D

Application of Type C Arresters—Where the maximum open-circuit voltage of the constant-current regulator does not exceed the voltage given in the table below, use the corresponding combination of arresters.

Max. Open Circuit	Combination of Arresters
2200 Volts	1 arrester connected as in Fig. A
4500 Volts	2 arresters connected as in Fig. B
8000 Volts	3 arresters connected as in Fig. C
11000 Volts	4 arresters connected as in Fig. D

Note—In all interconnected double-circuit constant-current regulators, the open circuit voltage is the maximum voltage that can be generated by the regulator and not the voltage of each of the two circuits.

When more than one arrester (type **I, J or C**) is used between each line and ground, the customer should provide extra insulation for the arrester next to the line by mounting it on wood.

PRICES

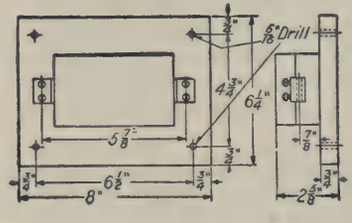
Style number and list price include lightning arrester complete, ready for installation.

Style No.	Type	Circuit	Mounting	List Price
1810	I	D.C.	Indoor	$14 75
1811	J	D.C.	Outdoor	14 75
241167	C	A.C.	Indoor	7 75
62133	C	A.C.	Outdoor	*

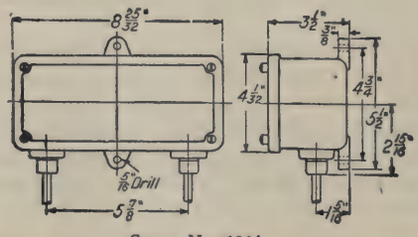
*See price of same style number listed under "Type C Lightning Arresters."

Order by Style Number

OUTLINE DIMENSIONS

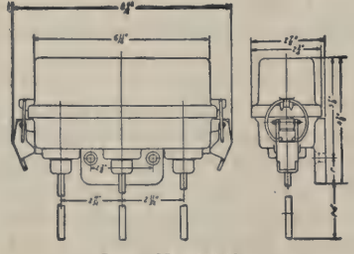


STYLE NO. 1810

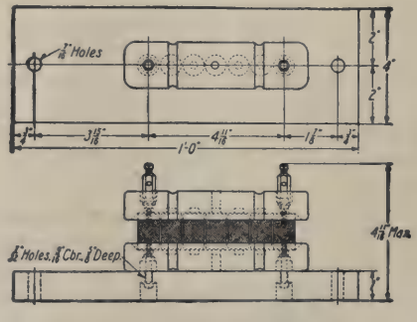


STYLE NO. 1811

Approximate weight, net 10 lbs.; boxed 15 lbs.



STYLE NO. 62133



STYLE NO. 241167

Approximate weight, net 7 lb.; boxed 9 lbs.

These dimensions are for reference only. For official dimensions apply to the nearest district office.

SPARK-GAP AND LOW EQUIVALENT LIGHTNING ARRESTERS

FOR A.C. LIGHT AND POWER CIRCUITS

These arresters are of two general types, classified according to their application. First, moderate priced arresters for protection of distributing transformers; second, high-capacity and high-voltage arresters for the protection of large transformers, generating apparatus, etc. The latter class must be higher in protective power than the former, owing to the greater importance and value of the apparatus protected, and these arresters are only exceeded in protective power by the electrolytic arresters, type AK, described elsewhere.

Application

Type MP arresters will give excellent protection when applied on alternating-current distributing circuits or transformer secondary circuits up to 750 volts. They are especially recommended for protection of low-voltage induction motors.

In the line of non-arcing metal multigap arresters the smaller and lower priced forms listed are applicable for protection of distributing transformers by mounting at the transformer and at intervals along the line. This application includes arresters types C, CR, G and W. For higher class protection, the type S or outdoor low-equivalent arresters are used at the transformer.

In the larger and more expensive forms, including the type S and the Low Equivalent arresters, the degree of protection offered is greater, and these arresters are, therefore, applicable for protection of station apparatus, such as transformers, which should be given high protection because of their importance in controlling an entire circuit, motors, small generators, rotaries, etc.

For protection of transformers on distributing circuits one single-pole arrester per phase or one multi-pole arrester should be used at the transformer and such additional arresters installed between transformers as will give a maximum of five sets to the mile of line.

For the protection of station apparatus, a set of arresters should be installed at the station on each incoming line or feeder, if full protection is required. If only the generators are to be protected, one arrester should be connected to each lead from generator to bus.

Distinctive Features

The distinctive features of Westinghouse arresters are: A variety designed to meet all requirements; arresters of the spark-gap type distinguished by the use of multiple gaps with gap electrodes of non-arcing metal; gap electrodes easily turned to present additional arcing surface, giving excellent life without renewal; resistances where used at lowest value compatible with protection of the arrester from destruction; equivalent spark-gap of each arrester lowest possible for the type of service for which the arrester is listed; resistance of a new and superior material; all arresters arranged for easy and safe inspection; all parts easily renewed when necessary and at low cost; outdoor arresters entirely rainproof, although easy of access.

Operation

All Spark-Gap and Low Equivalent arresters are of the non-arcing metal type, and consist of spark-gaps and non-inductive resistances mounted in various combinations.

The spark-gap points are made of an alloy, the fumes of which tend to extinguish an arc by failing to re-establish it after the zero point in the first half cycle. This quality avoids the necessity of special circuit-breaking devices with moving parts, and by confining the power arc to the limits of one-half cycle in time allow the use of a resistance smaller in size and of lower value than would ordinarily be required to carry the current without overheating.

These arresters are of four classes in their arrangement of gaps and resistances, as follows:

First—Series gaps only.

Second—Series gaps and series resistance.

Third—Series gaps and gaps shunted by resistance.

Fourth—Series gaps, series resistance, and gaps shunted by resistance.

In the first class is included the type C arrester. Such an arrester is limited in the kilovoltampere capacity of power behind the line, as there is no resistance within the arrester to limit the power current. In this arrester the static discharge across the series gaps to ground is followed by the power current, which, being properly limited in the application, is broken by the non-arcing gaps in the manner above indicated. This arrester affords most excellent protection within its limits of application, due to its great freedom of discharge.

The second class includes type CR and type W single-pole arresters, and type G multipole arresters. While not affording as free a discharge as arresters of the first and third classes, the series resistance of these arresters is necessary in order to allow their use on circuits of large capacity. The value of the resistance, however, is less than in the average arrester of the series resistance type, due to the use of non-arcing multiple gaps as explained above. The static discharge through these arresters, after passing the series gaps, goes through the resistance to ground, and the generator current which follows is limited by the resistance to a value that can be easily disrupted in the usual manner by the non-arcing gaps.

The third class includes the type S arresters, which, having no series resistances, are limited in the kilovoltampere capacity of the circuit upon

SPARK-GAP AND LOW EQUIVALENT LIGHTNING ARRESTERS—Continued

which they may be used to 2000 kilovoltampere of normal generator capacity. This rating can be increased by reactance of transformers or other apparatus in the circuit, or by any condition tending to limit the amount of power which can flow through the arrester on a short-circuit. This is explained very fully in the catalogue on oil circuit-breakers with regard to "breaking capacity."

In these arresters various steps of resistance are connected across the shunted gaps. Light discharges after closing the series gaps take the shunt resistance path to ground. Heavy discharges by breaking down the shunt gaps, find a free path to ground without resistance. When the power arc follows, however, the shunt gaps acting in addition to the series gaps quench it and shunt it to the resistance path. The resistances reduce the current to a value which the series gaps can easily disrupt.

The fourth class of arresters include the Low Equivalent arresters. These are similar to the third class, but include in addition a series resistor, and may, therefore, be used on circuits of greater capacity. (However, on modern circuits, of very large capacities the electrolytic form of arrester should be used). The operation is the same as in the case of the third class arresters, except that the series resistance helps the combined series and shunt resistance.

The low equivalent forms of arrester, including the type S and Low Equivalent arresters, represent the best protection known prior to the development of the electrolytic forms of arrester, and are still the most satisfactory which can be obtained in situations where the daily attention required by an electrolytic arrester cannot be given, such as isolated substations without attendants.

Construction

In all but the type W arresters the non-arcing metal-gap electrodes consist of knurled cylinders arranged so that they may be rotated after the exposed surface has been burned away by arcing. In the type W arrester non-arcing-metal cupped discs are used, thus giving without attention a very long arcing edge. Both forms of gaps, therefore, provide for long life without replacement.

The resistance rods used are of a new composition that is absolutely unaffected by high frequencies, and has an almost negligible temperature coefficient. These resistors also defy breakage more than the usual forms heretofore employed. They are mounted in fuse clips so as to be easily removed for inspection and replaced when broken.

All arresters are mounted with ample insulation, which consists of porcelain or marble in all except the type W arrester, where bakelized micarta and moulded spacers form the insulation.

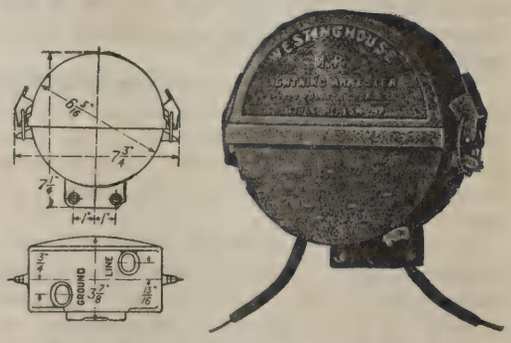
For the smaller outdoor arresters iron boxes are used on account of their unbreakable nature and facility for weatherproofing. In the larger outdoor arresters the usual form of wooden box is used, this being well made and entirely weatherproof. The type W, being a line suspension type of arrester, is made dampproof, and in the outdoor form is protected from direct action of rain by a metal hood. All exposed parts are weatherproof.

TYPE MP LIGHTNING ARRESTERS

Single Pole, for 100 to 750 Volts, A.C. or D.C.

For protection of alternating-current or direct-current circuits of 750 volts or under, the type MP arrester as given on pages describing arresters for railway service, is used with the following changes:

This arrester, which consists of a multitude of minute spark-gaps contained in a moulded carborundum block and a single series spark-gap between metal surfaces, is supplied for service from 400 to 750 volts, with the main gap open, which is the standard form as listed for railway use. For voltages up to 400 the main spark-gap is eliminated, leaving only the carborundum block gaps to be broken down by the static surge. At normal voltage these arresters provide perfect insulation from ground, while at a very small raise over normal voltage they will break down and discharge in a multitude of small arcs with great freedom, as no series resistance is used. Upon voltage dropping to normal the power current cannot follow, owing to the finely divided arcs. Therefore they provide great freedom of discharge, and are unlimited in capacity.



These dimensions are for reference only.
For official dimensions apply to the nearest district office.

They are especially recommended for 250-volt alternating-current or direct-current distributing systems; for alternating current 110, 220, 440 or 550 volt secondary circuits, and for 250-volt direct-current mine haulage systems.

Prices

Style No.	Description	Approx. Wt. Lbs. Net	Boxed	List Price
	Type MP lightning arrester for wall or pole mounting:			
230110	100 to 400 volts	7½	9	*
154297	400 to 750 volts	7½	9	*

*See price of same style number listed under "Type MP D.C. Arresters."

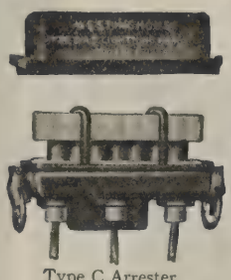
Order by Style Number

SPARK-GAP AND LOW EQUIVALENT LIGHTNING ARRESTERS—Continued

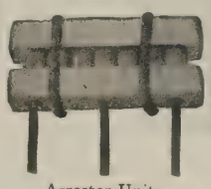
TYPE C LIGHTNING ARRESTERS

Double-Pole, for 1000 to 1250 Volts, 60 Cycles only
Single-Pole, for 1250 to 2500 Volts, 60 Cycles only
For Single Distributing Transformer Protection, Limited Application

The type C arresters are for use on 60-cycle circuits not exceeding 200 kilovoltamperes of station power when installed within 2 miles of the source of power. For each additional 100 kilovoltamperes of capacity there should be an additional mile of line before this type of arrester is applied. Where the generator capacity is over 200 kilovoltamperes and the distributing circuit is fed by transformers instead of direct by the generator, these arresters may be applied if the transformers are not over the following capacities. For arresters installed within one mile from the transformers the capacity of the transformer should not exceed 20 kilovoltamperes and for each additional mile of circuit an additional two kilovoltamperes of transformer capacity is allowable. These transformer capacities refer to transformers in the generating or substation, and not to the distributing transformers which the arresters are to protect. For circuits of larger capacity, or 25 cycles, types CR, G or S arresters are recommended.



Type C Arrester



Arrester Unit

Type C Arrester on Pole

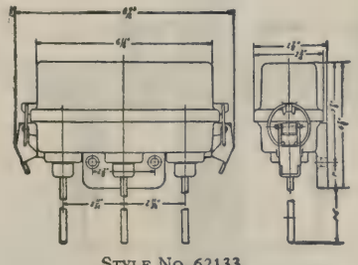
For application up to 1250 volts the arrester may be used double-pole by connecting middle lead to ground and each end lead to a line wire, thus giving three gaps in series. Above 1250 volts the arrester should be used single-pole by cutting out the middle lead, connecting one end lead to the line and the other end lead to ground, thus giving six gaps in series. The type C arresters cannot be used on 3-phase, 4-wire, 4000-volt, grounded-neutral circuits.

This arrester consists of seven non-arcing metal cylinders mounted on a porcelain base, encased in a weatherproof iron box arranged for mounting on pole or cross arm.

Separate resistors as listed below may be used for changing existing installations of type C arresters from limited to unlimited capacity. These are supplied in two forms—one being uninsulated, arranged with clip connectors at each end, one being attached to the line and the other to the line lead of the arrester. The other form is insulated, and supplied with flexible leads at each end instead of clips. Both are weatherproof.

In application, these resistors in series with three gaps make a complete arrester between line and ground up to 2500 volts, consequently, one type C arrester becomes double-pole instead of single-pole on 2500 volts, and the middle lead of the arrester should be used for ground connection. One type C arrester and two resistors are required for a 2-wire line, 1½ arresters and three resistors for a 3-wire line, and two arresters with four resistors for a 4-wire line.

These resistors may be mounted rigidly by the use of a mounting bracket. This bracket consists of a standard wood insulator pin and iron cradle arranged so that the resistor can be clamped in the cradle by the use of heavy cord. An ordinary glass insulator (not supplied with the bracket) is hung from the line and the mounting bracket screwed into same. This prevents the resistors swinging in the wind.



STYLE NO. 62133

Prices

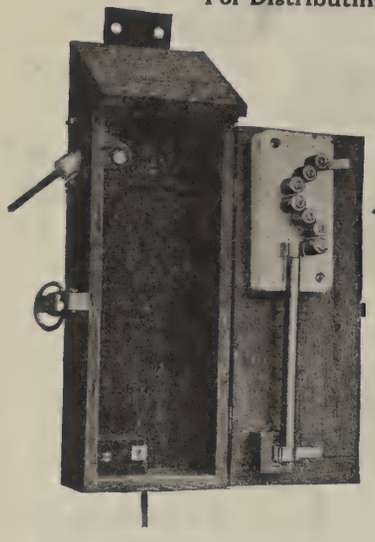
Style No.	Description	Approx. Wt. Lbs. Net	Approx. Wt. Lbs. Boxed	List Price
62133	Type C Arrester	7	9	$8 10
48231	Gap Unit	2½	3½	4 40
219533	Uninsulated Type C Arrester Resistor			2 90
	Insulated Type C Arrester Resistor			3 40
	Mounting Bracket for Resistors			75

Order by Style Number

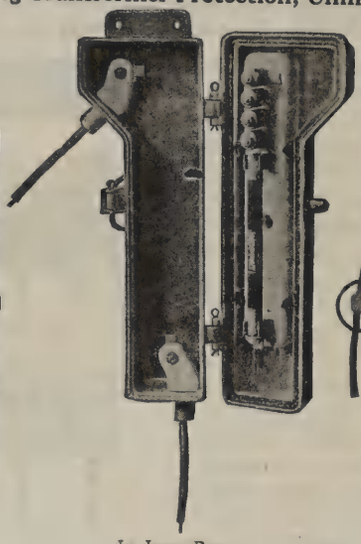
SPARK-GAP AND LOW EQUIVALENT LIGHTNING ARRESTERS—Continued

TYPE CR LIGHTNING ARRESTERS

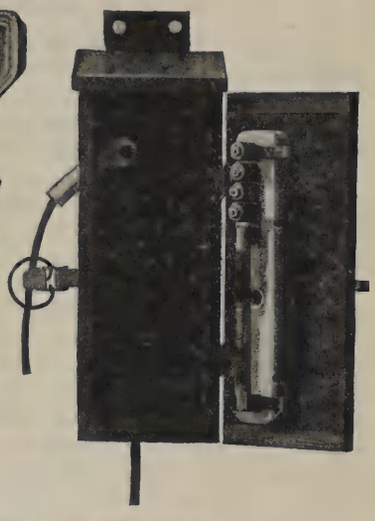
Single-Pole For 1000 to 5000 Volts, Any Frequency
For Distributing Transformer Protection, Unlimited Application



TYPE CR 5000-VOLT WOOD BOX ARRESIER



IN IRON BOX
TYPE CR 2500-VOLT ARRESTER SHOWING DOOR OPEN



IN WOOD BOX

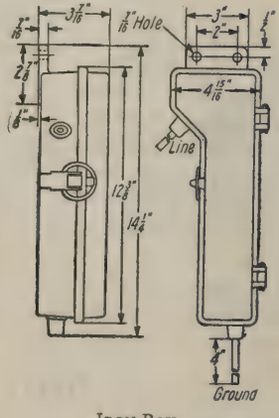
The type CR arresters are for use on any circuit of 2500 or 5000 volts maximum potential or under. The 2500-volt maximum potential arrester can be used on a 3-phase 4-wire 4000-volt grounded-neutral circuit when connected the same as for a 2500-volt 3-phase 3-wire circuit.

The 2500-volt maximum potential arrester is similar to the type C with the addition of series resistance, and consists of four knurled non-arcing metal cylinders mounted on a porcelain base, with a series resistor which is held in an enclosed fuse clip, the whole mounted in an iron box or a wooden box.

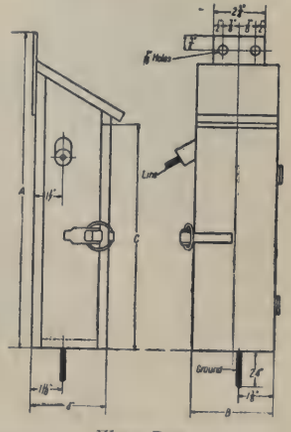
The 5000-volt maximum potential arrester is similar to the 2500-volt arrester except that seven knurled non-arcing metal cylinders and a larger resistor rod are used. This arrester is supplied mounted in a wooden box only.

In all these arresters the unit is mounted on the inside front cover so that it is automatically disconnected from the circuit when the box is opened. This makes inspection and repairs entirely safe for the linemen and is an especially desirable feature in an arrester of this type which ordinarily is used in considerable numbers on a line and receives routine inspections.

TYPE CR ARRESTER MOUNTED



IRON BOX



WOOD BOX

OUTLINE DIMENSIONS

Voltage	Description	Dimensions—Inches A	B	C	Approx. Wt.—Lb. Net	Boxed	Style No.	List Price
2500	Type CR Arrester, Iron Box	....	....	....	10	13	240916	$ 5 50
2500	Type CR Arreser, Wood Box	16⅞	4 ⅜	12 1/16	10	13	272985	8 50
2500	Gap Unit, including Resistor Rod	....	....	....	2	3	242017	4 80
2500	Resistor Rod	....	....	....	⅛	¼	210233	1 50
5000	Type CR Arrester, Wood Box	18 1/16	5½	13½	13	16	275976	13 50
5000	Gap Unit, not including Resistor Rod	....	....	....	3	4	280837	[illegible] 30
5000	Resistor Rod	....	....	....	¼	⅜	257788	[illegible] 30

SPARK-GAP AND LOW EQUIVALENT LIGHTNING ARRESTERS—Continued

TYPE G LIGHTNING ARRESTERS

Multipole, For 1000 to 2500 Volts, Any Frequency

For Distributing Transformer Protection, Unlimited Application

TWO-POLE TYPE G

THREE-POLE TYPE G

Type G arresters are for use on alternating-current circuits from 1000 to 2500 volts of any frequency, and of unlimited capacity. They are for the same application as the type CR arresters, but are made in multipole form only, making it necessary to install and use only one arrester, instead of two, three, or four single-pole arresters. The type G arresters can be used on 3-phase 4-wire 4000-volt grounded-neutral circuits.

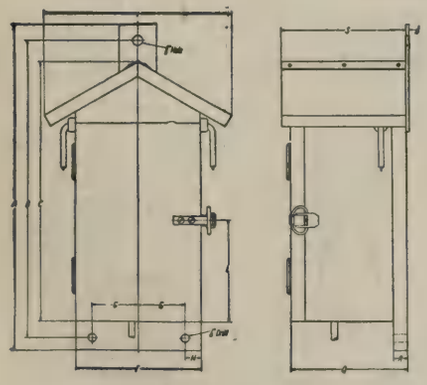
The non-arcing metal cylinders are supplied in sets of seven, with the middle cylinder connected to ground, so that one set is used for a 2-pole arrester; two sets for a 4-pole arrester; and two sets with one side disconnected for a 3-pole arrester. These arresters are for outdoor mounting on pole or cross arm. The gaps and resistors are mounted on a porcelain base with barriers between resistors. This base is encased in a weatherproof wooden box of good construction.

Prices

Description	Poles	Approx. Wt. Lbs. Net	Boxed	Style No.	List Price
Type G Arrester	2-pole	13¼	35	151225	$17 00
Type G Arrester	3-pole	25	57	151224	25 50
Type G Arrester	4-pole	25	57	151223	34 00
Gap Unit	.....	..	..	9587	*
Resistance Rod	.....	½	2	98062	†

*See price of same style number under "Type S Lightning Arresters."
†See price of same style number under "Low Equivalent Lightning Arresters"

TYPE G OUTLINE DIMENSIONS



Style No.	Dimensions in Inches A	B	C	F	G	H	I	L	Q	R	S
151225	19⅝	17⅞	15⅝	7½	2¾	1	11¼	6	7	⅞	7½
151224	22 9/16	20 1/16	18 1/16	11⅜	4⅞	13/16	15⅜	7	9¼	⅞	9½
151223	22 9/16	20 13/16	18 7/16	11⅜	4⅞	13/16	15⅜	7	9¼	⅛	9½

These dimensions are for reference only. For official dimensions apply to nearest district office.

Order by Style Number

SPARK-GAP AND LOW EQUIVALENT LIGHTNING ARRESTERS—Continued

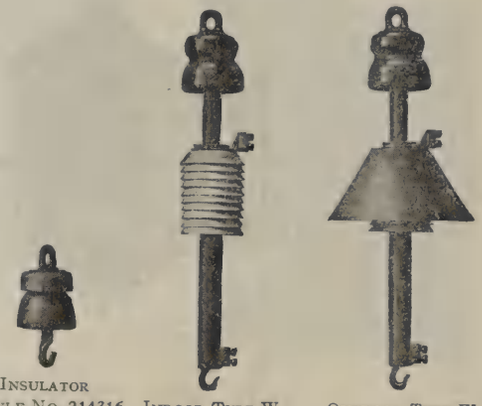
TYPE W LIGHTNING ARRESTERS

Single-Pole For 3000 to 13,200 Volts, Any Frequency

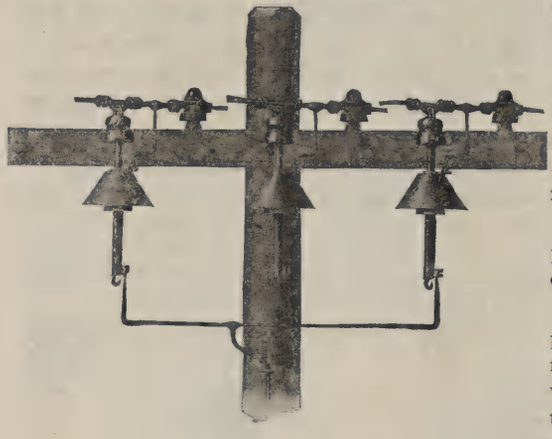
For Distributing Transformer Protection, Unlimited Application

The type W arresters are for use on alternating-current circuits of any frequency, and of unlimited capacity. A single unit may be used for voltages above 5000 and up to 6600, while two units in series may be used for voltages above 6600 and up to 13,200.

The type W arrester consists of a set of non-arcing-metal cupped discs mounted on a center insulating rod, with arcing gaps formed by molded insulating spacers. A resistor is connected in series, and encased in a weatherproof micarta tube. An eye at the top of the arrester, insulated by a porcelain cap, allows the arrester to be supported either from the line or from the cross arm, and no other form of mounting is necessary. When used for 13,200-volt circuits two arresters are mechanically hooked together, electrically connected in series and are supported from the line wire or cross arm by an insulator, Style number 214316, which provides the necessary insulation between line and arrester. Connection is made from the line to a binding post at the top of the arrester, and from a binding post at the bottom of the arrester to ground, the ground wire acting as a guy to hold the arrester from swinging. The type W arrester cannot be used on 3-phase, 4-wire, 11000-volt or higher grounded-neutral circuits in single units.



INSULATOR STYLE NO. 214316 — INDOOR TYPE W — OUTDOOR TYPE W



TYPE W ARRESTERS, MOUNTED

For outdoor service the standard arrester is provided with a metal rain shield, to prevent direct contact of rain or snow against the metal gaps.

This type W form of arrester represents adequate protection for transformers, and is of the most rugged and simple design possible, thus providing for the first time a moderate priced protection for distributing transformers of the higher voltages.

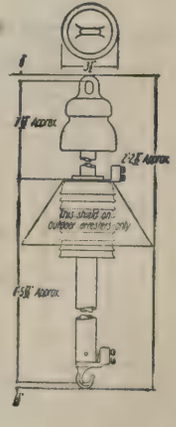
Style No.	Type	Voltage	Approx. Wt. Lbs. Net	Boxed	List Price
179914	Indoor	6600	9½	21½	$25 50
201673	Outdoor	6600	10	25	27 00
214316	Insulator*				†3 10

*For use with two type W arresters in series on 13,200 volt-circuits.

†Supplied without additional charge when specified on order for type W arresters in the quantity of one insulator for each set of two arresters.

OUTLINE DIMENSIONS

STYLE NO. 214316



Order by Style Number

TYPE S LIGHTNING ARRESTERS

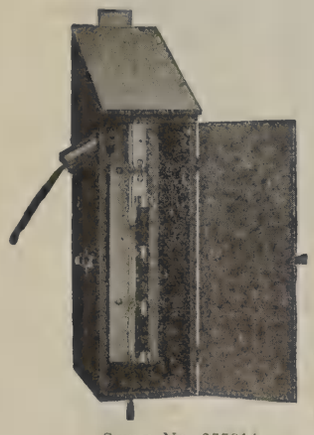
Single-Pole, For 2,000 to 7,500 Volts, Any Frequency

For Transformer or Station Protection, Limited Application

Type S lightning arresters are single-pole for use on alternating-current circuits of any frequency, from 2000 to 7500 volts but limited in capacity to 2000 kilovoltamperes in terms of normal generator capacity, except that where used on circuits connected to the secondary of transformers of not over 1000 kilovoltamperes capacity the generator capacity may be disregarded.

Type S unenclosed lightning arresters Style Nos. 100727 and 277817 are designed for indoor service but may also be used as safety spark-gaps on the same voltages for which they are here listed as lightning arresters, and with the same limitations as given above.

The type S arrester consists of a larger number of non-arcing metal cylinders, between which are formed the series gaps and shunt gaps (according to voltage), and rod resistors connected across the shunt-gaps. The cylinders are mounted in a porcelain container, and the resistors in enclosed fuse clips, both being mounted on a marble base. In the outdoor form this unit is encased in a weather-proof wooden box of good construction.



STYLE NO. 277814

STYLE NO. 277817

STYLE NO. 100727

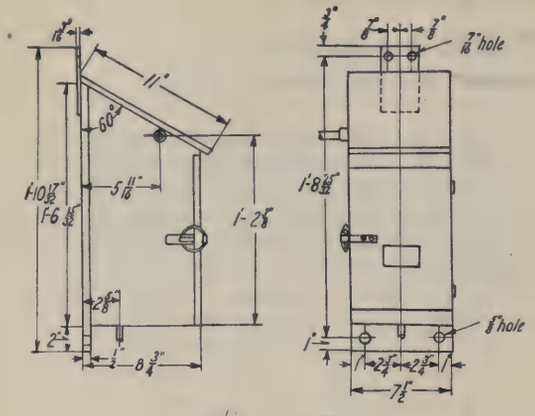
These are essentially low equivalent arresters, and where arresters of this type are desired for capacities greater than above stated the Low Equivalent arresters should be used. For circuits of greater capacity, where an arrester for less protective power may be used, the types CR, G or W should be used, according to voltage.

Prices—Type S Arresters

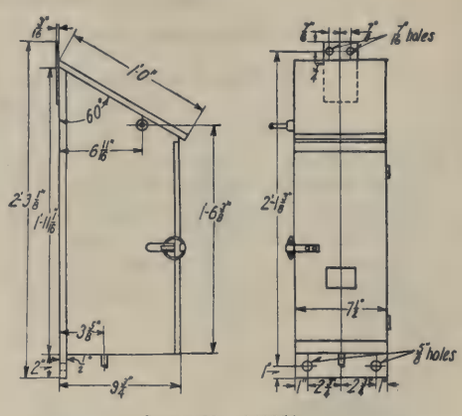
Voltage	INDOOR ARRESTERS Approx. Wt., Lbs. Net	Boxed	Style No.	List Price	OUTDOOR ARRESTERS Approx. Wt., Lbs. Net	Boxed	Style No.	List Price
2000–3500	14½	25	100727	$16 75	25	45	262067	$23 50
3500–5000	15	27	277817	25 75	30	50	262054	38 25
5000–7500	17	30	262063	38 25	33	55	277814	46 75

	Style No.	List Price
Gap unit	9587	$1 60
Resistance Rod	239186	1 00

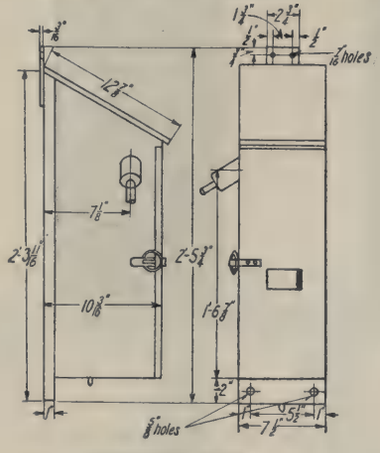
SPARK-GAP AND LOW EQUIVALENT LIGHTNING ARRESTERS—Continued



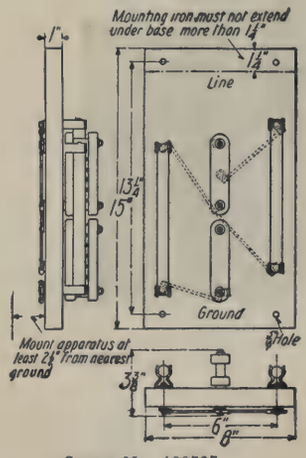
STYLE No. 262067



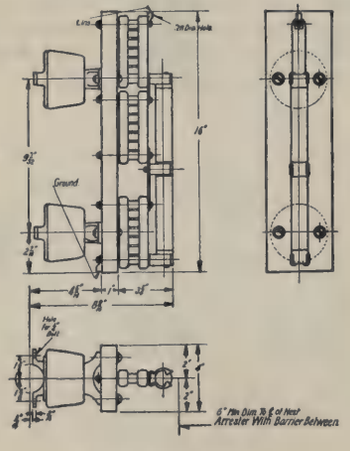
STYLE No. 262054



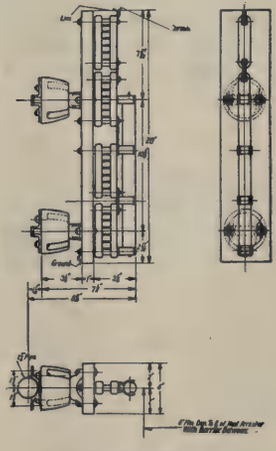
STYLE No. 277814



STYLE No. 100727



STYLE No. 277817



STYLE No. 262063

These dimensions are for reference only. For official dimensions refer to nearest district office.

LOW EQUIVALENT LIGHTNING ARRESTERS

Single-Pole, For 2000 to 39,000 Volts

For Protection of Transformers and Station Apparatus

STYLE NO. 201599

STYLE NO. 263045

The Low Equivalent arresters are for use on alternating-current circuits of any frequency, from 2000 to 39,000 volts and of unlimited capacity. Together with the limited capacity type S arresters they afford a degree of protection second only to the electrolytic arresters.

They are especially applicable for protection of small or moderate-sized stations, and for use where maximum protection is required, but where the daily attention necessitated by electrolytic arresters cannot be provided.

The outdoor form of this arrester provides in the higher voltages a more moderately priced high grade arrester than the electrolytic. In this form, therefore, it is especially applicable for protection of outdoor transformer substations.

It is recommended that a disconnecting switch be supplied with each arrester, in order to easily disconnect it from the line when desired.

These arresters consist of series and shunt-gaps between non-arcing metal cylinders mounted in porcelain containers; also series and shunt rod resistors mounted in enclosed fuse clips. Both the gap units and the resistors are mounted on a marble base. In the outdoor form this marble base is encased in a weatherproof wooden box of good construction.

Style numbers and list prices include arresters complete as described, ready for mounting, but do not include mounting bolts. In ordering state voltage upon which arresters are to be used.

Prices—Low Equivalent Arresters

	INDOOR ARRESTERS			OUTDOOR ARRESTERS		
Voltage	Style No.	Approx. Wt. Lb. Boxed	List Price	Style No.	Approx. Wt. Lb. Boxed	List Price
2000–3500	16598	150	$24 50	201597	240	$ 40 00
3500–5175	16599	160	33 50	201598	256	50 00
5175–7500	16600	175	50 00	201599	280	74 00
10,000–14,500	16602	225	80 00	201601	360	129 00
19,000–27,500	25028	375	220 00	201603	600	320 00
27,500–39,000	25029	450	240 00	263045	700	540 00
Gap Unit, Style No. 9587, all Voltages						*
Resistance Rod, Style No. 98062, 2000–7500 Volts						1 25
Resistance Rod, Style No. 210610, 10,000–14,500 Volts						1 50
Resistance Rod, Style No. 214245, 19,000–39,000 Volts						2 00
Tell-Tale Papers, Form No. 5491, for Shunted Gaps, per Pad of 50						1 50
Tell-Tale Papers, Form No. 5492, for Series Gaps, per Pad of 50						2 20

*See price of same style number shown under "Type S Lightning Arresters."

Order by Style Number

SPARK-GAP AND LOW EQUIVALENT LIGHTNING ARRESTERS—Continued

Outline Dimensions—Low Equivalent Arresters

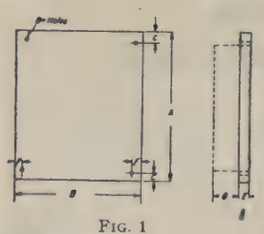


FIG. 1

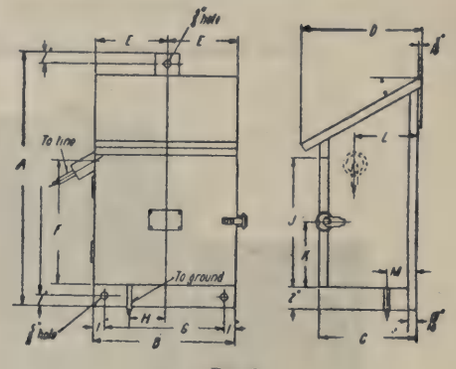


FIG. 3

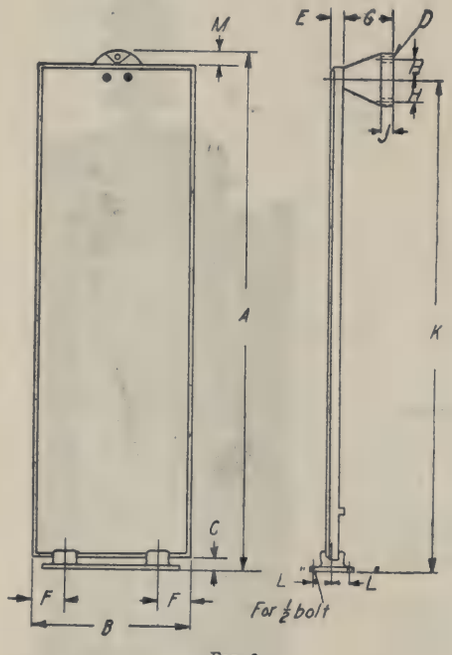


FIG. 2

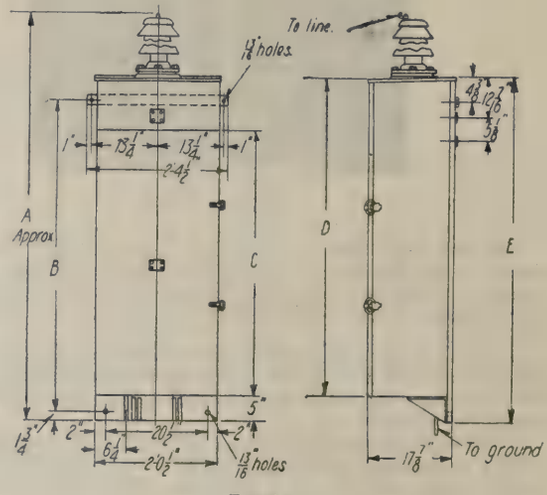
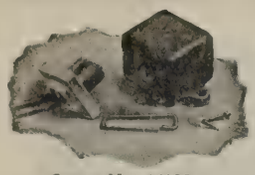


FIG. 4

Style No.	Dimensions in Inches											
	Fig.	A	B	C	D	E	F	G	H	J	K	L	M
16598	1	13	11	¾		1	¾	....	....	....	....	....	....
16599	1	20	8	¾		1	1	2	....	....	....	....	....
16600	1	32	10	1		1	1	3⅛	....	....	....	....	....
16602	2	32⅞	12	1⅛	½	1½	6	6	2	1⅜	29¾	1	1¾
25028	2	58⅞	18	1⅛	½	1½	3	5⅝	2	1⅜	55¾	1	1¾
25029	2	80⅞	18	1⅛	½	1½	3	12⅝	2	1⅜	77¾	1	1¾
201597	3	23½	18	9	11	6½	11¾	11	3¼	12	6	5	2
201598	3	29¾	11	9	11	5½	17¼	9	2	18¼	9⅛	5	2
201599	3	42	18	9	11	6½	25	11	3	30	15	2	2
201601	3	44	15	13	15¾	7½	26¼	13	4¼	29	14½	3	5
201603	4	102	71⅜	57½	72	77½	....	....	....	....	....	....	....
263045	4	127	93⅜	79½	94	99⅛	....	....	....	....	....	....	....

SAFETY SPARK GAPS



STYLE No. 46185

STYLE No. 4753

It is well known that with transformers, operating on high voltage lines with ungrounded neutral, and having large ratios of transformation, there may occur, on the low tension side, momentary voltages to ground, called "static disturbances", greatly in excess of the normal voltage. In general they are the result of a change in the static balance of the high-tension side and its connecting circuits. Unless certain precautions are taken, such a static disturbance on the low tension side may cause serious stresses in the secondary insulation of a transformer with ratio of transformation more than 5 to 1, because the insulation of its secondary is less able to withstand them.

A method of relieving this disturbance is to connect a discharge spark gap between some point of the low tension side of the transformer to be protected (a middle or neutral point, if one is available) and the ground. The spark-gap opening is such that any voltage very much in excess of the maximum normal will cause a discharge to ground, and thus the low tension side is practically tied to ground during such disturbance, while at other times it is ungrounded. It is the usual practice to ground the secondaries of low tension lines and spark gaps are not required in such cases.

The spark gaps style numbers 4753 and 46185 are designed for use on transformer secondary circuits and for protecting individual series arc lamps. These spark gaps are single-pole, and consist of two cylinders of non-arcing metal with an air-gap between. One of the cylinders is connected to ground the other to the line.

Type S unenclosed lightning arresters, Style Nos. 100727, 277817 and 262063 are used as safety spark gaps on the same voltages for which they are listed as lightning arresters and with the same limitations as given for type S lightning arresters.

Style number and list price include spark gap complete and ready for installation.

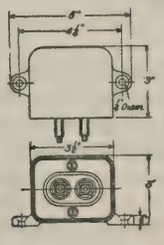
Prices

Style No.	Type	Voltage	List Price
46185	Outdoor	0-1100	$ 3 75
4753	Indoor	0-1100	14 50
100727	Indoor	1100-3500	*
277817	Indoor	5000†	*
262063	Indoor	7500†	*

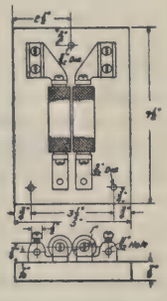
For voltages above 7500 a spark gap is not ordinarily used. Special recommendations will be made for such voltages.

Order by Style Number

OUTLINE DIMENSIONS



STYLE No. 46185
Approx. Shipping
Wt.—5 Pounds



STYLE No. 4753
Approx. Shipping
Wt.—15 Pounds

These dimensions are for reference only. For official dimensions apply to the nearest district office.

*See price of same style number shown under "Type S Lightning Arresters."
Maximum Voltage.

FUSE-TYPE LIGHTNING ARRESTERS

SINGLE POLE, FOR ALTERNATING-CURRENT RAILWAY AND POWER SYSTEMS

For Voltages up to 22,000

Application—In single phase railway work the fuse-type arrester meets the demand for a simple low-priced, yet effective device for protection from the effects of lightning discharge or overvoltage. As the lines between transformer sub-stations and cars are most in need of protection, in order to drain the trolley wire of dangerous static discharges and thoroughly protect the cars, these arresters should be placed at frequent intervals along the track so that a car is never further than 1000 feet from an arrester.

For use on alternating current lighting and power systems the fuse-type arrester should be considered an auxillary to the standard form of arrester, providing extra protection and reducing the severity of discharge reaching the station arresters. These arresters can be of considerable value if their use is not taken as a reason for omitting the usual methods of protection, since after the fuse is blown no protection is given by this arrester until the fuse is replaced. This fuse-type arrester would, therefore, be applied at special danger points on a transmission line, such as on hill tops. The blowing of the small fuse used takes place so quickly that synchronous apparatus is not effected. The use of a horn gap makes this arrester applicable to both grounded and ungrounded neutral lines.

Operation—The horn gap holds the normal voltage but breaks over completely when the voltage is excessive. This horn gap, as will be seen from the illustration, can be adjusted for any normal voltage from 0 to 22,000 and fastened by lock nuts. The fuse permits the lightning discharge to go freely to ground, but the short circuit is opened immediately after the discharge passes by the blowing of the fuse which releases the tube. The action of the breaker is positive and direct without chance of failure.

The fuse should be of about No. 28 B. & S. copper wire. When the fuse blows, the trigger at the bottom is released and the tube swings out to a vertical position thus indicating that a new fuse is needed. The tube may then be removed from the trunion with a pair of wooden fuse tongs, a new fuse inserted, and the tube replaced. The fuse tube is made of Micarta.

Advantages and Disadvantages—The fuse-type arrester has the advantages that it is simple low-priced, and does the work without the danger of permanently grounding the line. It has the disadvantage that the arrester is useless for further service until the fuse has been replaced. On this account it will be necessary to use a sufficient number of arresters to prevent them all being blown in one storm and then to inspect them regularly. This involves considerable labor but no arrester in giving the desired protection will be free from the necessity of such inspection.

Mounting—The arrester should be mounted on the pole high enough to be out of reach except by using the fuse tongs.

PRICES

Style number and price include lightning arrester complete, as illustrated.

Style No.	Volts	List Price
48814	6600	$22 00
93590	11000	24 00
190159	22000	29 00

The voltage of the circuit should always be specified when ordering this arrester.

Order by Style Number

LIGHTNING ARRESTER FITTINGS

GROUND PLATE

GROUND POINT AND CAP

POLE BAND

The fittings listed herein provide simple and sufficient means of effecting a good ground and also a substantial but inexpensive method of mounting the types MP, C, and CR lightning arresters on iron poles.

Ground Plate—This plate consists of a circular piece of cast iron, 12 inches in diameter, ¾ inches thick with a ¾ inch pipe tap in the center for connecting to the arrester. The surface is increased by means of corrugations, as shown in the accompanying illustrations, to 336 square inches, affording ample contact with the earth, and capable of taking care of all discharges through the arrester.

The plate should preferably be buried at the foot of the pole so that the ground wire runs to it in a straight line from the arrester. Care should, of course, be taken to see that the earth in which the plate is buried is damp.

If the ground wire is placed within the pipe leading to the ground plate it should be soldered to a cap at the top of the pipe to eliminate the inductive effect due to the wire being surrounded by the iron.

Ground Point and Cap—The simplest and most effective method of securing a good ground for line arresters is by means of an iron pipe with a malleable iron point having a dipped galvanized finish, and a brass cap with a lug for soldering the ground wire.

The pipe may be driven into the earth, or if it is too hard to permit driving, a hole may be dug and the pipe placed therein. It should extend from eight to ten feet above and below the earth to secure, respectively, a good ground and prevent any tampering with the ground wire.

Should it be desired to make use of a longer pipe which would be inconvenient to drive into the earth two pieces can be used and connected together by a coupling.

The brass cap and malleable iron point are tapped for use with ¾-inch pipe.

Iron Pole Bands for MP, C and CR Arresters—For affording a convenient and ready method of mounting the types MP, C and CR arresters on iron poles of various diameters, there are listed below three-pole band brackets. These brackets consist of two semi-circular light iron straps which are clasped around the pole and tightened by means of two bolts and nuts.

The arrester is mounted on the flattened part and secured thereto by bolts.

PRICES

Style No.	Description	Weight, Pounds Net	Weight, Pounds Shipping	List Price Per 100
157171	Ground plate	7	13	$188 00
157170	Brass Cap	½	½	67 00
157169	Malleable point	1		102 00
157172	6⅝-inch diameter pole band	2	2	157 00
157173	7⅝-inch diameter pole band	2⅛	2⅛	160 00
157174	8⅝-inch diameter pole band	2¼	2¼	163 00

Order by Style Number

LIGHTNING ARRESTER FITTINGS—Continued

APPROXIMATE DIMENSIONS

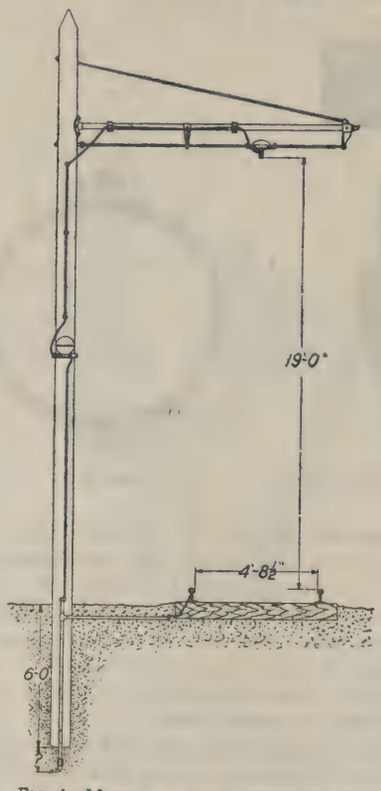


FIG. 4—METHOD OF MOUNTING TYPE MP ARRESTER ON IRON POLE

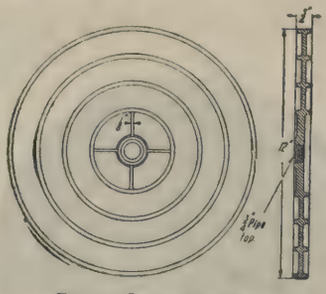


FIG. 5—GROUND PLATE

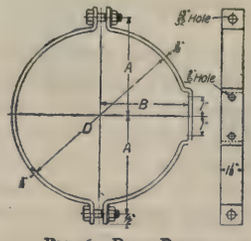


FIG. 6—POLE BAND

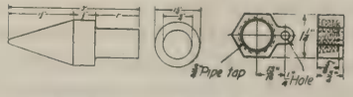


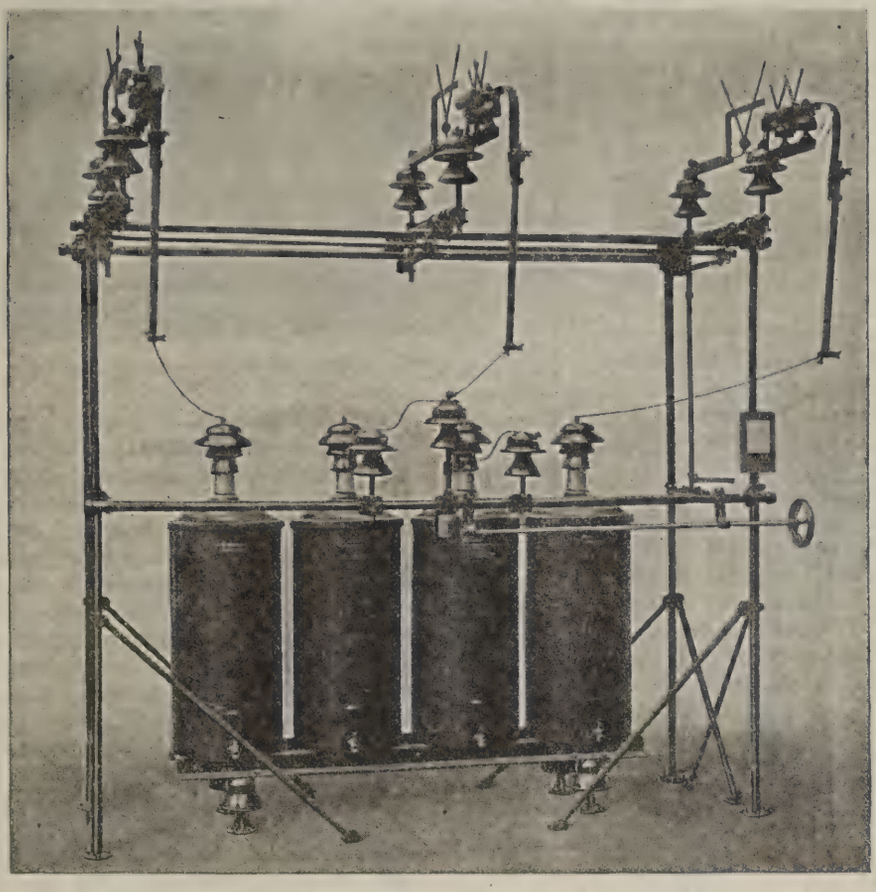
FIG. 7—GROUND POINT AND CAP

These dimensions are for reference only.
For official dimensions apply to the nearest district office.

	Dimensions in Inches		
Style No.	A	B	D
157172	4	3½	6⅝
157173	4½	4	7⅝
157174	4	4½	8⅝

TYPES AK AND AL ELECTROLYTIC LIGHTNING ARRESTERS

FOR A.C. LIGHT AND POWER CIRCUITS



TYPE AK ELECTROLYTIC LIGHTNING ARRESTER FOR 15001 TO 25000-VOLT SERVICE

Electrolytic lightning arresters are recommended for stations of large capacity operating at 1000 volts and above, particularly where generators are to be protected. If properly maintained, they excel every other known device in the protection given from lightning and all kinds of static disturbance.

Essential Properties—There are two essential properties inherent in the electrolytic arrester that make it virtually an electric safety valve: first, it offers a very high resistance to the flow of current at normal voltages and a very low resistance at abnormal voltages, the change in resistance being instantaneous with the change in voltage; second, it acts as a condenser, so that its effective resistance to current at low (normal) frequencies is great, but to currents at high (abnormal) frequencies such as the frequencies of static disturbances, it is small. These vital properties are due to films electrochemically deposited on aluminum trays in the arrester.

The distinctive features of the type AK arrester are: **An inorganic electrolyte** that is more stable chemically, less affected by heat, and which causes less dissolution of the film between charging periods than any electrolyte previously on the market; double cone-shaped aluminum tray. the area exposed to electrolyte being double that of any other arrester; trays spaced by porcelain pieces and not touching wood; ventilating duct in center of tray stack for additional circulation of oil; tank linings of bakelite micarta, impervious to moisture; charge and-discharge resistor on all arresters; fuses included with all arresters; the use of sphere gaps on arresters, 15001 volts and above.

Application of Arresters—All listed three-phase arresters are adapted for grounded or ungrounded neutral service. These arresters consist of four elements, one connected to each phase with the fourth element connected between the common point of the three and ground.

For three-phase four-wire solidly grounded neutral service a special arrester of three elements, when desired, can be supplied at a lower expense than the four-element arrester listed. These arresters are supplied with elements sufficient to stand full voltage between each phase and ground. Dimensions and price upon application.

TYPES AK AND AL ELECTROLYTIC LIGHTNING ARRESTERS—Continued

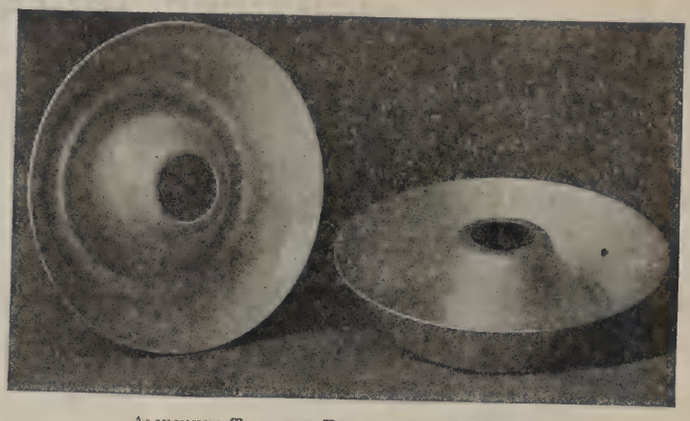
Application Voltage—In applying type AK electrolytic lightning arresters, it should be carefully borne in mind that it is not the normal operating voltage of the circuit that determines the rating of the arrester to be used. The maximum rated voltage of the arrester must be at least equal to the maximum operating voltage that may exist at any time at the point where the arrester is installed. This maximum voltage usually occurs at the time of no-load and is equal approximately to the voltage of the generator or transformer feeding the line upon which the arrester is installed. On long transmission lines of considerable electrostatic capacity, the maximum voltage at the end of the line farthest from the generator or transformer may be even higher at times of no load. Where this condition is known to exist and the maximum rated voltage of an arrester is very near the maximum line voltage, it is recommended that an arrester for the next higher voltage be installed.

It is the practice of some operating companies to purchase arresters for the ultimate voltage of their lines and then operate the arresters at the present line voltage which is materially lower than the ultimate. When the foregoing condition exists it is recommended that (1st) when the lines will be changed to the higher voltage within one year from date of delivery, the higher voltage arrester be purchased and used complete; and (2nd), when the lines will not be changed to the higher voltage within one year from date of delivery the higher voltage arrester with trays omitted to make the arrester directly applicable at the service voltage be purchased complete. Under the second condition of purchase the necessary additional trays can be inserted for use on full voltage with little trouble when wanted.

STRUCTURE USED FOR VOLTAGES UP TO 7500

This shows aluminum trays nested in wooden supporting frame for a 7500-volt ungrounded neutral arrester.

All test guarantees are based on the nominal voltage, but the arresters may be used on voltages up to the maximum.

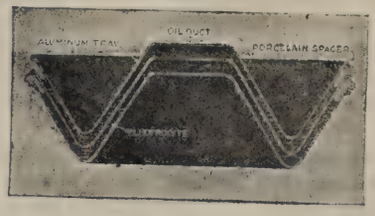


ALUMINUM TRAY FOR ELECTROLYTIC ARRESTER
(STYLE NO. 229147)

General Construction—The type AK electrolytic lightning arrester consists of a system of nested aluminum cup-shaped trays (supported on porcelain and secured in frames of treated wood) arranged in a steel tank. The system of trays is electrically connected between line and ground, and between line and line. These trays contain a liquid electrolyte which, on charging the arrester, forms a film on their surfaces. This film prevents flow of current at normal voltages but forms a free path for abnormal voltages or static discharges. Upon cessation of the abnormal stress, the film regains its original resistance practically instantaneously and prevents power current from following the discharge.

Type AK arresters equipped with sphere gaps are listed herein for voltages of 15,001 volts and above. Arresters with horn gaps are listed up to and including 15,000 volts. The gaps are so arranged that they are readily adjustable for any line voltage, and are provided with charge-and-discharge resistors on all arresters. Suitable mounting supports carry the sphere or horn gaps and their accessories.

Arrangement of Tanks—On indoor arresters for three-phase circuits up to 7500 volts, the electrolytic elements are contained in one grounded tank. On indoor arresters for three-phase circuits for 7501 to 15,000 volts, two grounded tanks are used. On three-phase indoor arresters of 15,001 volts and higher, four ungrounded tanks are used one for each phase leg of the system and a ground leg. On all listed single-phase and two-phase arresters, one ungrounded tank is used.



CROSS-SECTION OF TRAYS SHOWING SPACES

TYPES AK AND AL ELECTROLYTIC LIGHTNING ARRESTERS—Continued

Arresters for outdoor service are the same as indoor arresters except that outdoor insulators are provided on terminals. They are not provided for voltages of less than 5001. For voltages below this, the gaps cannot, with safety, be set close enough together out of doors to take advantage of the freedom of discharge of the electrolytic element. If the horn gaps are set too close together, they are short-circuited by rain. If type AK arresters for less than 5001 volts must be installed out of doors, a shelter should be built for their protection.

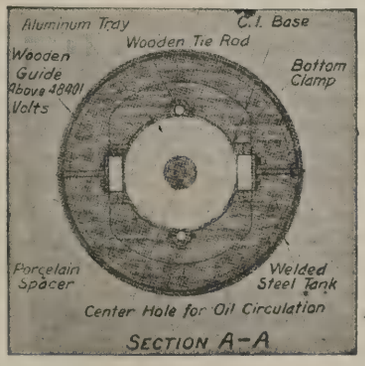
Horn and sphere gap structures for indoor arresters for voltages up to 15,000 and outdoor arresters for voltages up to 7,500 are arranged for wall mounting. Horn and sphere gap structures are self-supporting on indoor arresters of 15,001 to 25,000 volts and outdoor arresters of 7301 to 69,300 volts. The vertical pipe or structural steel for horn and sphere gap structures is not furnished on indoor arresters for voltages above 25,000 and outdoor arresters for voltages above 69,300.

The supporting structure for the transfer switch and the "footstep bearing" structure for the horn or sphere gap short-circuiting device is furnished on all arresters.

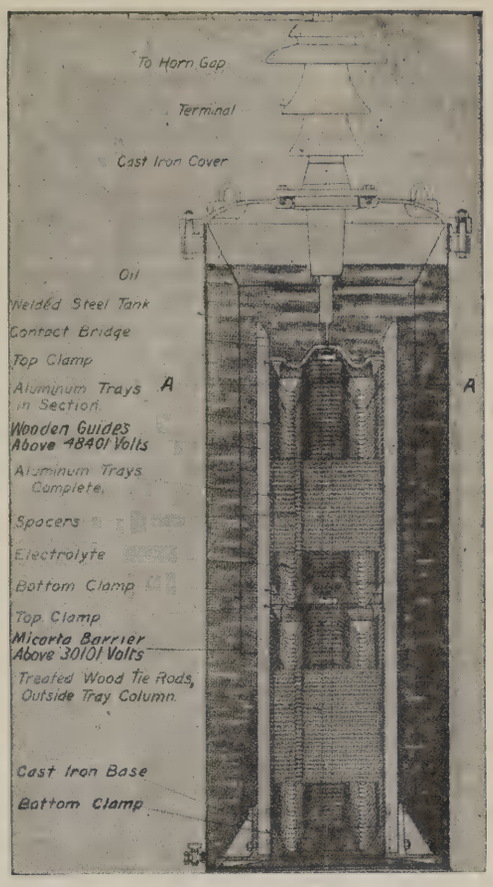
The treated aluminum trays are annular in shape thus providing a larger area exposed to the electrolyte than any other shape of tray in general use.

This gives proportionately greater freedom of discharge. Another advantage of the annular shape is that it provides an opening up through the center of each stack of trays for the circulation of the cooling oil where it is most needed.

The trays are separated from each other by porcelain spacers arranged around the edge of the tray insuring positive separation and ample space between trays for the escape of such gases as are formed during a heavy discharge. The porcelain being an inorganic material and not of vegetable origin, offers the least possibility of carbonized paths bridging the trays. The porcelain spacers inherently vary slightly in thickness but this does not affect the operation of the arrester because the resistance of the cell resides primarily in the film on the tray



CROSS-SECTION THROUGH TANK AT A-A



SECTION OF TYPICAL TYPE AK ELECTROLYTIC LIGHTNING ARRESTER

and only slightly in the electrolyte. The trays are thoroughly treated chemically and electrically before leaving the factory and are shipped with the film already built up, thus making it easy to place the arrester in service without initial charging.

Tray elements for arresters of 46,201 volts and above are assembled in sections. Each section is contained in a frame which slides in guides to its position in the tank. Elements for voltages below 46,201 are built as a unit to fit the tanks.

The tanks are of sheet steel with all joints welded. Every precaution is taken to guard against the possibility of oil leakage. Tanks for arresters rated above 25,000 volts have an insulating "chimney" lining of micarta, spaced from the tank surface to facilitate the circulation of oil and increase the insulation.

Oil—The trays, filled with electrolyte, are completely immersed in transformer oil in the tanks. As the oil is lighter it does not mix with the electrolyte. The oil provides for insulation and cooling and prevents evaporation of electrolyte. The volume and circulation of oil in the tank which is nearly filled, is great enough to absorb the heat due to a continuous discharge for a long period.

TYPES AK AND AL ELECTROLYTIC LIGHTNING ARRESTERS—Continued

Electrolyte—Type D electroylte is an inorganic solution and is more stable chemical y and more satisfactory in general than any electrolyte previously avai able. It will permit operation of the arresters at temperatures as high as 135 degrees Fahrenheit.

The films on the surfaces of the trays gradually dissolve and require periodical "charging" to keep the arrester in operating condition. Daily charging is recommended as best practice, but longer periods are practicable depending on the condition of arresters and surrounding temperature. Charging is accomplished by bridging the horn gaps for a few moments; this impresses line voltage on the arrester and rebuilds the films.

Type D electrolyte is furnished in powder or dry form to be mixed with distil ed water before using. Liquid electrolyte will be furnished only when specially required due to difficulty generally experienced by the purchaser in procuring a supply of pure distilled water or mixing the electrolyte so as to preserve its chemical purity.

The following **instructions for making liquid electrolyte** from dry electrolyte are sent with each shipment of dry electrolyte on Instruction Label, No. 947.

Contents—This bottle or vessel contains dry chemicals, which are to be used only in the preparation of electrolyte for use in Westinghouse electrolytic lightning arresters.

Cleanliness—Cleanliness in handling and mixing the electrolyte is a prime requisite. The successful operation of the arrester depends largely upon cleanliness. When properly mixed with pure water, this electrolyte will give very satisfactory results, but the Westinghouse Company can not be responsible for unsatisfactory operation of the arrester that is clearly due to the use of impure water or unclean methods of mixing.

Distilled Water—Only distilled water should be used in mixing electrolyte. Not all forms of commercial distilled water are sufficiently pure for use for this purpose. Distilled water made from saturated, superheated or exhaust steam often gives trouble due to presence of boiler compounds, cylinder oils, or other impurities. The safest and most satisfactory form of distilled water is made in a tinned copper still.

Caution— Before Mixing—(1) When not in use, keep bottle or vessel corked or closed.

(2) Mix entire contents of this bottle or vessel at one time, in order to secure uniformity of mixture (liquid electrolyte).

(3) For container in which electrolyte is to be mixed, use a wide mouthed glass jar, a porcelain enamelled vessel (with porcelain free from cracks) or a glazed earthenware jar. Vessels or containers used in mixing electrolyte must be thoroughly clean and not previously used for acids or alkalis. Containers previously used for mixing electrolyte may be used again for that purpose.

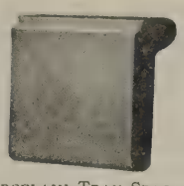
(4) Stirring rod to be used in the mixing of electrolyte may be of aluminum or glass.

Mixing—(1) In the preparation of electrolyte, the hands should not come in contact with the water or chemicals, as perspiration contains chlorides which may cause the electrolyte to give unsatisfactory service.

(2) To prepare electrolyte, mix the contents of this bottle or vessel, as given below, with distilled water. The mixture should be stirred until the crystals are dissolved, and the solution may be hastened by slightly heating the solution.

Dry Electrolyte.....Contents of this bottle

Distilled Water..... { .....gallons / .....liters



PORCELAIN TRAY SPACER

Caution—After Mixing—(1) Before placing electrolyte in the lightning arrester, make sure that no crystals remain on the bottom of the mixing container undissolved.

(2) Liquid electrolyte for future use may be kept in clean glass carboys, glass bottles or aluminum containers. Vessels containing liquid electrolyte must be corked or sealed to keep out dirt and foreign substances.

(3) Liquid electrolyte should be kept in a warm place to prevent freezing and subsequent breaking of the containers.

Charging-current indicators, for use in measuring the current taken by the type AK arresters in charging, consist of an ammeter mounted on the switch stick and a set of jacks mounted on the arrester tanks, on the bushings, or on the horn or sphere gaps, depending on the construction of the arrester. The jack is, in reality, a receptacle arranged for the insertion of the switch stick, and is so connected in the arrester circuit, that when the stick is inserted and the sphere or horn gaps short circuited, the charging current flows through and is indicated on the ammeter.

Horn and Sphere Gaps—The sphere gap has shorter dielectric spark lag than the horn gap, that is, it has a greater speed of discharge. The use of sphere gaps on the high voltage arresters, therefore, considerably increases the protection afforded the apparatus. On the lower voltage arresters, the rods forming the horn gaps are of such a diameter that they have the same effect as sphere gaps, that is, the gap is so small in proportion to the diameter of the horn that the effect is the same as if sphere gaps were used.

It is to be noted that sphere gaps have horn extensions, rising above the spheres, to assist the arc to rise, and thus be quickly extinguished.

On all electrolytic arresters for alternating-current circuits the horns or spheres when in the operating position are on a straight line. The charging operation is performed by rotating one horn or sphere with respect to the other one until it is offset sufficiently for one or the other of the horns or spheres of each gap to come in contact with a phosphor-bronze strip attached to the support of the opposite horn or sphere making up the gap. The gap may be swung out to the widest extent on open position and used as a disconnecting switch.

On indoor arresters for voltages less than 15001 volts the horns are held in their normal operating position by stops located on the horizontal bar which connects and operates, as a unit, the several movable horns. The stops on this horizontal bar may be disengaged by rotating the bar which is normally held in position by gravity acting through the combination of a weight and the

TYPES AK AND AL ELECTROLYTIC LIGHTNING ARRESTERS—Continued

operating handle. When the stops are disengaged the movable horns may be pushed to the left by means of the handle into the charging position, to the right into the open position, or into the intermediate or operating position. When the operating handle is released in either the charging or open positions, gravity again returns the stops to the engaged or normal position, and holds the gaps in that position.

On all indoor arresters for voltages above 15,000 and on all outdoor arresters the gaps are operated as described above, with the exceptions noted below. The horizontal bar for operating the gaps instead of being actuated by a handle is actuated by a rod and lever system. At the right hand end of the supporting framework a horizontal bar or lever which moves over a plate, with operating and

Charging-Current Indicator for Use on Type AK Lightning Arresters

open positions indicated, is placed at a convenient height for handling. The horizontal lever is held in either the operating or open position by a pin arrangement, and is connected to the horizontal bar operating the gaps by a vertical rod. The charging operation is performed by pushing the operating horizontal lever beyond the normal operating position, thus permitting the short-circuiting clips to make contact across the gap.

The adjustment of the gap setting is obtained by placing the gap in the operating position, loosening the set screws, which hold horn or sphere in position, and moving the horn or sphere either forward or backward until the desired setting is obtained.

All arresters for voltages above 73,000 have the same design of gap structure and transfer switch irrespective of the differences in the shape of tanks or the mounting of trays.

Charge and Discharge Resistance—All type AK arresters include a charge and discharge resistance connected between the main horn or sphere gap and the arrester proper. These resistance units consist of rod resistors shunted by one or more spark gaps. The resistor is of a composition which possesses the quality of remaining practically uniform under all conditions of service. The shunt gaps are between small horn gaps.

In the operation of charging, the normal generator current takes the resistance path, thus limiting the charging current to a low value and damping out any oscillations that might result from charging, due to the inductance and capacity of the line and arrester.

Lightning discharges of lesser intensity pass through the resistance, but heavy discharges find too much impedance in that path and instead break over the shunt gaps. After the lightning discharge has passed, the films on the trays rebuild and reduce the current to a value such that it is drawn out of the shunt gaps into the resistances. These now assist the main gaps to break the arc and interrupt the current flow. The resistances thus come into play at the end of a discharge before the main arc breaks, and are able to prevent the discharge from setting up secondary oscillations in the same way that they do during the charging operation.

These resistance units may be omitted from the standard arrester where it is thought that charging surges will not affect apparatus connected in the circuit, and allowance will be made for this omission.

Transfer Switch—On each occasion of "charging" arresters to rebuild their films, after once bridging the gaps the leads connecting the two middle legs to the ground pipe and to the center fuse respectively, should be interchanged and the gaps again bridged. Each tank serves alternately as the ground leg until the next charging period. Transfer switches are provided which, when thrown, affect this interchange of connections.

Fuses—It is often desirable to set the gaps so that they will discharge in the event of a ground occurring on one leg. To prevent such a discharge, which might be heavy from continuing indefinitely, and injure the arrester, fuses are inserted which protect the arrester but in no way reduce its effectiveness. The fuses are on the arrester side of the horn gaps and serve as disconnecting switches for the arrester tanks.

An alarm bell attachment, which can be connected to the ground lead of the arrester to indicate when a discharge is taking place, can be furnished at extra cost. This attachment consists of a small safety spark gap, around which is shunted an alarm bell. Another more satisfactory but more expensive form of this device substitutes a small electrolytic cell for the spark gap, which reduces the danger of puncturing the bell winding. The bell itself may be placed at any desirable point with leads from it connecting to the arrester.

A measuring cup is furnished with each arrester outfit for filling the trays with electrolyte.

Complete directions for the installation and maintenance of electrolytic lightning arresters are contained in Instruction Book 5127.

TYPES AK AND AL ELECTROLYTIC LIGHTNING ARRESTERS—Continued

When ordering or requesting information on special electrolytic lightning arresters, the following data should be given in every case:

(1) Rated voltage of circuit, phases, frequency.

(2) What is maximum operating voltage at power station?

(3) Is any part to be mounted outdoors?

(4) Is the neutral of the system grounded directly or through a low or high resistance?

(5) Is any special construction desired to fit local surroundings?

(6) Is it expected that the operating voltage will be increased at a later date?

(7) Remarks.

Copper Tubing for Wiring Arresters—In order to reduce the impedance as much as possible, copper tubing is recommended for use in wiring high-voltage type AK arresters. The use of this tubing secures the advantage of a large conductor surface without using large wires and at a lower cost than wires.

Copper tubing has the additional advantage of being easy to install and requiring fewer insulators.

Arresters for outdoor service are furnished complete with copper tubing for wiring for voltages from 15,001 to 69,300.

As the **indoor** installations of lightning arresters vary greatly in detail, it is not desirable to provide copper tubing for wiring the arresters complete. Copper tubing, therefore, is listed from which parts may be selected for wiring the arrester after the layout has been decided.

TYPE OF PHASE LEG FOR 69,301 TO 138,600 VOLT ELECTROLYTIC LIGHTNING ARRESTER—(BARRIER NOT SHOWN.)

Elliptical tank with two terminals, tray structure in two columns, tray structure insulated from tanks; tanks may be mounted on any foundation and solidly grounded thus giving increased protection to operator.

TYPES AK AND AL ELECTROLYTIC LIGHTNING ARRESTERS—Continued

TYPE AL IMPULSE GAPS

TYPE AL (IMPULSE-GAP) ELECTROLYTIC ARRESTER INSTALLED AT A 66000-VOLT STATION

Application—The type AL impulse gaps for lightning arresters are recommended for use in connection with lightning arresters which protect stations of large capacity operating at 11,000 volts and higher. The impulse gap excels every other known gap in assisting arresters to give protection from lightning and other high-frequency or high-voltage disturbances.

The impulse gaps, as listed herein, are for use in connection with electrolytic or other three-phase (grounded or ungrounded-neutral-circuit) lightning arresters now in service.

Distinctive Features—The impulse gap protects the insulation against high-frequency or steep wave-front surges of high potential at a lower voltage than does any other known gap.

Operation—The old-fashioned plain horn gaps had considerable time-lag, allowing a high-frequency surge to rise to a much higher voltage than would a low-frequency surge before discharging and giving protection. The development of the sphere gap partly prevents this situation by eliminating the time lag so that all frequencies are discharged at the same voltage. The new impulse gap has a negative time lag; that is, the higher the frequency the lower the voltage at which the gap discharges. Thus the impulse gap automatically selects the dangerous surges and gives protection more quickly than any other known form of gap.

The impulse gap not only incorporates all of the virtues of the horn gap and the high-speed sphere gap, but also possesses the property of selecting high-frequency or steep-wave-front surges and discharging them at a lower voltage than the normal voltage setting of the gap. It should be particularly noted that the impulse gap is the only device which will protect insulation against a steep-wave-front surge of reverse potential, that is, a sudden drop in voltage. The high-frequency discharge voltage may be as low as two-thirds, or even one-third, of the normal-frequency value. It is, therefore, possible to use a gap setting that will permit of the desired degree of protection against dangerous surges while not permitting too frequent discharging on minor surges at normal frequency.

The high speed of the sphere gap as compared with the horn gap is due to the elimination of the time required to build up a sphere of equal-potential surface at the discharge part of the horn gap. The sphere of the sphere gap provides at once for this sphere of equal potential surface and practically eliminates corona and reduces field distortions when the gap is set equal to, or less than, the sphere diameter. By the use of the sphere gap the voltage to ground, or the break-down voltage, at any frequency does not materially exceed the 60-cycle discharge voltage of the gap. However, the sphere gap does not give the desired protection against steep-wave-front, or high-frequency surges, due to its inability to discharge these disturbances at lower voltage than the normal frequency setting of the gap. It is necessary to set all arrester gaps for a

sufficiently high normal frequency break-down voltage so that they will not discharge too frequently on comparatively harmless low-frequency switching surges. With the impulse gap, however, the advantages of this high normal-frequency setting of the gap can be had without the corresponding disadvantage of reduced protection, since the high-frequency break-down value of the gap is much lower. This is because high-frequency discharges start from the auxiliary electrode and have only one-half of the gap to jump. The latter electrode, also, is so shaped that although the gap is one-half of the main gap, the break-down voltage is only about one-fourth as great: that is to say, high-frequency surges not only are not delayed in discharging, as with plain horns, by the need of building up a static field; but, instead, discharge at a voltage even lower than the normal value of the main gap, since they automatically select the auxiliary gap of much lower voltage break-down.

Fig. 2 illustrates this graphically. V_2 T_2 represents the point and time of break-down of a properly designed sphere gap which has no time lag. V_1 T_1 shows the delay resulting from the time lag of an ordinary horn gap and the consequent greater rise of voltage before the discharge takes place. V_3 T_3,

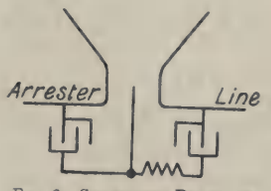


FIG. 3—SCHEMATIC DIAGRAM OF IMPULSE GAP

on the other hand, shows the earlier discharge and the quicker and better protection resulting from the lower voltage break-down of the impulse gap due to its selective property.

The impulse gap uses a circuit (see Fig. 3) that, at normal frequency, is balanced as to voltage, but becomes unbalanced and starts a discharge in the case of any high-frequency surge. At normal frequency there is no difference of potential between the mid-point of the condensers and the auxiliary electrode midway between the auxiliary horn and sphere gap. A high frequency, however, passes freely through the condensers and piles up its full voltage across the resistance, that is, across one-half of the total gap. This gap, therefore, breaks down, resulting in the total voltage being impressed on the remaining gap, which breaks down in turn, dissipating the disturbance to ground. The break-down of each half of the gap is facilitated by the

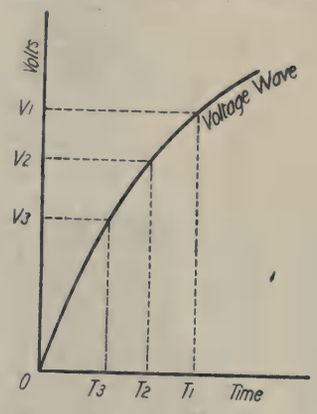
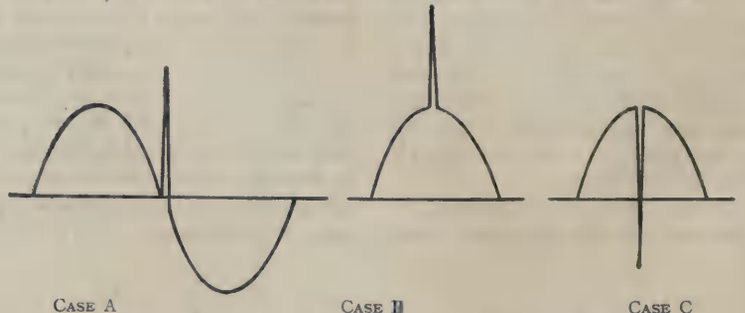


FIG. 2—TYPICAL CURVE OF A HIGH-VOLTAGE WAVE

fact that the auxiliary electrode is small in size (having needle gap characteristics) so that the discharge voltage of each half of the gap is about one quarter, rather than one half, of that of the total gap between the spheres. It should be especially noted that the danger to apparatus from steep-wave-front surges, particularly of reverse potential, may be out of proportion to their actual magnitude, due to the inductance of apparatus, which not only produces a high voltage across the first few turns of the winding of any apparatus, but also a much higher voltage to ground than the normal voltage of the impulse, due to the addition of induced or reflected voltage to the normal voltage of the impulse. If the apparatus is to be protected with a gap and lightning arrester, the gap should be one that will select and discharge the high frequency disturbances at a voltage lower than the normal voltage of the gap. The impulse gap accomplishes the desired result.

The necessity of selective action in the gap is emphasized by the following possible combinations (see Fig. 4) of the impulse and line voltage. (Assume that an ordinary sphere gap to ground is set to discharge at twice the line voltage.)



CASE A CASE B CASE C

FIG 4—IMPULSE VOLTAGE SUPERIMPOSED ON 60-CYCLE WAVE

TYPES AK AND AL ELECTROLYTIC LIGHTNING ARRESTERS—Continued

Case A—The voltage of the line does not affect the action of the impulse, and the impulse must reach twice the line voltage before the gap protecting the apparatus will discharge.

Case B—The voltage of the impulse must reach only the same voltage as that of the line, before the gap discharges.

Case C—The voltage must have a value three times the line voltage before the gap discharges. In this case, it is to be noted that conditions are such that the high-voltage stress is present not only to ground, but also between turns of windings of apparatus. Adequate protection against this condition demands the use of a gap which is very sensitive to steep-wave-front surges. If the impulse is oscillating the second half cycle may cause a discharge, but the time for protection against the destructive effect of the first half cycle will have passed.

It is to be noted that with the impulse gap, the discharge begins at a lower voltage than with a sphere gap, and hence, operates more quickly than a sphere gap.

Construction—The impulse gap consists of standard (Faradoid* and pillar) porcelain insulators (two of which are used as condensers), unbalancing resistor, auxiliary electrode or tickler, a sphere gap, an auxiliary horn gap, a short circuiting clip, a charge-and-discharge resistor, and a supporting framework. The framework is equipped with feet which can be mounted upon an existing structure if the purchaser supplies inverted feet or other standard pipe connections and fittings.

*For a description of Faradoid insulators see section 6-A.

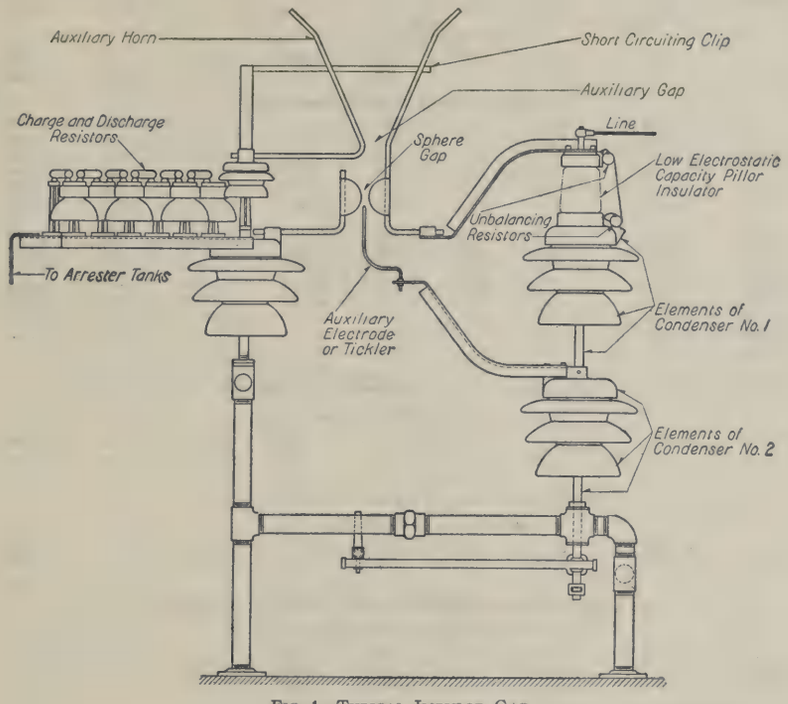


FIG. 1—TYPICAL IMPULSE GAP

TYPES AK AND AL ELECTROLYTIC LIGHTNING ARRESTERS—Continued

PRICES—TYPE AK LIGHTNING ARRESTERS

Style number and list price include arrester with gaps as described complete with necessary oil and electrolyte and with charge-and-discharge resistor. Pipe supports for horn and sphere gap structures are included up to 25000 volts indoor and 73000 volts outdoor and are not included above these voltages.

Style No.	Voltage Normal	Voltage Minimum	Voltage Maximum	Gal. Electrolyte	Gal. Oil	Weight in Pounds: Net Erected Inc. Oil and Electrolyte	Weight in Pounds: Approximate Shipping: Complete With Oil and Electrolyte	Weight in Pounds: Approximate Shipping: Electrolyte in Carboys	Weight in Pounds: Approximate Shipping: Oil	List Price
For Three-Phase Grounded or Ungrounded Neutral Circuits										
Indoor Arresters With Horn Gaps**										
231380	.....	1000	3000	1¾	37	563	1050	54	348	396 00
231384	.....	3001	5000	3	46	648	1140	62	530	439 00
231386	.....	5001	7500	4½	54	728	1320	72	496	497 00
272967	.....	7501	15000	7¾	78	1155	2065	134	727	910 00
Indoor Arresters With Sphere Gaps										
231394	.....	15001	25000	13½	128	2350	3090	220	1180	1290 00
280844	.....	25001	37000	22	184	3149	5263	312	1690	1788 00
289642	44000	37001	46200	25	190	3995	6270	330	1710	2267 00
280845	.....	46201	50000	27	200	4085	6500	355	1800	2289 00
289641	66000	46201	69300	38	426	7327	9760	597	3920	3640 00
280847	.....	69301	73000	40	440	7447	10000	617	4055	3723 00
Outdoor Arresters With Horn Gaps**										
266821	.....	5000	7500	4½	54	800	1400	72	496	800 00
272969	.....	7501	15000	7¾	92	1955	3000	134	727	1025 00
Outdoor Arresters With Sphere Gaps										
231426	.....	15001	25000	13½	128	2333	3130	220	1180	1383 00
231428	.....	25001	37000	22	184	3188	5300	312	1690	2155 00
289639	44000	37001	46200	25	190	3995	6370	330	1710	2853 00
231430	.....	46201	50000	27	200	4395	6600	355	1800	2878 00
289640	66000	46201	69300	38	426	7890	9910	597	3920	4612 00
231434	.....	69301	73000	40	440	8018	10150	617	4055	4695 00
*280848	88000	69301	92400	55	1060	16536	19890	785	8490	7923 00
‡280849	88000	69301	92400	55	3550	41000	51500	785	32660	12183 00
*280850	110000	92401	115500	64	1280	18019	21500	955	10785	8823 00
‡280851	110000	92401	115500	64	3880	43536	53000	955	36000	14175 00
†280852	132000	115501	138600	86	2840	37796	52000	1283	26135	18033 00
‡280853	132000	115501	138600	86	5200	57000	70000	1283	47840	19000 00
.....	154000	138601	161700	....	....	.....	.....	....	.....	21667 00
.....	220000	161701	231000	....	....	.....	.....	....	.....	On request
For Two-Phase Four-Wire Circuits										
Indoor Arresters With Horn Gaps										
266740	.....	1000	3000	1¾	37	620	1110	54	348	491 00
266743	.....	5000	7500	4½	54	790	1382	72	496	634 00
For Two-Phase Three-Wire Circuits										
Indoor Arresters With Horn Gaps										
266746	.....	1000	3000	1¾	36	557	1025	54	340	375 00
266749	.....	5000	7500	4½	52	720	1300	72	480	478 00
For Single-Phase Ungrounded Neutral Circuits										
Indoor Arresters With Horn Gaps										
266752	.....	1000	3000	1¼	34	550	975	42	320	353 00
266755	.....	5001	7500	3	46	700	1280	56	475	448 00
266757	.....	7501	15000	6	65½	940	1800	80	705	555 00

*Round tanks, tray structure in one column, tanks mounted on insulated platform.

†Elliptical tanks, tray structure in two columns, bottom insulated from tanks, tanks mounted on insulated platform, top of one tray column connected to line, and top of other tray column connected to tank.

‡Elliptical tanks with two terminals, tray structure in two columns, tray structure insulated from tanks, tanks may be mounted on any foundation and solidly grounded, thus giving increased protection to operator.

**Arresters for voltages below 15001 have horn gaps. The diameter of the rod used for making the horns of the gap, is so large with reference to the gap that the result obtained is practically the same as though sphere gaps were used.

PRICES—TYPE AL ELECTROLYTIC LIGHTNING ARRESTERS

Construction and Description—The type AL electrolytic lightning arrester is the same in construction as the type AK electrolytic lightning arrester except that in place of sphere gaps or horn gaps the type AL impulse gap described in the foregoing is used.

Style number and list price include arrester with type AL impulse gaps as described, complete with necessary oil and electrolyte and with charge-and-discharge resistor.

The supports for the gap structures are included up to 25000 volts indoor and 73000 volts outdoor and are not included above these voltages.

Style No.	Voltage Normal	Voltage Minimum	Voltage Maximum	Gal. Electrolyte	Gal. Oil	Weight in Pounds: Net Erected Inc. Oil and Electrolyte	Weight in Pounds: Approximate Shipping Complete With Oil and Electrolyte	Weight in Pounds: Approximate Shipping Electrolyte in Carboys	Weight in Pounds: Approximate Shipping Oil	List Price
For Three-Phase Grounded, or Ungrounded-Neutral Circuits										
Indoor Arresters With Impulse Gap										
282247	.....	10000	15000	8½	92	1450	2400	130	850	$1140 00
277811	.....	15001	25000	13½	128	2520	4000	220	1187	1427 00
262066	.....	25001	37000	20	184	3040	4760	308	1610	1870 00
289635	44000	37001	46200	25	198	4120	6270	340	1730	2429 00
262051	.....	46201	50000	27	208	4350	6600	370	1910	2450 00
289636	66000	46201	69300	38	426	7400	9850	550	3825	3942 00
262042	.....	69301	73000	40	440	7820	11080	580	4055	4025 00
Outdoor Arresters With Impulse Gap										
280499	.....	10000	15000	8½	92	1490	2460	130	850	1187 00
277808	.....	15001	25000	13½	128	2560	4100	220	1187	1480 00
277806	.....	25001	37000	20	184	3060	4960	308	1610	2250 00
289637	44000	37001	46200	25	198	4400	6270	340	1730	3025 00
262050	.....	46201	50000	27	208	4500	6820	370	1910	3050 00
289638	66000	46201	69300	38	426	7790	9850	550	3825	4917 00
280480	.....	69301	73000	40	440	7920	11800	580	4055	5000 00

PRICES—ACCESSORIES AND PARTS

Type AL Impulse Gaps

Style number and list price include type AL impulse gaps complete as described.

Style No.	Voltage Normal	Voltage Minimum	Voltage Maximum	Weight in Pounds: Net Weight Erected	Weight in Pounds: Approximate Shipping Weight	List Price
Indoor						
282246	.....	10000	15000	250	450	$275 00
Outdoo						
262046	....	10000	15000	550	880	275 00
Indoor and Outdoor						
262058	.....	15001	25000	575	925	285 00
277813	.....	25001	37000	650	1040	298 50
*262070	44000	.....	.....	1150	1760	560 00
*277810	66000	.....	.....	1480	2480	715 00

*Style number 262070 listed at normal voltage of 44000 is a 50000 maximum rated impulse gap and style number 277810 listed at normal voltage of 66000 is a 73000 volt maximum rated impulse gap. These gaps may be applied up to maximum rating

Type AK Sphere Gaps
To Replace Horn Gaps

Type AK arresters as formerly supplied were equipped with horn gaps for indoor and outdoor service above 15000 volts. As some users may desire to equip their arresters with sphere gaps, sphere gaps for replacing horn gaps are listed below.

The **style numbers** include a horn complete with sphere.

Note—Two horns with spheres are required for one complete gap or pole. The sphere gaps as furnished are interchangeable with the horn gaps.

Arresters for voltage below 15001 have horn gaps. The diameter of the rod used for making the horns of the gap is so large with reference to the gap that the result obtained is practically the same as though sphere gaps were used.

Indoor and Outdoor

Voltage of Arrester	Style Number of Sphere Gap	Number Required Per Arrester	List Price Each
15001 to 37000	272702	6	$ 7 50
37001 to 73000	272705	6	15 00
73001 to 115500	272706	6	17 00

TYPES AK AND AL ELECTROLYTIC LIGHTNING ARRESTERS—Continued

Trays

The prices of the trays and the number required to completely make over the tray structure of the arresters are given in the tables below.

Prices

Style No.	Description	List Price Each
229147	Aluminum tray (treated) without connection lug	$1 70
229148	Aluminum tray (treated) with connection lug	2 00

Number of Trays Required

Style No. of Arrester	No. of Trays Style No. 229147	No. of Trays Style No. 229148
Type AK		
Three-Phase		
231380	16	6
231384	32	6
231386	48	6
272967	100	6
231394	176	4
280844	268	4
289642	332	4
280845	352	4
289641	512	0
280847	532	0
266821	48	6
272969	104	6
231426	176	4
231428	268	4
289639	332	4
231430	352	4
289640	512	0
231434	532	0
280848	708	0
280849	712	8
280850	840	0
280851	840	8
280852	988	0
280853	1000	8
Single-Phase		
266752	12	5
266755	36	5
266757	75	5
Two-Phase, Four-Wire		
266740	15	8
266743	55	8
Two-Phase, Three-Wire		
276746	16	6
276749	50	6
Type AL		
Three-Phase		
277811	180	4
262066	268	4
289635	340	4
262051	360	4
289636	512	4
262041	532	4
280499	108	4
277808	180	4
277806	268	4
289637	340	4
262050	360	4
289638	512	4
280480	532	4

Charge and Discharge Resistors

The following resistors are 1 inch in diameter and of different lengths according to resistance values. For resistor rods of ¾-inch or 1½-inch diameter for older forms of arresters, apply to nearest District Office, giving reading of nameplate on arrester tank, size of rods desired, voltage of arrester and order number upon which arrester was furnished.

Prices

Style Number Resistor Rod	List Price per Rod
276669	$3 70
276671	3 70
276672	3 70

Number of Rods

Style Number Resistor Rod	Voltage Range of Arrester Minimum	Maximum	Number of Rods Required per Arrester
For Type AK Arresters			
Three-Phase			
276669	1000	7500	3
276671	7501	15000	3
276671	15001	25000	6
276672	25001	37000	6
276671	37001	46200	12
276671	46201	50000 / 69300 / 73000	18
276671	73001	92400	24
276672	92401	115500	30
276671	115501	138600	30
Single-Phase			
276669	1000	7500	2
276671	7501	15000	2
Two-Phase, Four-Wire			
276669	1000	7500	4
Two-Phase, Three-Wire			
276669	1000	7500	3
For Type AL Arresters			
Three-Phase			
276671		15000	3
276671		25000	6
276672		37000	6
276671		46200	12
276671		50000 / 69300 / 73000	18

TYPES AK AND AL ELECTROLYTIC LIGHTNING ARRESTERS—Continued

Unbalancing Resistors

For Type AL Arresters

Style No.	Voltage Range of Arresters Minimum	Maximum	Number Required Per Arrester	List Price Each
280498	10000	73000	6	$3 00
277637	Porcelain container for Style No. 280498		6	1 50

Copper Tubing for Wiring Arresters

Style No.	Description	Inside Diameter Inches	Outside Diameter Inches	List Price
253971	Bend 90 degrees, 6-inch radius	$\frac{9}{16}$	$\frac{5}{8}$	$1 00 each
253972	Bend 60 degrees, 6-inch radius	$\frac{9}{16}$	$\frac{5}{8}$	1 40 each
253973	Bend 45 degrees, 6-inch radius	$\frac{9}{16}$	$\frac{5}{8}$	1 40 each
253974	Bend 30 degrees, 6-inch radius	$\frac{9}{16}$	$\frac{5}{8}$	1 40 each
253975	Tee connector	$\frac{9}{16}$	$\frac{5}{8}$	1 80 each
253977	Terminal connector	..	..	50 each
253976	Connector 2 inches long	$\frac{1}{16}$	$\frac{1}{2}$	20 each
.....	Tubing, any length up to 10 ft.	$\frac{9}{16}$	$\frac{5}{8}$	25 per foot

Oil

Standard transformer oil is used. See section 5-A of this catalogue, "Insulation and Supplies," for prices.

Type D Electrolyte

Dry type D electrolyte is standard. Westinghouse electrolyte is of slightly acid nature and when in mixed form must be shipped in glass to preserve its chemical purity. Shipment in this fashion is bulky, subject to loss from breakage at all times and during the winter is especially subject to loss from freezing of electrolyte at about 28° F. and consequently from breakage of carboys. For these reasons mixed electrolyte will only be shipped when especially required due to the inability of purchaser to secure a supply of pure distilled water or to mix the electrolyte so as to preserve its chemical purity. Liquid electrolyte must be specified on the order if required.

Dry

Jar Filled With Dry Electrolyte Style No.	Amount of Liquid Electrolyte to Be Made From Contents of Jar Gallons	Liters	List Price
276310	1	3.8	$ 1 00
276311	2	7.6	2 00
280788	3	11.4	3 00
276312	4	15.2	4 00
280789	8	30.3	8 00
280790	16	60.5	16 00
280791	32	121.0	32 00

Liquid

*Type D liquid electrolyte per gallon without container	$1 00 List each
12-Gallon glass carboy	4 50 Net each
5-Gallon glass carboy	3 90 Net each

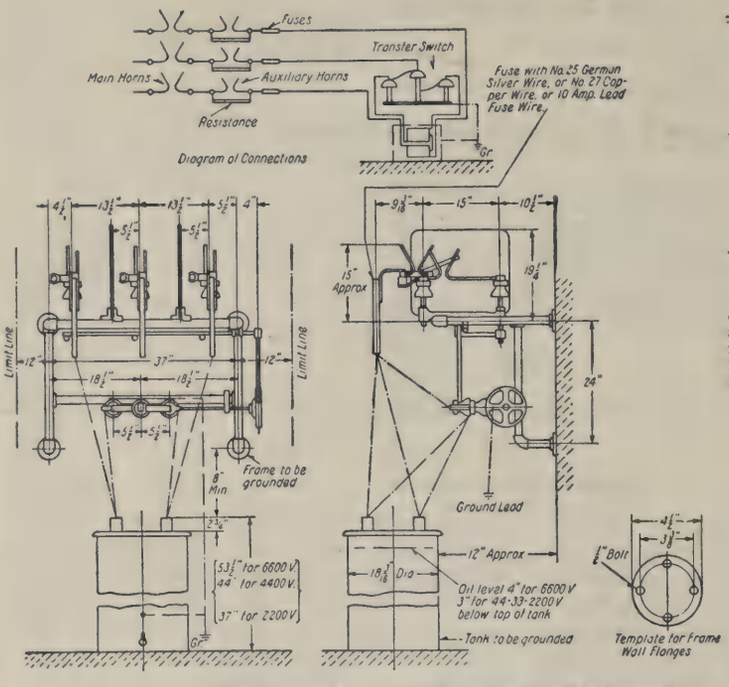
*Quantity specified on order will be shipped only in the above size carboys. For all carboys returned at shipper's risk, transportation charges prepaid, and received at East Pittsburgh in good condition, a credit of the net prices as above will be allowed. Classification of these returned carboys as "empty carboys returned" will insure lowest obtainable freight rate. A copy of bill-of-lading with full reference to original order or invoice number must be forwarded to the district office handling the order to insure prompt issuance of credit memorandum.

MISCELLANEOUS

Style No.	Description	List Price
139794	Porcelain spacing block for trays	$ 1 80 per 100
125412	Cup for filling trays	1 50 each
197590	Alarm bell attachment including safety spark gap and alarm bell	72 50 each
182908	Alarm bell attachment including electrolytic cell and alarm bell	110 00 each
119083	Alarm bell alone	53 00 each
248115	Charging-current jacks, up to 7500 volts indoor	11 00 each
248116	Charging-current jacks, 7501 to 15000 volts indoor	11 00 each
207064	Charging-current, jacks, 15001 to 138600 volts indoor	11 00 each
207064	Charging-current jacks, 7501 to 138600 volts outdoor	11 00 each
201604	Charging-current switch stick with ammeter for voltages up to 15000	35 50 each
201605	Charging-current switch stick with ammeter for voltages 15001 to 50000	36 25 each
201606	Charging-current switch stick with ammeter for voltages 50001 to 73000	37 50 each
201607	Charging-current switch stick with ammeter for voltages 73001 to 115500	38 50 each
201608	Charging-current switch stick with ammeter for voltages 115501 to 138600	42 00 each

TYPES AK AND AL ELECTROLYTIC LIGHTNING ARRESTERS—Continued

APPROXIMATE DIMENSIONS

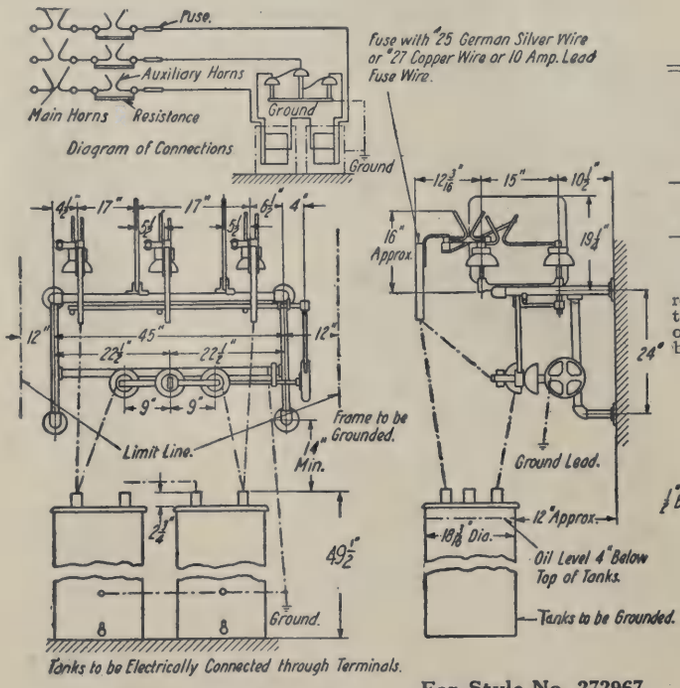


Voltage	Approx. No. Gals. Required	
	Electrolyte	*Oil
7500	4½	44
5000	3	36
3000	1¾	29

*Lectroseal oil preferred.

Horn gap should be short-circuited daily for rebuilding films and testing arresters. Reverse transfer switch and repeat charge. Unless otherwise specified all electrical connections to be furnished by customer.

For Style Nos. 231380, 231384, 231386, 266746 and 266749



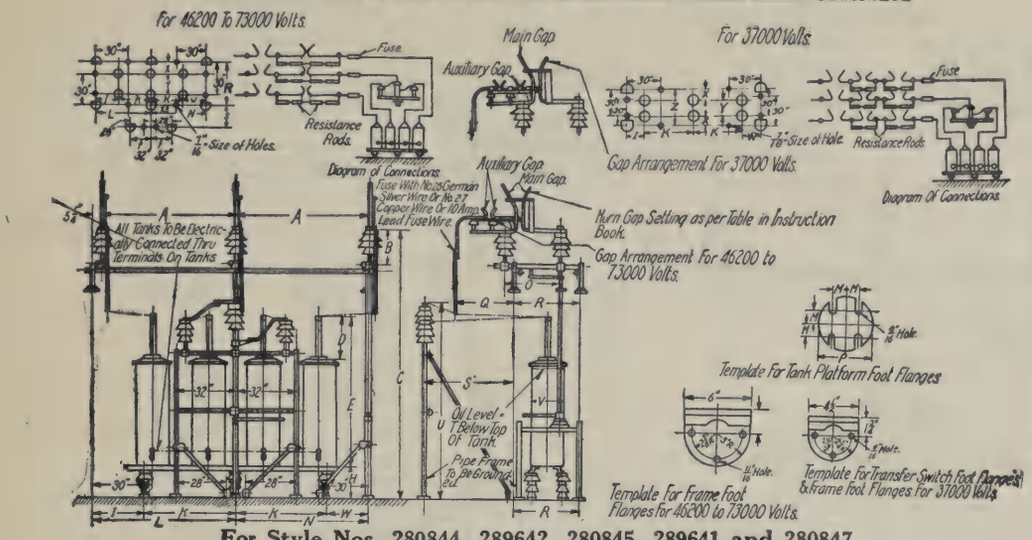
Voltage	Approx. No. Gals. Required	
	Electrolyte	*Oil
15000	9	78

*Lectroseal oil required.

Horn gaps should be short-circuited daily for rebuilding films and testing arrester. Reverse transfer switch and repeat charge. Unless otherwise specified all electrical connections to be furnished by customer.

For Style No. 272967

TYPES AK AND AL ELECTROLYTIC LIGHTNING ARRESTERS—Continued

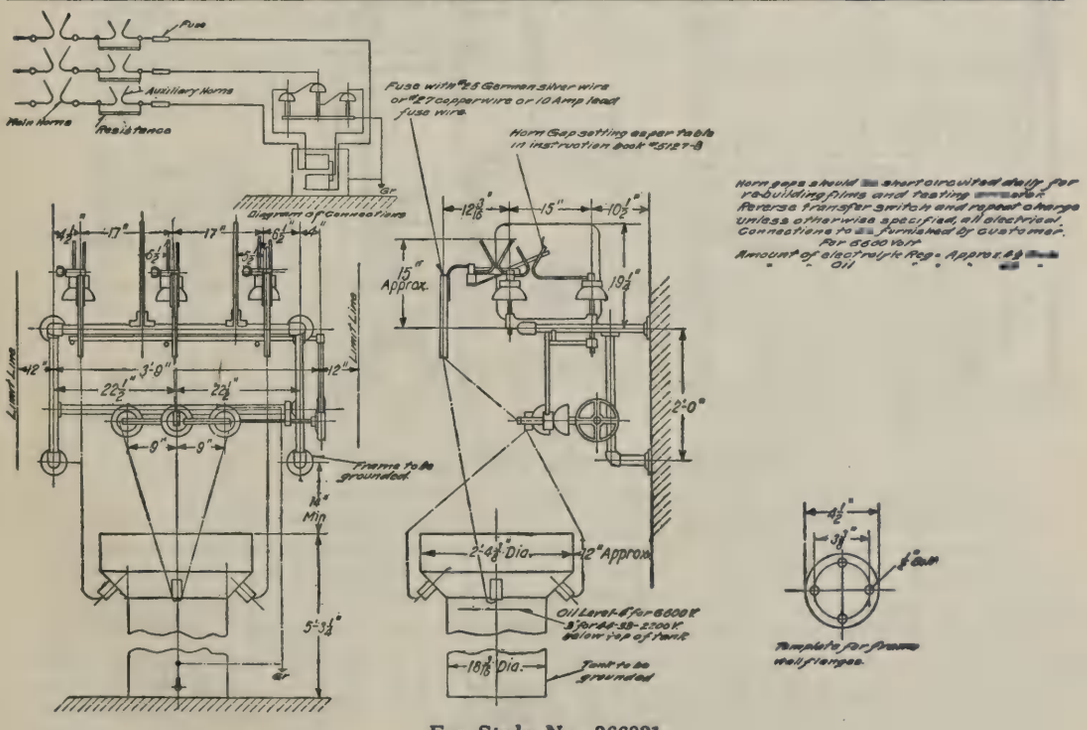

For 46200 To 73000 Volts.
Fuse
Resistance Rods
Diagram of Connections
Main Gap
Auxiliary Gap
For 37000 Volts.
Gap Arrangement For 37000 Volts.
Resistance Rods
Diagram Of Connections
Auxiliary Gap
Main Gap
Fuse With No. 28 German Silver Wire Or No. 27 Copper Wire Or 10 Amp. Lead Fuse Wire.
All Tanks To Be Electrically Connected Thru Terminals On Tanks
Horn Gap Setting as per Table in Instruction Book.
Gap Arrangement For 46200 to 73000 Volts.
Oil Level 1" Below Top Of Tank
Pipe Frame To Be Grounded
Template For Tank Platform Foot Flanges
Template For Frame Foot Flanges for 46200 to 73000 Volts.
Template For Transfer Switch Foot Flanges & Frame Foot Flanges for 37000 Volts

For Style Nos. 280844, 289642, 280845, 289641 and 280847

Style No.	Voltage Min.	Voltage Max.	Approx. No. Gal. Required Electrolyte	Approx. No. Gal. Required *Oil
280844	25001	37000	22	184
289642	37001	46200	25	190
280845	46201	50000	27	200
289641	46201	69300	38	426
280847	69301	73000	40	440

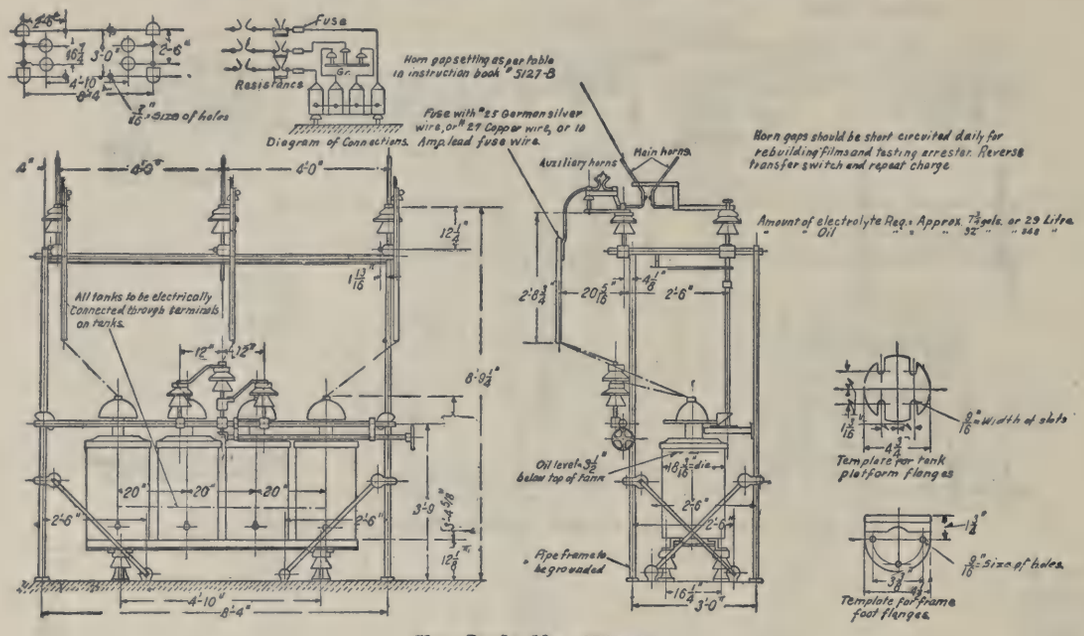
*Lectroseal oil preferred.

Style No.	Dimensions in Inches																				
	A	B	C	D	E	H	I	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y
280844	60	14	134	19 1/8	71 1/8	13 3/4	27	37	64	1 3/4	60	30	6 1/2	25 11/16	36	23 7/8	3 1/2	84 7/8	18 1/16	23	9 7/8	16 1/4
289642	72	19	145	22 3/4	78 1/2	17	28 1/4	49	77 1/4	1 3/16	72	30	6 1/2	31 5/16	36	68	3 1/2	108 1/2	18 3/16	23	9 7/8	16 1/4
280845	72	19	145	22 3/4	80 1/2	17	28 1/4	49	77 1/4	1 3/16	72	30	6 1/2	31 5/16	36	68	3 1/2	108 1/2	18 3/16	23	9 7/8	16 1/4
289641	96	22	184	31	111 1/2	20	47 1/4	54	101 1/4	2 3/8	96	42	10	36 5/16	48	72	5	112	22 1/4	42	13 7/8	20 1/4
280847	96	22	184	31	114	20	47 1/4	54	101 1/4	2 3/8	96	42	10	36 5/16	48	72	5	112	22 1/4	42	13 7/8	20 1/4

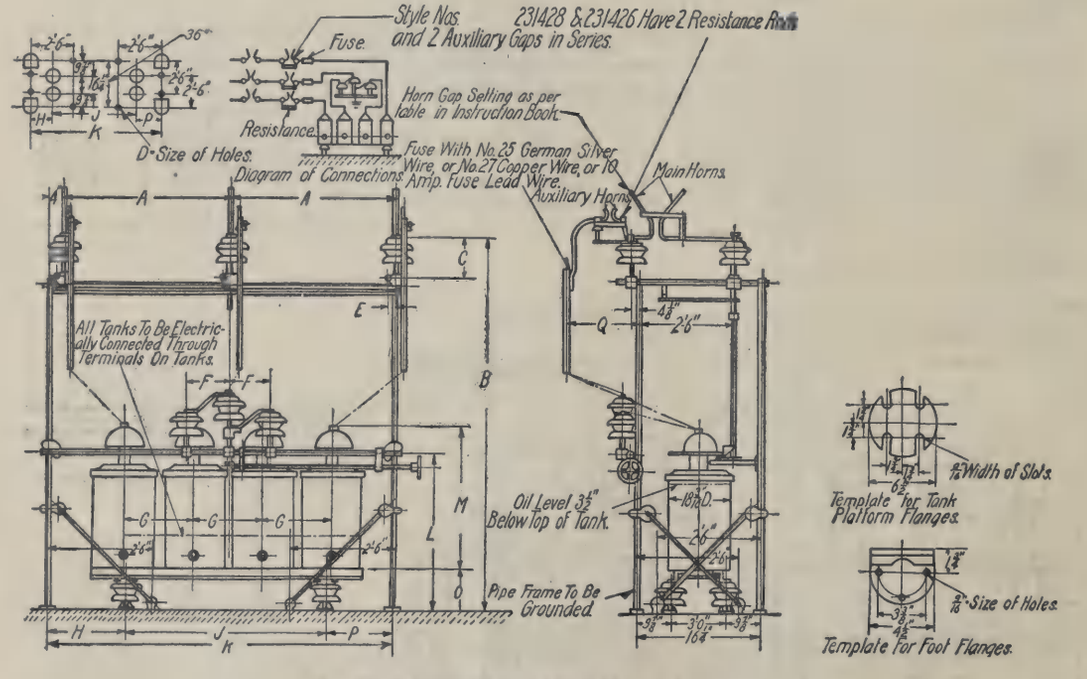

Fuse
Auxiliary Horns
Main Horns
Resistance
Fuse with No. 28 German silver wire or No. 27 copper wire or 10 Amp lead fuse wire.
Horn Gap setting as per Table in instruction book No. 5127-B
Diagram of Connections
Horn gaps should be short circuited daily for rebuilding films and testing arrester.
Reverse transfer switch and repeat charge unless otherwise specified, all else Priced.
Connections to be furnished by customer.
For 6600 volt
Amount of electrolyte req'd - Approx. 4 gals.
Oil
Limit Line
Limit Line
Frame to be grounded
Oil Level 6" for 6600 V. 3" for 44-88-2200 V. below top of tank
Tank to be grounded
Template for frame wall flanges.

For Style No. 266821

TYPES AK AND AL ELECTROLYTIC LIGHTNING ARRESTERS—Continued


Fuse
Resistance
Diagram of Connections
Horn gap setting as per table in instruction book "5127-B
Fuse with "25 German silver wire, or "27 Copper wire, or 10 Amp lead fuse wire.
Auxiliary horns
Main horns
Horn gaps should be short circuited daily for rebuilding films and testing arrester. Reverse transfer switch and repeat charge.
Amount of electrolyte Req'd: Approx. 7½ gals. or 29 Litre. " " Oil " " 32 " " 868 "
All tanks to be electrically connected through terminals on tanks.
Oil level 3½" below top of tank
Pipe frame to be grounded
Template for tank platform flanges
Template for frame foot flanges
Size of holes
Width of slots

For Style No. 272969

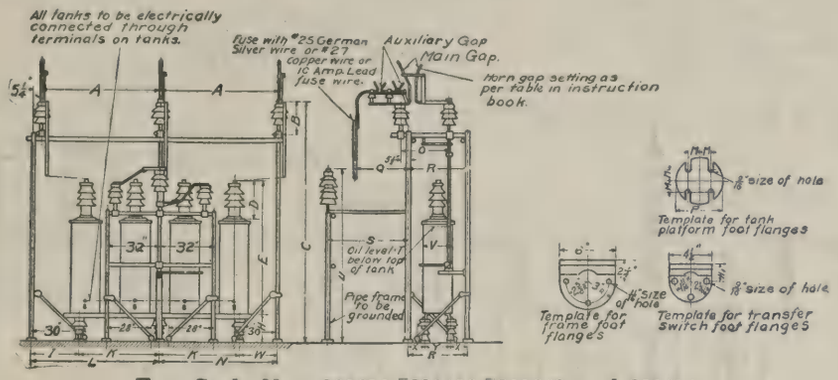

Style Nos. 231428 & 231426 Have 2 Resistance Rods and 2 Auxiliary Gaps in Series.
Fuse.
Resistance.
Horn Gap Selling as per table in Instruction Book.
Fuse With No. 25 German Silver Wire, or No. 27 Copper Wire, or 10 Amp. Fuse Lead Wire.
Main Horns.
Auxiliary Horns.
Diagram of Connections.
D-Size of Holes.
All Tanks To Be Electrically Connected Through Terminals On Tanks.
Oil Level 3½" Below Top of Tank.
Pipe Frame To Be Grounded
Template for Tank Platform Flanges.
Template for Foot Flanges.
Size of Holes.
Width of Slots.

For Style Nos. 231394, 231426 and 231428

Style No.	Voltage		Approx. No. Gal. Required		Dimensions in Inches														
	Min.	Max.	Electrolyte	*Oil	A	B	C	D	E	F	G	H	J	K	L	M	O	P	Q
231394	15001	25000	13½	128	48	105¼	12¼	7/16	1 13/16	12	20	23	58	100	45	58⅛	12⅛	19	23 11/16
231426	15001	25000	13½	128	48	105¼	12¼	7/16	1 13/16	12	20	23	58	100	45	53½	12⅛	19	23 11/16
231428	25001	37000	22	184	60	134	14	7/16	1 13/16	14	24	27	73	124	60	66½	13¾	23	25 11/16

*Lectroseal oil preferred.

TYPES AK AND AL ELECTROLYTIC LIGHTNING ARRESTERS—Continued

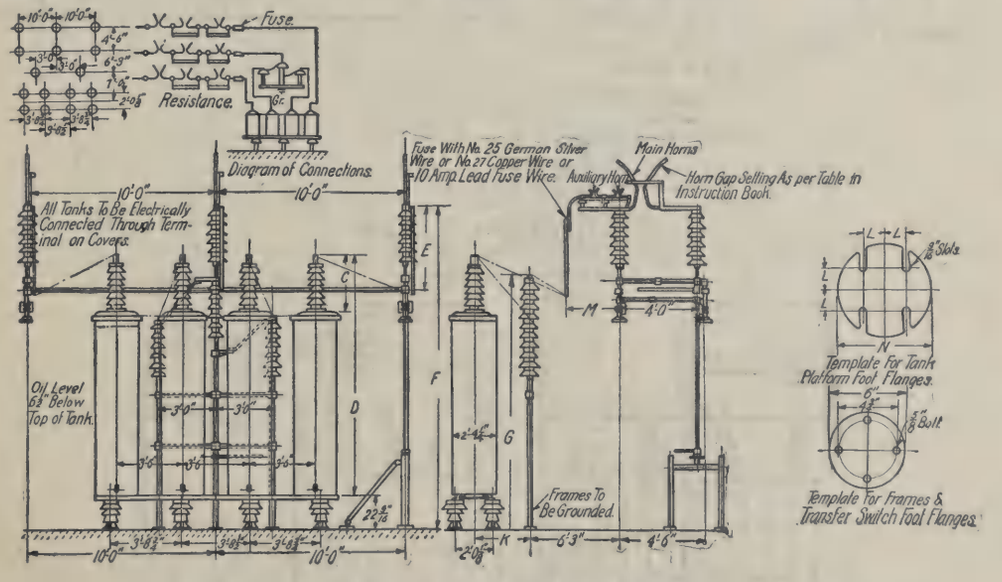

All tanks to be electrically connected through terminals on tanks.
Fuse with #25 German Silver wire or #27 copper wire or 10 Amp. Lead fuse wire.
Auxiliary Gap
Main Gap.
Horn gap setting as per table in instruction book.
Oil level 1" below top of tank
Pipe frame to be grounded
Template for tank platform foot flanges
Template for frame foot flanges
Template for transfer switch foot flanges

For Style Nos. 289639, 231430, 289640 and 231434

Style No.	Voltage Min.	Voltage Max.	Approx. No. Gal. Required Electrolyte	Approx. No. Gal. Required *Oil
289639	37001	46200	25	190
231430	46201	50000	27	200
289640	46201	69300	38	426
231434	69301	73000	40	440

*Lectroseal oil preferred.

Style No.	Dimensions in Inches A	B	C	D	E	H	I	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y
289639	72	19	145	24	79¾	17	28¼	49	77¼	1 3/16	72	30	6½	31 9/16	36	68	3½	108½	18 3/16	23	9⅞	16¼
231430	72	19	145	24	81¾	17	28¼	49	77¼	1 3/16	72	30	6½	31 9/16	36	68	3½	108½	18 3/16	23	9⅞	16¼
289640	96	22	184	32	112½	20	47¼	54	101¼	2 3/8	96	42	10	36 9/16	48	72	5	112	22¼	42	13⅞	20¼
231434	96	22	184	32	115	20	47¼	54	101¼	2 3/8	96	42	10	36 9/16	48	72	5	112	22¼	42	13⅞	20¼

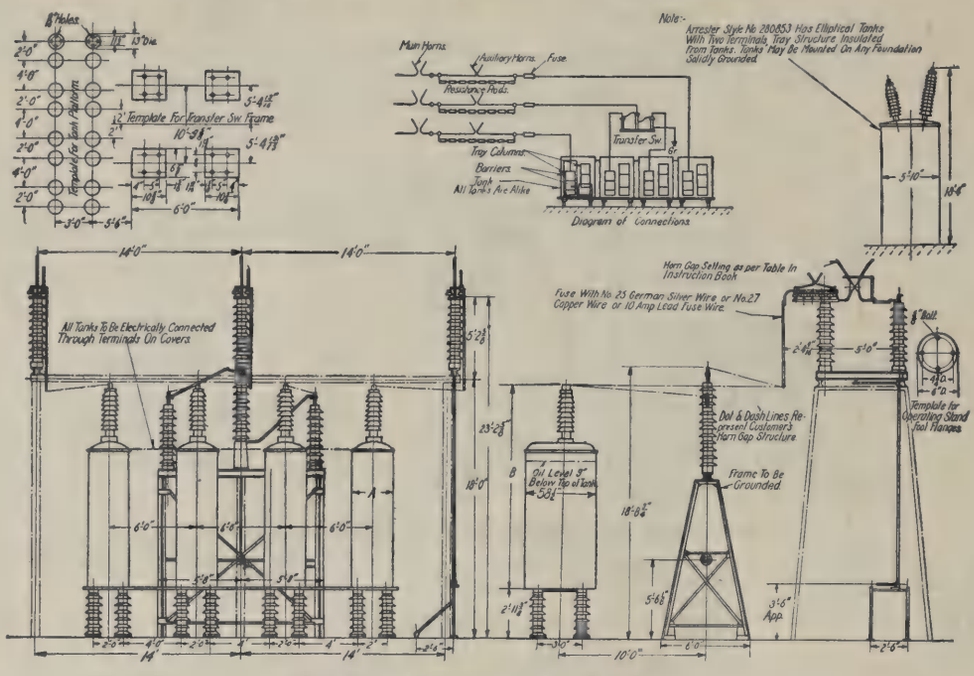

Fuse
Resistance
Diagram of Connections
All Tanks To Be Electrically Connected Through Terminal on Covers.
Fuse With No. 25 German Silver Wire or No. 27 Copper Wire or 10 Amp. Lead Fuse Wire.
Main Horns
Auxiliary Horn
Horn Gap Setting As per Table in Instruction Book.
Oil Level 6½" Below Top of Tank.
Frames To Be Grounded.
Template for Tank Platform Foot Flanges.
Template For Frames & Transfer Switch Foot Flanges.

For Style Nos. 280848 and 280850

Style No.	Voltage Normal	Voltage Min.	Voltage Max.	Approx. No. Gal. Required Electrolyte	Approx. No. Gal. Required *Oil	Dimensions in Inches C	D	E	F	G	K	L	M	N
280848	88000	69301	92400	55	1060	38¾	155¾	52¾	132½	163 3/16	84	2⅜	32 1/16	10
280850	110000	92401	115500	64	1280	37⅛	175 5/8	58¾	210½	169 3/16	96	2⅜	34 1/16	10

*Lectroseal oil preferred.

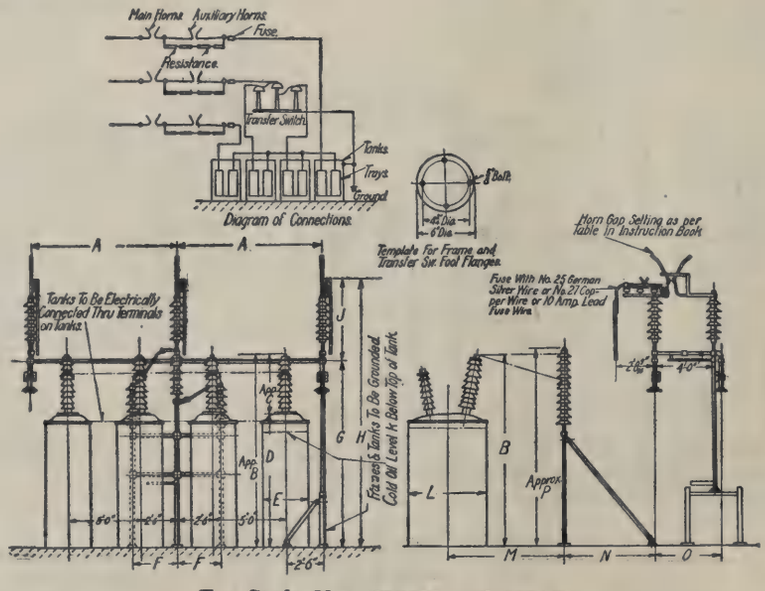
TYPES AK AND AL ELECTROLYTIC LIGHTNING ARRESTERS—Continued


Main Horns
Auxiliary Horns
Fuse
Resistance Rods
Transfer Sw.
Tray Columns
Barriers
Tank
All Tanks Are Alike
Diagram of Connections
Note:- Arrester Style No 280853 Has Elliptical Tanks With Two Terminals, Tray Structure Insulated From Tanks. Tanks May Be Mounted On Any Foundation Solidly Grounded
All Tanks To Be Electrically Connected Through Terminals On Covers
Horn Gap Setting as per Table In Instruction Book
Fuse With No. 25 German Silver Wire or No. 27 Copper Wire or 10 Amp. Lead Fuse Wire
Oil Level 3" Below Top of Tank
Frame To Be Grounded
Template for Operating Stand Foot Flanges
Template For Transfer Sw. Frame

For Style Nos. 280849 and 280851

Style No.	Voltage		Approx. No. Gal. Required		Dimensions in Inches														
	Min.	Max.	Electrolyte	*Oil	A	B	C	D	E	F	G	H	J	K	L	M	N	O	P
280849	66301	92400	55	3550	120	159½	50¼	109¼	38½	36	151¾	205¼	53½	4	64	96	75	54	140
280851	92401	115500	64	3880	120	169¾	49¼	120½	38½	36	151¾	211¼	59½	5½	64	96	75	54	170

*Lectroseal oil preferred.

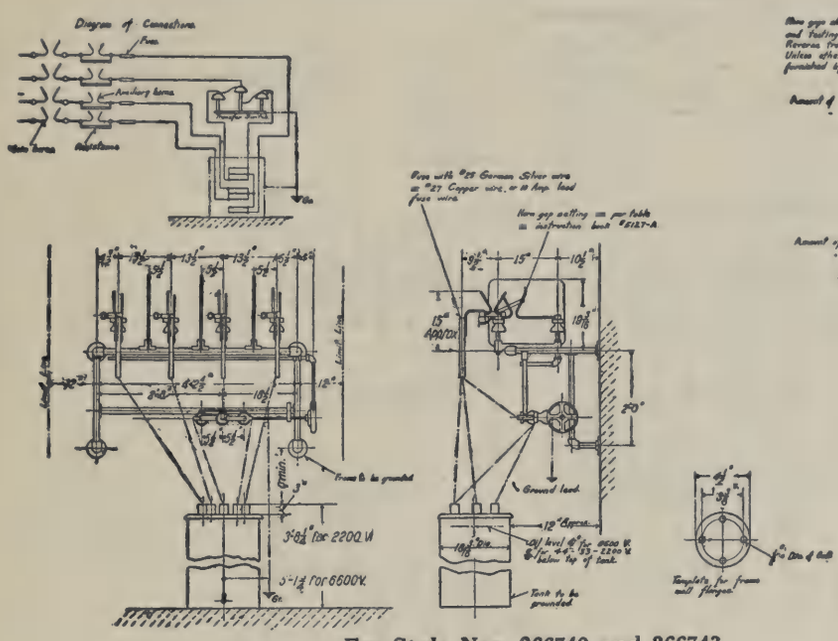

Main Horns
Auxiliary Horns
Fuse
Resistance
Transfer Switch
Tanks
Trays
Ground
Diagram of Connections
Template For Frame and Transfer Sw. Foot Flanges
Horn Gap Setting as per Table In Instruction Book
Fuse With No. 25 German Silver Wire or No. 27 Copper Wire or 10 Amp. Lead Fuse Wire
Tanks To Be Electrically Connected Thru Terminals on Tanks
Frame To Be Grounded. Cold Oil Level 4" Below Top of Tank
Approx.

For Style Nos. 280852 and 280853

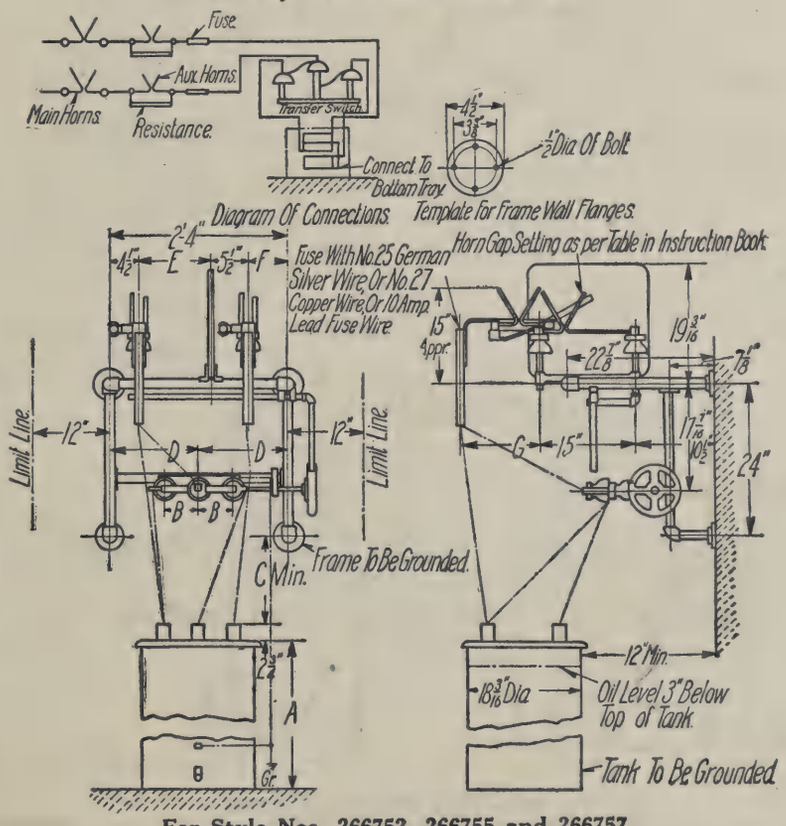
Style No.	Voltage Normal	Approx. No. Gal. Required Electrolyte	*Oil	Dimensions in Inches A	B
280852	132000	86	2840	34½	159¼
280853	132000	86	5200	44½	220

*Lectroseal oil preferred.

TYPES AK AND AL ELECTROLYTIC LIGHTNING ARRESTERS—Continued



For Style Nos. 266740 and 266743


Fuse.
Aux. Horns.
Main Horns.
Resistance.
Transfer Switch.
Connect To Bottom Tray.
1/2 Dia Of Bolt.
Diagram Of Connections.
Template for Frame Wall Flanges.
Horn Gap Setting as per Table in Instruction Book.
Fuse With No. 25 German Silver Wire, Or No. 27 Copper Wire, Or 10 Amp. Lead Fuse Wire.
Limit Line.
Frame To Be Grounded.
Oil Level 3" Below Top of Tank.
Tank To Be Grounded.

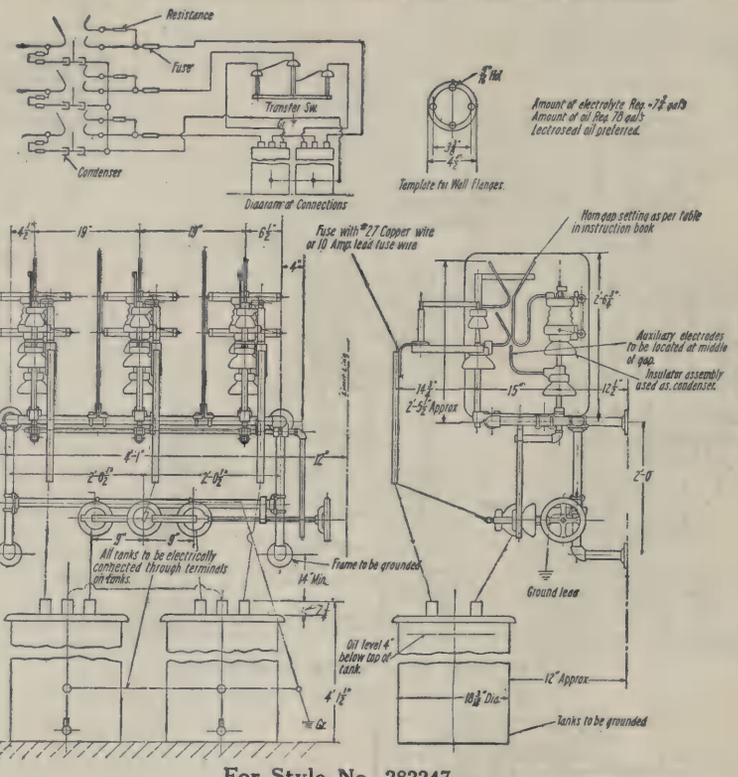
For Style Nos. 266752, 266755 and 266757

Style No.	Voltage Min.	Voltage Max.	Approx. No. Gal. Required Electrolyte	Approx. No. Gal. Required *Oil	Dimensions in Inches A	B	C	D	E	F	G
266752	1000	3000	1¼	34	34¼	5½	▪	11¾	▪	5½	10 5/16
266755	5001	7500	3	46	44¾	5½	8	11¾	▪	5½	11
266757	7501	15000	6	65½	61¾	9▪	12	14	11½	6½	11

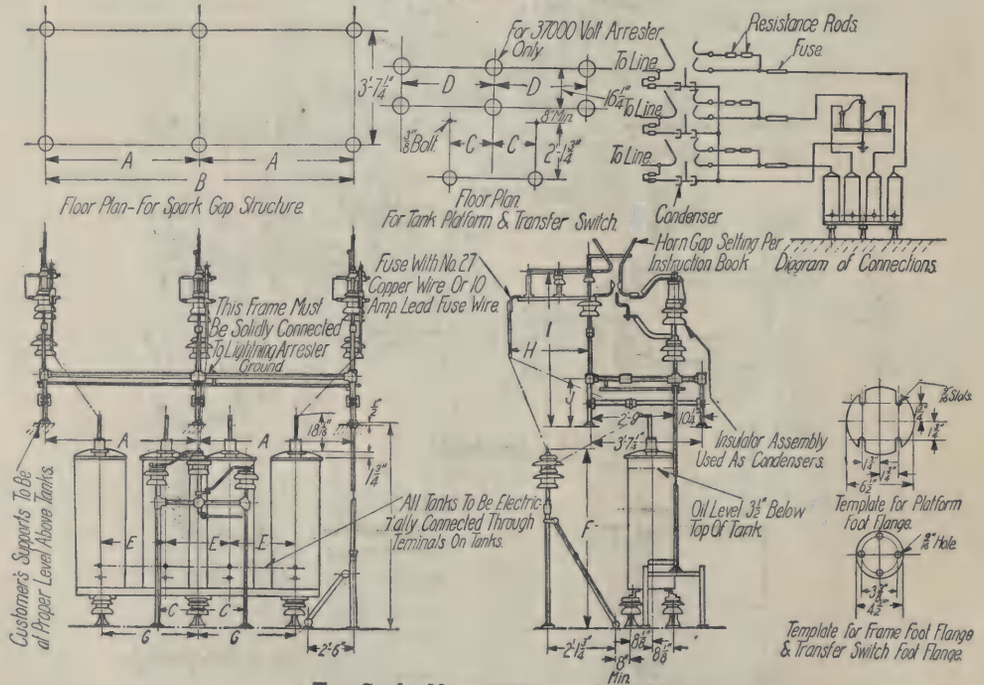
*Lectroseal oil preferred.

1014-22A

TYPES AK AND AL ELECTROLYTIC LIGHTNING ARRESTERS—Continued


Resistance
Fuse
Transfer Sw.
Condenser
Diagram of Connections
Template for Wall Flanges
Amount of electrolyte Req. 7½ gals
Amount of oil Req. 70 gals
Lectroseal oil preferred.
Fuse with #27 Copper wire or 10 Amp. lead fuse wire
Horn gap setting as per table in instruction book
Auxiliary electrodes to be located at middle of gap.
Insulator assembly used as condenser.
Limit Line
All tanks to be electrically connected through terminals on tanks.
Frame to be grounded
Ground lead
Oil level 4" below top of tank.
12" Approx.
Tanks to be grounded

For Style No. 282247

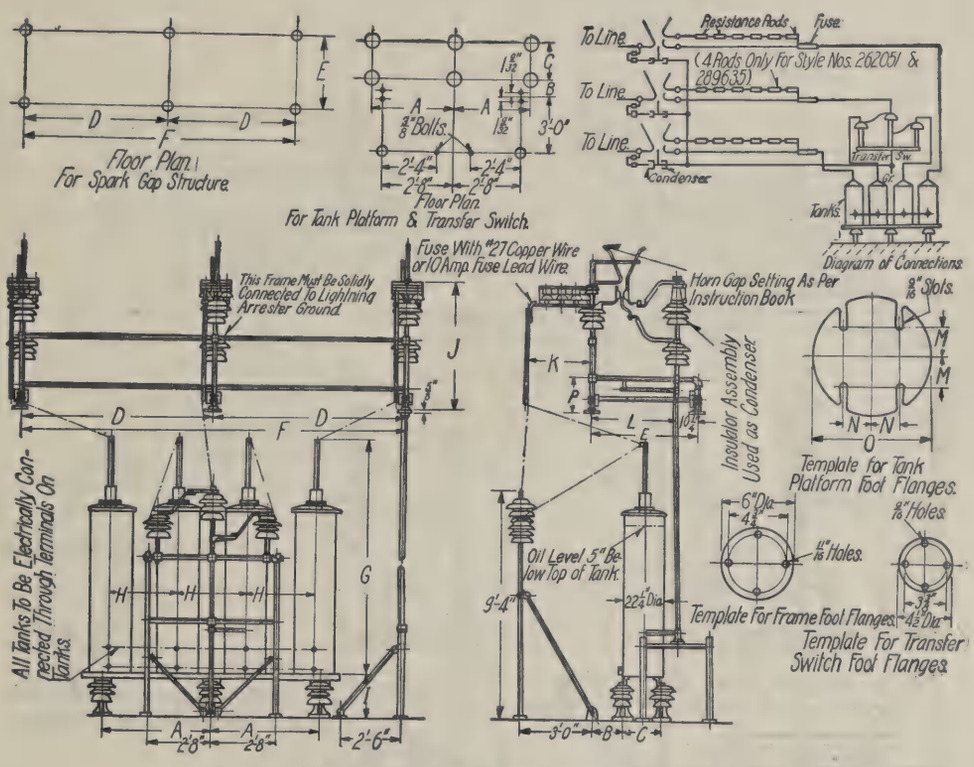

Floor Plan-For Spark Gap Structure
Floor Plan For Tank Platform & Transfer Switch
For 37000 Volt Arrester Only
To Line
Resistance Rods
Fuse
Condenser
Horn Gap Setting Per Instruction Book
Diagram of Connections
Fuse With No. 27 Copper Wire Or 10 Amp. Lead Fuse Wire
This Frame Must Be Solidly Connected To Lightning Arrester Ground
Customer's Supports To Be at Proper Level Above Tanks.
All Tanks To Be Electrically Connected Through Terminals On Tanks.
Insulator Assembly Used As Condensers.
Oil Level 3½" Below Top Of Tank.
Template for Platform Foot Flange.
Template for Frame Foot Flange & Transfer Switch Foot Flange.

For Style Nos. 277811 and 262066

Style No.	Voltage		Approx. No. Gal. Required		Dimensions in Inches									
	Min.	Max.	Electrolyte	*Oil	A	B	C	D	E	F	G	H	I	J
277811	15001	25000	13½	128	48	96	16	29	20	62⅞	29	29⅞	46¼	13
262066	25001	37000	19¾	184	59¼	118½	16	37	25¼	84⅞	37	28 1/16	49⅝	13

*Lectroseal oil preferred.

TYPES AK AND AL ELECTROLYTIC LIGHTNING ARRESTERS—Continued.

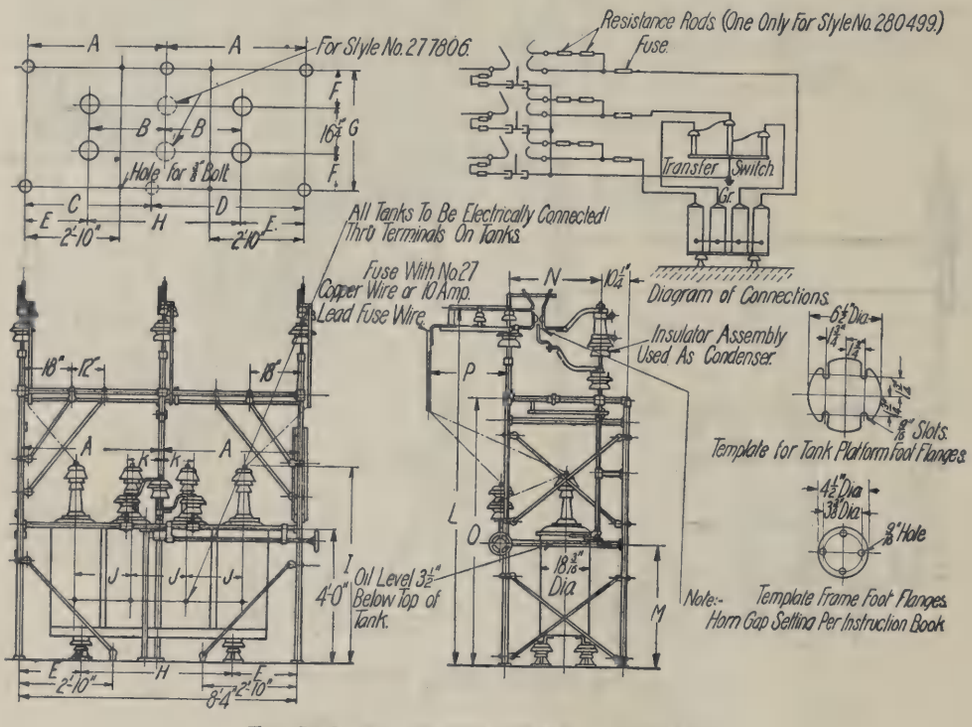

Floor Plan For Spark Gap Structure
Floor Plan For Tank Platform & Transfer Switch
Resistance Rods
Fuse
To Line
(4 Rods Only for Style Nos. 262051 & 289635)
Transfer Sw.
Condenser
Tanks
Diagram of Connections
This Frame Must Be Solidly Connected To Lightning Arrester Ground
Fuse With #27 Copper Wire or 10 Amp. Fuse Lead Wire
Horn Gap Setting As Per Instruction Book
Insulator Assembly Used as Condenser
All Tanks To Be Electrically Connected Through Terminals On Tanks
Oil Level 5" Below Top of Tank
Template for Tank Platform Foot Flanges.
Template For Frame Foot Flanges.
Template For Transfer Switch Foot Flanges.

For Style Nos. 289635, 262051, 289636 and 269042

Style No.	Voltage		Approx. No. Gal. Required		Dimensions in Inches													
	Min.	Max.	Electrolyte	*Oil	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
289635	37001	46200	25	198	49	10	16¼	70 9/16	49¾	141⅛	79¼	30	15⅝	53¾	31⅞	39½	1¾	1¾	6½
262051	46201	50000	27	208	49	10	16¼	70 9/16	49¾	141⅛	81¾	30	15⅝	53¾	31⅞	39½	1¾	1¾	6½
289636	46201	69300	38	426	54	16	20¼	94½	52¼	189	112	34	21	59	32⅛	42	2⅜	2⅜	10
262042	69301	73000	40	440	54	16	20¼	94½	52¼	189	114½	34	21	59	32⅛	42	2⅜	2⅜	10

*Lectroseal oil preferred.

TYPES AK AND AL ELECTROLYTIC LIGHTNING ARRESTERS—Continued

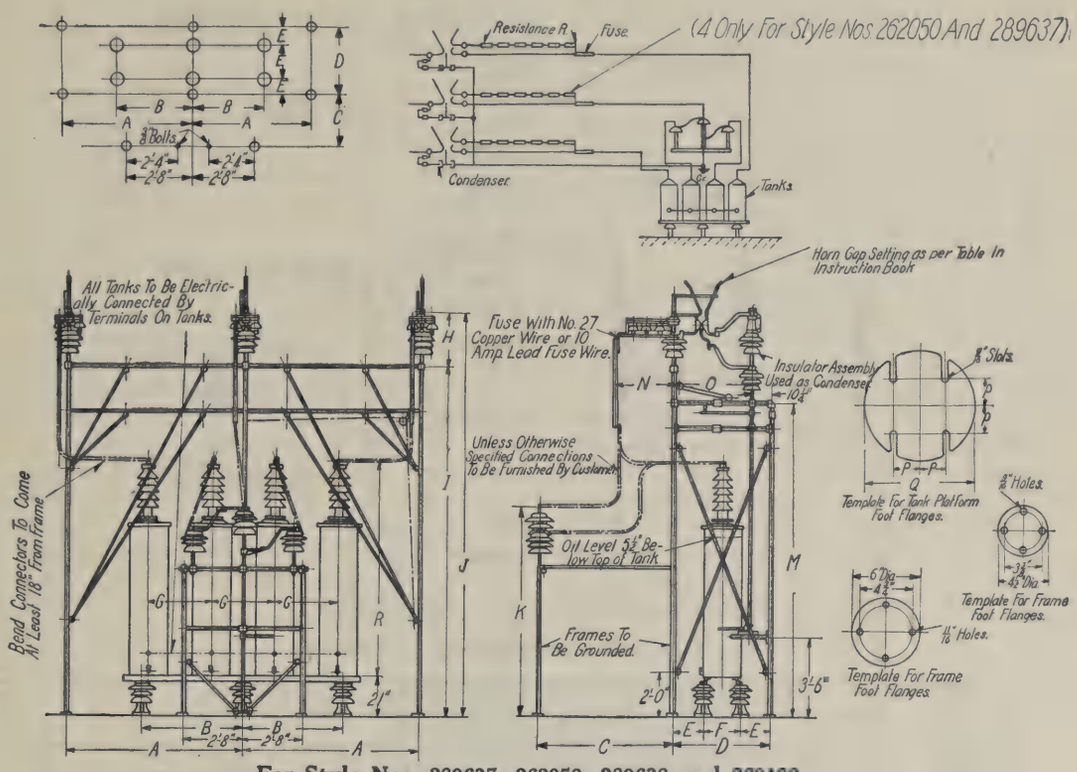

Resistance Rods (One Only For Style No. 280499.)
Fuse
For Style No. 277806.
Transfer Switch
To Gr.
All Tanks To Be Electrically Connected Thru Terminals On Tanks.
Fuse With No. 27 Copper Wire or 10 Amp. Lead Fuse Wire
Diagram of Connections.
Insulator Assembly Used As Condenser
Hole for ⅞" Bolt
Template for Tank Platform Foot Flanges.
⅞" Slots.
⅞" Hole
Oil Level 3½" Below Top of Tank.
4'-0"
Dia.
Note:- Horn Gap Setting Per Instruction Book
Template Frame Foot Flanges.

For Style Nos. 280499, 277808 and 277806

Style No.	Voltage		Approx. No. Gal. Required		Dimensions in Inches														
	Min.	Max.	Electrolyte	*Oil	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
280499	10000	15000	8¼	92	47¼	29	....	....	18¼	12	40¼	58	52⅛	20	12	124¾	43½	30	96	18½
277808	15001	25000	13½	128	50	29	45½	54½	21	13½	43¼	58	67½	20	12	130¾	43½	33	96	29⅞
277806	25001	37000	20	184	59¼	37	....	....	22¼	13½	43¼	74	83 13/16	25¼	14	145⅝	43½	33	108	28 15/16

*Lectroseal oil preferred.

TYPES AK AND AL ELECTROLYTIC LIGHTNING ARRESTERS—Continued

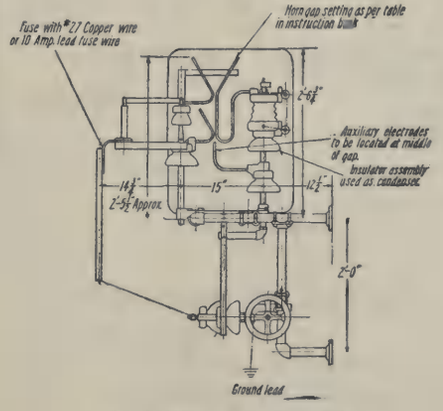

Resistance R.
Fuse.
(4 Only For Style Nos. 262050 And 289637)
Condenser
Tanks
Horn Gap Setting as per Table In Instruction Book
All Tanks To Be Electrically Connected By Terminals On Tanks.
Fuse With No. 27 Copper Wire or 10 Amp. Lead Fuse Wire.
Insulator Assembly Used as Condenser
Unless Otherwise Specified Connections To Be Furnished By Customer
Oil Level 5½" Below Top of Tank
Frames To Be Grounded.
Bend Connectors To Come At Least 18" From Frame
Template for Tank Platform Foot Flanges.
Template for Frame Foot Flanges.
Template For Frame Foot Flanges

For Style Nos. 289637, 262050, 289638 and 280480

Style No.	Voltage Min.	Voltage Max.	Approx. No. Gal. Electrolyte	Approx. No. Gal. *Oil
289637	37001	46200	25	198
262050	46201	50000	27	208
289638	46201	69300	38	426
280480	69301	73000	40	440

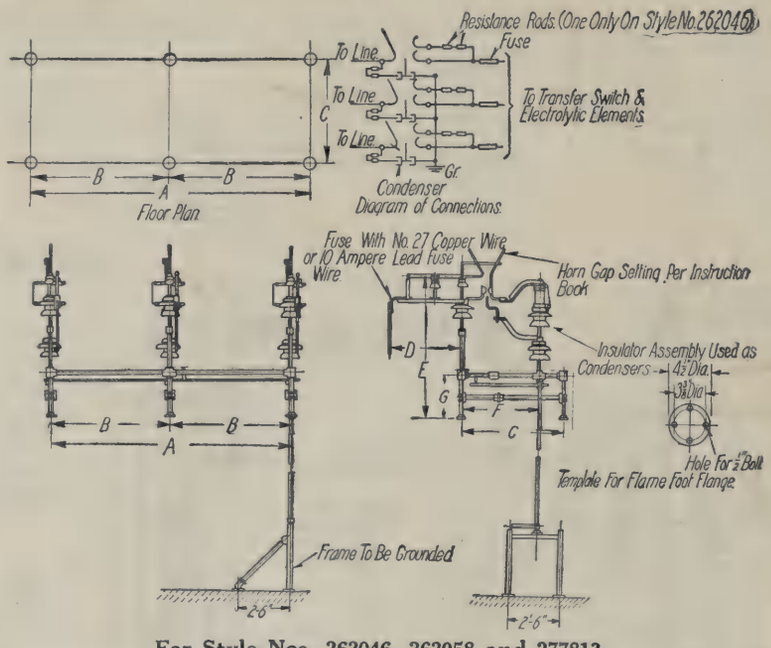
*Lectroseal oil preferred.

Style No.	Dimensions in Inches																	
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
289637	70 3/16	49	32	49¾	16¾	16¼	30	26¼	141½	167¾	112½	18 3/16	126	31⅞	39½	1¾	6½	112
262050	70 3/16	49	32	49¾	16¾	16¼	30	26¼	141½	167¾	112½	18 3/16	126	31⅞	39½	1¾	6½	114½
289638	84½	54	72	52¼	16	20¼	34	29	186	215	112	22¼	168	32⅛	42	2⅜	10	112
280480	84½	54	72	52¼	16	20¼	34	29	186	215	112	22¼	168	32⅛	42	2⅜	10	114½


Fuse with #27 Copper wire or 10 Amp. lead fuse wire
Horn gap setting as per table in instruction book
Auxiliary electrodes to be located at middle of gap.
Insulator assembly used as condenser.
Ground lead

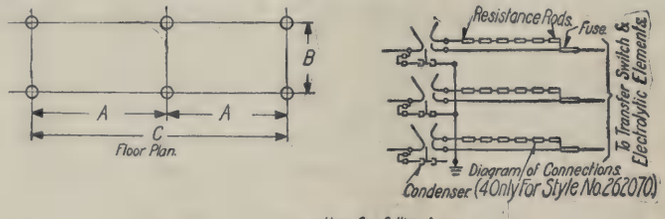
For Style No. 282246,

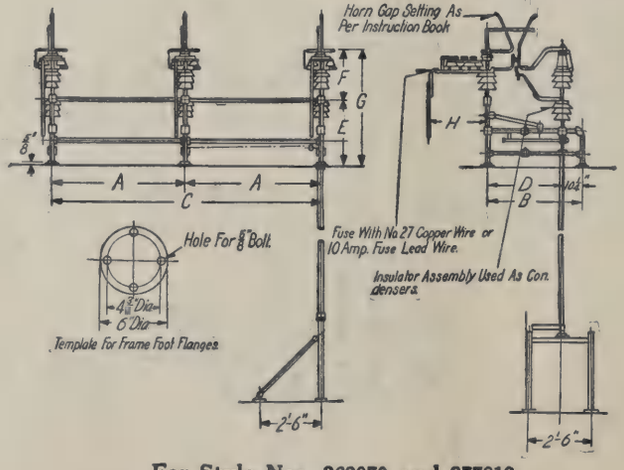
TYPES AK AND AL ELECTROLYTIC LIGHTNING ARRESTERS—Continued



For Style Nos. 262046, 262058 and 277813

Style No.	Volts		Dimensions in Inches					
	Min.	Max.	A	B	C	D	E	F
262046	10000	15000	94½	47¼	40¼	18½	40¾	30
262058	15001	25000	100	50	43¼	29⅞	46¼	33
277813	25001	37000	118½	59¼	43¼	28 7/16	49⅝	33





For Style Nos. 262070 and 277810

Style No.	Voltage Normal	Dimensions in Inches							
		A	B	C	D	E	F	G	H
262070	44000	70 3/16	49¾	141⅛	39½	32¼	26¼	58½	31⅜
277810	66000	94½	52¼	189	42	34½	29	63½	32⅛

CHOKE COILS

FOR A. C. LIGHT AND POWER CIRCUITS

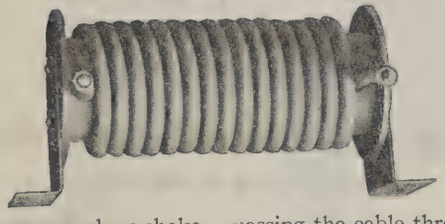
Whenever a surge of high frequency or a steep wave front due to lightning or any other cause travels along a line and strikes an inductive winding, it builds up a high voltage between the end turns of that winding and also a high voltage to ground. This may cause a breakdown of the insulation between turns or to ground through which a heavy power current may follow and cause great damage. A choke coil is intended to be connected between such a transformer or generator winding and the lightning arrester line connection to take the brunt of such surges in place of the end turns of the power apparatus. It is necessary, therefore, that the choke coil be strongly insulated both between turns and to ground. Besides relieving the end turns of the power apparatus by receiving the first shock of a surge and flattening it out before it can enter the power apparatus, it likewise, by delaying the progress of the surge and piling up the voltage momentarily at the line end of the choke coil, gives the lightning arrester more time and more tendency to discharge and relieve the line.

The relative ability of a choke coil of the helix form to perform this function is, for any given number of turns per inch length of coil, determined by the total length and the square of the mean diameter of the coil. With choke coils of equal length and equal mean diameter, this varies as the square of the number of turns.

While a very small choke coil has low protective power, a very large coil will introduce excessive reactance in the line and impair the regulation. It is therefore necessary to choose for any service a choke coil proportional to the needs of the apparatus to be protected. It must also, of course, have a current capacity suited to the circuit in which it is to be used, so as to avoid overheating.

TYPE 191 CHOKE COIL CORES

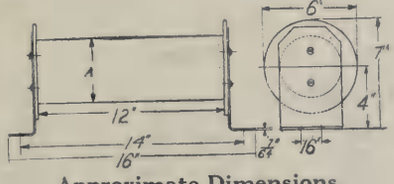
For Voltages Up to 1500 D. C.



Type 191 core is used on railway cars where choke coils are wanted in addition to lightning arresters. This core should be wound with a layer of trolley cable during installation, for which there will be required from 20 to 30 feet extra of cable depending upon the size. The end turns can be fastened by passing the cable through holes in the end washers or central cylinder.

The current capacity depends upon the size of cable used.

The type 191-A core has a plain wooden drum and insulating end washers carried on sheet metal end brackets.



Approximate Dimensions

Style No.	Type	Approximate Weight Net	Approximate Weight Boxed	List Price Each
170643	191-A	5	8	$2 80

TYPE D-6 INDOOR CHOKE COILS

For Voltages Up to 15000 Maximum

The type D-6 choke coil, which is a suitably mounted coil of insulated wire wound on a small diameter wooden core, may be used where only a moderate degree of protection is desired.

This type is available in three forms up to 200 amperes capacity for three voltage classes; 5000 volts, 7500 volts, and 15,000 volts, all using the same coil, but different mountings.

The 5000-volt coil consists of the standard core and winding with iron feet for support. This coil is adapted to mounting in any position.

The 7500-volt coil is the standard 5000-volt coil complete mounted on a suitable marble base.

The 15,000-volt coil consists of the standard core and winding supported by porcelain pillar insulators on the bases of which are clamped flat iron mounting castings.

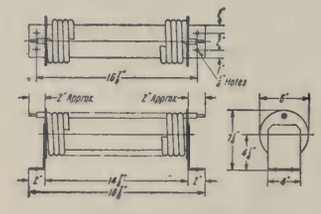
CHOKE COILS—Continued

Prices

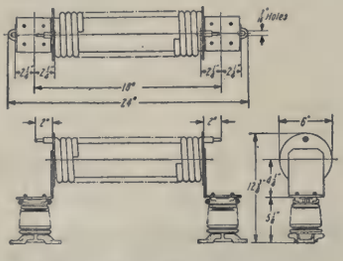
Style No.	Maximum Voltage	Amperes Mounting		Approx Wt., Lb. Net	Boxed	List Price
237782	5000	25		14	30	$20 00
237783	5000	50		15	31	23 50
237784	5000	75	Iron	16	32	27 00
237785	5000	100	Feet	18	34	30 00
242685	5000	150		20	36	38 75
242686	5000	200		24	40	43 00
242687	15000	25		20	38	27 50
242688	15000	50	Porcelain	21	39	32 00
242689	15000	75	Pillar	22	40	37 00
242690	15000	100	Insulators	24	42	42 00
237786	7500	25		54	84	27 50
237787	7500	50	Marble	55	85	30 50
237788	7500	75	Base	56	86	34 00
237789	7500	100		58	88	37 00

Order by Style Number

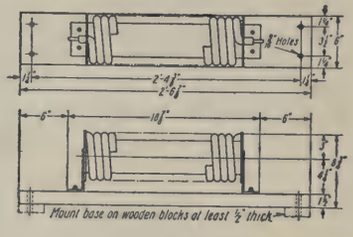
Approximate Dimensions



Txpe D-6 with Iron Feet



Type D-6 with Porcelain Pillar Insulators



Type D-6 with Marble Base

TYPE DM INDOOR CHOKE COILS

For Voltage Up to 7500 Maximum

The type DM choke coil, consisting of a 9-inch air core helix of aluminum rod supported by cast terminals direct on a marble base, affords a high protective value for service up to its voltage rating. This type uses the same coil as the type D-9, with consequent equal protective value, but for low voltage circuits has the advantage of a more compact method of mounting.

Type DM Choke Coil

Prices

Style No.	Maximum Voltage	Amperes	Mounting	Approx. Wt., Lbs. Net	Boxed	List Price
230225	7500	200	Marble Base	55	110	$ 62 50
230226	7500	400	Marble Base	63	118	96 00
230227	7500	600	Marble Base	85	140	130 00
236440	7500	800	Marble Base	105	160	163 00
236441	7500	1000	Marble Base	125	180	196 00
236442	7500	1400	Marble Base	145	205	255 00
236443	7500	1700	Marble Base	169	230	312 50
236444	7500	2000	Marble Base	203	265	362 50
236445	7500	2400	Marble Base	240	305	430 00

Order by Style Number

CHOKE COILS—Continued

Approximate Dimensions

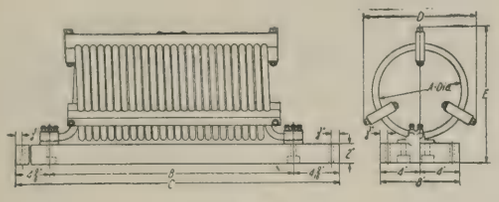


Fig. 1

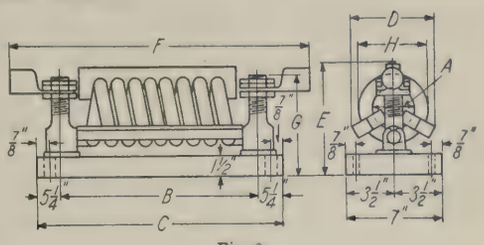


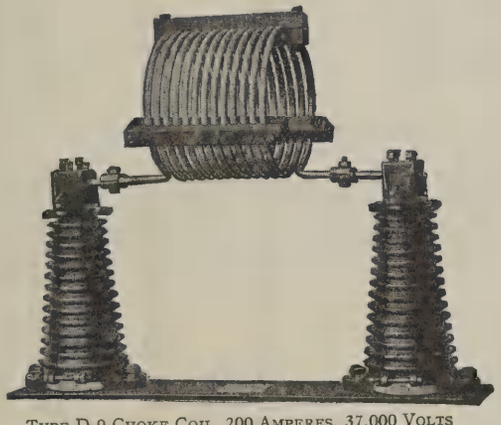
Fig. 2

Amperes	Fig.	Dimensions in Inches A	B	C	D	E	F	G	H
200	1	8 1/8	18 1/8	27 1/4	10 3/8	13 1/8	10	...	....
400–600	1	8 3/8	23 1/8	32 1/8	11 1/8	14 1/4	12 3/4	...	....
800	2	8	16 1/2	27	11 7/8	13 5/8	24 1/4	5 3/4	9 5/8
1000	2	8	16 1/2	27	12	16 1/16	24	6	10
1400	2	8	19 1/2	30	12 1/8	14 1/16	27	6	10 1/4
1700	2	8	19 1/2	30	12 1/4	14 3/8	27 5/8	8 1/4	10 1/2
2000	2	8	23 1/2	34	12 3/8	14 1/2	31 5/8	8 1/4	10 3/4
2400	2	8	23 1/2	34	12 1/2	14 5/8	31 3/8	9 3/4	11

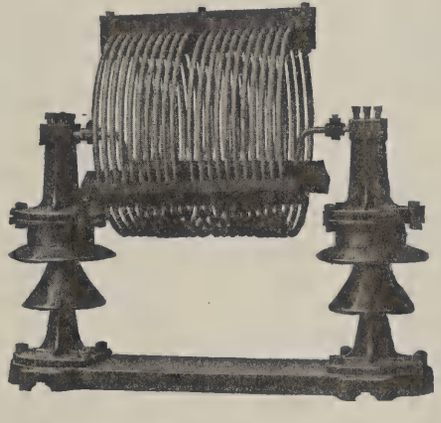
These dimensions are for reference only.
For official dimensions apply to the nearest district office.

TYPE D-9 AND D-15 CHOKE COILS

For Voltages Up to 132,000



Type D-9 Choke Coil, 200 Amperes, 37,000 Volts



Type D-15 Choke Coil (Up to 50,000 Volts)

The types D-9 and D-15 choke coils are available for service over the entire range of standard voltages.

The type D-9 is a 9-inch coil as used in the type DM, and offers sufficient protection for many installations.

The type D-15, using a 15-inch coil, with consequently approximately six times the impedance of the type D-9, represents a design available for installations where maximum protection with this type of coil is desired or warranted.

General Construction—The coil in these types is a helix of aluminum rod in 200 and 400 ampere capacities, and of copper in capacities of 600 amperes and above. The type D-9 coil is about 9 inches in diameter and contains 13 turns. The type D-15 coil is about 15 inches in diameter and contains 20 turns in all sizes up to 66,000 rated volts. Above this voltage the coils contain 30 turns. Bracing clamps are provided to rigidly separate the turns and give mechanical strength to the helix.

Mounting—Both types are listed for outdoor mounting up to 132,000 rated volts, and a separate line of indoor type D-9 coils is shown for voltages up to 66,000 rated volts. All ratings of indoor type D-9, outdoor type D-9 above 66,000 volts, and all type D-15 coils are adapted to inverted mounting.

All coils are thoroughly insulated according to standard practice for this class of apparatus.

The type D-9 indoor coils are mounted on porcelain pillar insulators, which in the standard form are bolted to sheet steel bases for wall mounting, or are provided with clamp castings for pipe mounting.

The type D-9 outdoor coils up to 44,000 rated volts are mounted on pin-type insulators, two of which are required for each coil. The insulators are in turn mounted on a channel iron base. The coils can be mounted only in an upright horizontal position.

The type D-9 outdoor coils in 66,000 rated volts, is mounted on two pin type insulators which are bolted to a sheet steel base. This unit in turn is supported by a single pin-type insulator mounted on a channel iron base.

The type D-9 outdoor coils, 88,000 rated volts and

CHOKE COILS—Continued

above, are mounted the same as outlined in the preceeding paragraph, except that instead of the single pin-type insulator a built-up and bolted-together main insulator is used. This bolted-together construction makes it possible to change easily the number of insulators used per column, or to replace defective porcelain units without replacing the entire column. This type is invertible by inverting all three insulators.

The type D-15 coils up to 88,000 rated volts are supported directly on two pin-type insulators, which are bolted to a cast iron base. The type D-15 coils 88,000 rated volts and above are mounted similarly on two built-up insulators mounted on a channel iron base.

Prices

Style No.	Voltage Normal	Voltage Maximum	Amperes	Mounting	Approx. Wt., Lb. Net	Approx. Wt., Lb. Boxed	List Price
Type D-9 Indoor Choke Coils (Invertible)							
Wall Mounting							
236603	.....	7500	200	Sheet Steel Base	32	60	$ 52 00
236604	.....	15000	200	Sheet Steel Base	34	64	60 00
236605	.....	25000	200	Sheet Steel Base	37	68	66 00
236606	.....	37000	200	Sheet Steel Base	42	72	76 00
236607	44000*	.....	200	Sheet Steel Base	48	78	81 00
270574	66000*	.....	200	Sheet Steel Base	100	150	127 00
236608	.....	7500	400	Sheet Steel Base	41	69	70 00
236609	.....	15000	400	Sheet Steel Base	43	73	76 00
236610	.....	25000	400	Sheet Steel Base	46	77	85 00
236611	.....	37000	400	Sheet Steel Base	51	81	94 00
236612	44000*	.....	400	Sheet Steel Base	57	87	100 00
270575	66000*	.....	400	Sheet Steel Base	109	139	142 00
236613	.....	7500	600	Sheet Steel Base	76	104	90 00
236614	.....	15000	600	Sheet Steel Base	78	108	97 00
236615	.....	25000	600	Sheet Steel Base	81	112	105 00
236616	.....	37000	600	Sheet Steel Base	86	116	112 50
236617	44000*	.....	600	Sheet Steel Base	92	122	120 00
270576	66000*	.....	600	Sheet Steel Base	44	174	150 00
Type D-9 Indoor Choke Coils (Invertible)							
Pipe Mounting							
263765	.....	7500	200	1¼-Inch Pipe	27	55	54 50
263766	.....	15000	200	1¼-Inch Pipe	29	59	62 50
263767	.....	25000	200	1¼-Inch Pipe	32	63	68 50
263768	.....	37000	200	1¼-Inch Pipe	37	65	78 50
263769	44000*	.....	200	1¼-Inch Pipe	43	73	83 50
270568	44000*	.....	200	2-Inch Pipe	43	73	90 00
270571	66000*	.....	200	2-Inch Pipe	75	105	134 50
263770	.....	7500	400	1¼-Inch Pipe	36	64	72 50
263771	.....	15000	400	1¼-Inch Pipe	38	68	78 50
263772	.....	25000	400	1¼-Inch Pipe	41	72	87 50
263773	.....	37000	400	1¼-Inch Pipe	46	86	96 50
263774	44000*	.....	400	1¼-Inch Pipe	52	82	102 50
270569	44000*	.....	400	2-Inch Pipe	52	82	109 00
270572	66000*	.....	400	2-Inch Pipe	62	110	150 00
263775	.....	7500	600	1¼-Inch Pipe	71	99	92 50
263776	.....	15000	600	1¼-Inch Pipe	73	103	99 50
263777	.....	25000	600	1¼-Inch Pipe	76	107	107 50
263778	.....	37000	600	1¼-Inch Pipe	81	111	115 00
263779	44000*	.....	600	1¼-Inch Pipe	87	117	122 50
270570	44000*	.....	600	2-Inch Pipe	87	117	129 00
270573	66000*	.....	600	2-Inch Pipe	98	146	158 00
Type D-9 Indoor or Outdoor Choke Coils (Invertible for 88,000 Volts and Above)							
285371	.....	15000	200	Channel Iron Base	70	140	$ 50 00
277954	.....	25000	200	Channel Iron Base	85	160	57 00
277809	.....	37000	200	Channel Iron Base	100	180	67 00
262062	44000*	.....	200	Channel Iron Base	120	205	71 00
285374	66000*	.....	200	Channel Iron Base	130	210	87 50
236621	88000†	.....	200	Channel Iron Base	182	280	170 00
236622	110000†	.....	200	Channel Iron Base	195	300	190 00
236623	132000†	.....	200	Channel Iron Base	210	320	207 00
285372	.....	15000	400	Channel Iron Base	92	160	67 00
277956	.....	25000	400	Channel Iron Base	102	180	75 00
267047	.....	37000	400	Channel Iron Base	117	200	84 00
262055	44000*	.....	400	Channel Iron Base	137	225	87 50
285375	66000*	.....	400	Channel Iron Base	147	230	104 00
237863	88000†	.....	400	Channel Iron Base	200	300	190 00
237864	110000†	.....	400	Channel Iron Base	222	320	210 00
237865	132000†	.....	400	Channel Iron Base	237	340	215 00

*Choke coils rated at 44,000 normal voltage have a maximum rating of 50,000 volts and choke coils rated at 66,000 normal voltage have a maximum rating of 73,000 volts. These coils may be applied up to maximum rating.

†Choke coils rated at 88,000 normal voltage or higher may be applied on systems having a maximum voltage not exceeding 9 per cent above rated voltage.

Order by Style Number

CHOKE COILS—Continued

Prices—Continued

Style No.	Voltage Normal	Voltage Maximum	Amperes	Mounting	Approx. Wt., Lb. Net	Approx. Wt., Lb. Boxed	List Price
Type D-9 Indoor or Outdoor Choke Coils—Continued							
285373	.....	15000	600	Channel Iron Base	185	280	$ 87 50
277955	.....	25000	600	Channel Iron Base	160	235	95 00
277807	.....	37000	600	Channel Iron Base	175	255	103 00
277816	44000*	.....	600	Channel Iron Base	195	280	109 00
285376	66000*	.....	600	Channel Iron Base	205	295	124 00
237870	88000†	.....	600	Channel Iron Base	260	355	213 00
237890	110000†	.....	600	Channel Iron Base	270	375	233 00
237891	132000†	.....	600	Channel Iron Base	285	395	250 00
Type D-15 Indoor or Outdoor Choke Coils (Invertible)							
183508	.....	25000	200	Cast Iron Base	110	241	84 00
183509	.....	37000	200	Cast Iron Base	126	258	96 00
183510	44000*	.....	200	Cast Iron Base	150	282	102 50
183511	66000*	.....	200	Cast Iron Base	180	311	120 00
142399	88000†	.....	200	Channel Iron Base	280	423	254 00
142400	110000†	.....	200	Channel Iron Base	300	460	302 00
237852	132000†	.....	200	Channel Iron Base	320	480	340 00
183512	.....	25000	400	Cast Iron Base	127	257	112 50
183513	.....	37000	400	Cast Iron Base	143	275	123 50
183514	44000*	.....	400	Cast Iron Base	167	298	130 00
183515	66000*	.....	400	Cast Iron Base	197	328	150 00
179961	88000†	.....	400	Channel Iron Base	303	446	327 00
179962	110000†	.....	400	Channel Iron Base	323	483	340 00
237871	132000†	.....	400	Channel Iron Base	343	503	380 00
183516	.....	25000	600	Cast Iron Base	187	330	150 00
223412	.....	37000	600	Cast Iron Base	233	376	162 50
223413	44000*	.....	600	Cast Iron Base	257	400	170 00
223414	66000*	.....	600	Cast Iron Base	290	430	187 50
237880	88000†	.....	600	Channel Iron Base	390	542	425 00
237881	110000†	.....	600	Channel Iron Base	410	565	460 00
237882	132000†	.....	600	Channel Iron Base	430	588	490 00
183517‡	.....	25000	800	Cast Iron Base	318	458	285 00
183518‡	.....	25000	1000	Cast Iron Base	405	555	467 00

*Choke coils rated at 44,000 normal voltage have a maximum rating of 50,000 volts and choke coils rated at 66,000 normal voltage have a maximum rating of 73,000 volts. These coils may be applied up to maximum rating.

†Choke coils rated at 88,000 normal voltage or higher may be applied on systems having a maximum voltage not exceeding 5 per cent above rated voltage.

‡On account of the considerable weight of these coils they should be mounted in a horizontal position. For other mounting, either vertical or ceiling mounting, special coils will be supplied.

Order by Style Number

Approximate Dimensions

Type D-9 Indoor Choke Coils (Invertible)

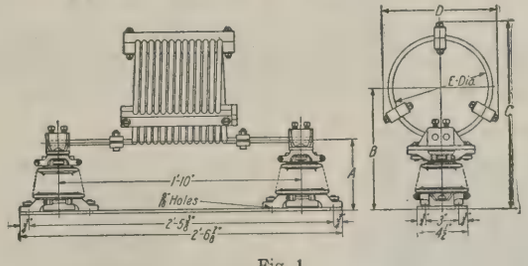


Fig. 1

Fig.	Amps	Voltage Normal	Voltage Maximum	Dimensions in Inches A	B	C	D	E
			Wall Mounting					
1	200	.....	7500	5 13/32	9 29/32	15 25/32	10 3/16	8 9/16
1	200	.....	15000	6 5/32	11 9/32	17 5/32	10 3/8	8 9/16
1	200	.....	25000	9 11/32	14 1/32	19 29/32	10 3/8	8 9/16
1	200	.....	37000	13 3/32	17 25/32	23 21/32	10 3/8	8 9/16
1	200	44000*	.....	17 13/32	21 21/32	27 5/32	10 3/8	8 9/16
1	200	66000*	.....	25 3/8	29 7/8	35 3/4	10 3/8	8 9/16
1	400–600	.....	7500	5 13/32	9 29/32	16 3/32	11 1/8	8 3/8
1	400–600	.....	15000	6 5/32	11 9/32	17 13/32	11 1/8	8 3/8
1	400–600	.....	25000	9 11/32	14 1/32	20 11/32	11 1/8	8 3/8
1	400–600	.....	37000	13 3/32	17 25/32	24 3/32	11 1/8	8 3/8
1	400–600	44000*	.....	17 13/32	21 21/32	28 5/32	11 1/8	8 3/8
1	400–600	66000*	.....	25 3/8	29 7/8	36 1/4	11 1/4	8 3/8

These dimensions are for reference only. For official dimensions apply to the nearest district office.

*Choke coils rated at 44,000 normal voltage have a maximum rating of 50,000 volts and choke coils rated at 66,000 normal voltage have a maximum rating of 73,000 volts. These coils may be applied up to maximum rating.

CHOKE COILS—Continued

Approximate Dimensions—Continued

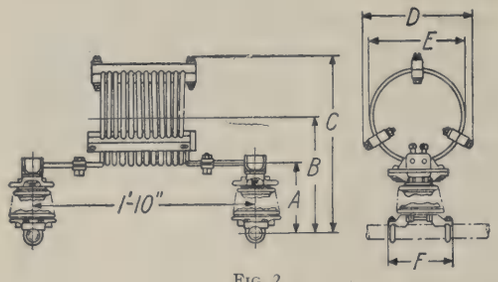


FIG. 2

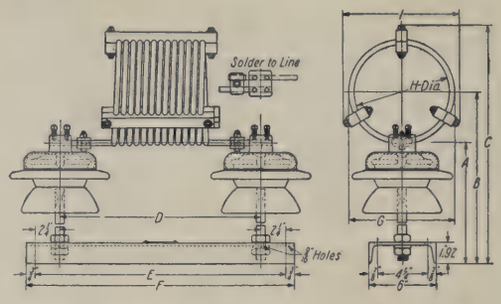


FIG. 3

Type D-9 Indoor Choke Coils—Continued

Fig.	Amps.	Voltage Normal	Voltage Maximum	A	B	C	D	E	F
				Pipe Mounting					
2	200	.....	7500	6¼	10¾	16⅝	10⅜	9 1/16	5¾
2	200	.....	15000	7⅝	12⅛	18	10⅜	9 1/16	5¾
2	200	.....	25000	10⅜	14⅞	20¾	10⅜	9 1/16	5¾
2	200	.....	37000	14¼	18¾	24⅝	10⅜	9 1/16	7½
2	200	44000*	.....	18⅜	22⅞	28¾	10⅜	9 1/16	7½
2	200	44000*	.....	18⅝	23⅛	29	10⅜	9 1/16	7½
2	200	66000*	.....	26¾	31¼	37⅛	10⅜	9 1/16	10⅝
2	400–600	.....	7500	6¼	10¾	17⅛	11¼	9⅝	5¾
2	400–600	.....	15000	7⅝	12⅛	18½	11¼	9⅝	5¾
2	400–600	.....	25000	10⅜	14⅞	21¼	11¼	9⅝	5¾
2	400–600	.....	37000	14¼	18¾	25⅛	11¼	9⅝	7½
2	400–600	44000*	.....	18⅜	22⅞	29¼	11¼	9⅝	7½
2	400–600	44000*	.....	18⅝	23⅛	28½	11¼	9⅝	7½
2	400–600	66000*	.....	26¾	31¼	37⅝	11¼	9⅝	10⅝

Type D-9 Indoor or Outdoor Choke Coils (Invertible for 88000 Volts and Above)

Fig.	Amps.	Voltage Normal	Voltage Maximum	A	B	C	D	E	F	G	H	I
3	200	.....	15000	9	13½	19⅜	18	22½	24	9 1/16	8 1/16	10⅜
3	200	.....	25000	13¾	18¼	24⅛	18	22½	24	9 1/16	8 1/16	10⅜
3	200	.....	37000	14½	19	24⅞	18	22½	24	9 1/16	8 1/16	10⅜
3	200	44000*	.....	15⅝	20⅛	26	18	22½	24	9 1/16	8 1/16	10⅜
3	400–600	.....	15000	9 1/16	13 11/16	20 1/16	22	26½	28	9⅝	8⅜	11¼
3	400–600	.....	25000	13¾	18¼	24⅝	22	26½	28	9⅝	8⅜	11¼
3	400–600	.....	37000	14¾	19¼	25⅝	22	26½	28	9⅝	8⅜	11¼
3	400–600	44000*	.....	15 13/16	20 5/16	26 5/16	22	26½	28	9⅝	8⅜	11¼

Fig.	Amperes	Voltage Normal	Voltage Maximum	A	B	C	D	E	F	G
4	200	66000*	.....	36 13/16	9	9 1/16	10⅜	....	....	...
4	400–600	66000*	.....	37 5/16	11	9⅝	11¼	....	....	...
5	200	88000†	.....	58 1/16	9	9 1/16	10⅜	45 15/16	....	...
5	200	88000†	.....	64 1/16	9	9 1/16	10⅜	51 15/16	....	...
5	200	110000†	.....	70 1/16	9	9 1/16	10⅜	37 15/16	....	...
5	200	132000†	.....	76 1/16	9	9 1/16	10⅜	63 15/16	....	...
5	400–600	88000†	.....	65⅛	11	9⅝	11¼	52	....	...
5	400–600	110000†	.....	71⅛	11	9⅝	11¼	58	....	...
5	400–600	132000†	.....	77⅛	11	9⅝	11¼	64	....	...

These dimensions are for reference only. For official dimensions apply to nearest district office.

*Choke coils rated at 44000 normal voltage have a maximum rating of 50000 volts and choke coils rated at 66000 normal voltage have a maximum rating of 73000 volts. These coils may be applied up to the maximum rating.

†Choke coils rated at 88000 normal voltage or higher may be applied on systems having a maximum voltage not exceeding 5 per cent above rated voltage.

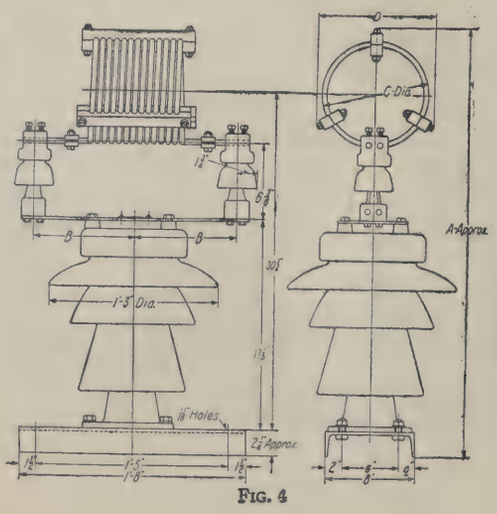


FIG. 4

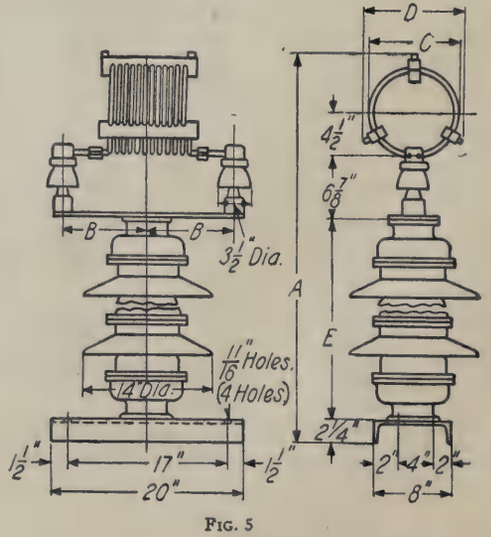


FIG. 5

CHOKE COILS—Continued

Approximate Dimensions—Continued

Type D-15 Indoor or Outdoor Choke Coils

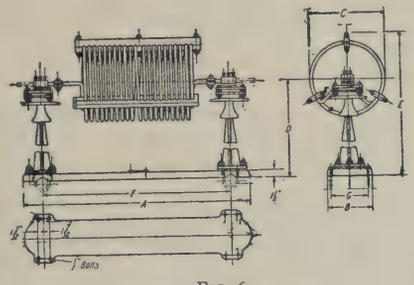


FIG. 6

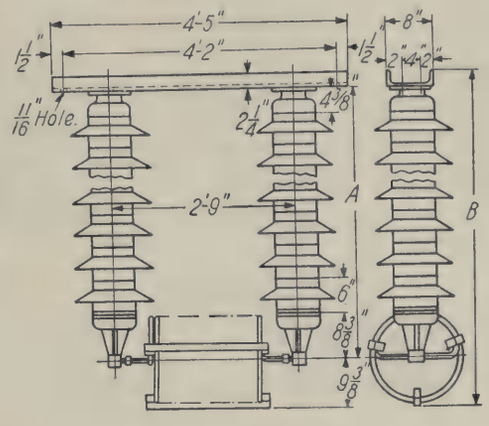


FIG. 7

Fig. No.	Amperes	Voltage Normal	Voltage Maximum	Dimensions in Inches A	B	C	D	E	F	G
6	200	.....	25000	32¼	9⅞	15 7/16	18½	27⅞	24	8½
6	200	.....	37000	33¼	10⅜	15 7/16	21 13/16	31 5/16	24	9
6	200	44000*	.....	33¼	10⅜	15 7/16	25 5/16	34 11/16	24	9
6	200	66000*	.....	33¼	10⅜	15 7/16	27	36⅜	24	9
6	400–600	.....	25000	32¼	9⅞	15⅝	18½	27⅞	24	8½
6	400–600	.....	37000	33¼	10⅜	15⅝	21⅞	31 5/16	24	9
6	400–600	44000*	.....	33¼	10⅜	15⅝	25 5/16	34 11/16	24	9
6	400–600	66000*	.....	33¼	10⅜	15⅝	27	36⅜	24	9
6	800	.....	25000	46¾	9⅞	15 13/16	19½	28⅞	38½	8½
6	1000	.....	25000	51	9⅞	16	18½	27⅞	42¾	8½
7	200–400–600	88000†	.....	48¾	60⅜	....	....	....	....	...
7	200–400–600	110000†	.....	54¾	66⅜	....	....	....	....	...
7	200–400–600	132000†	.....	60¾	72⅜	....	....	....	....	...

These dimensions are for reference only. For official dimensions apply at the nearest district office.

*Choke coils rated at 44,000 normal voltage have a maximum rating of 50,000 volts and choke coils rated at 66,000 normal voltage have a maximum rating of 73,000 volts. These coils may be applied up to their maximum rating.

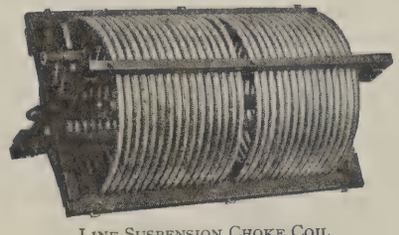
†Choke coils rated at 88,000 normal voltage or higher may be applied on systems having a maximum voltage not exceeding 5% per cent above rated voltage.

TYPE D-9 AND D-15 LINE SUSPENSION CHOKE COILS

For All Voltages Up to 220,000 Normal

Line suspension type D-9 and D-15 choke coils have been developed to meet the demand for a choke coil that can be inserted directly in the transmission line wire or in the station wiring and held in position by the tension of the line or station wires. Because of the fact that no insulators are required solely to support this choke coil, and that it can be installed in either a vertical or horizontal position it can often be utilized very effectively in power and sub-station lay-outs. Terminals to accommodate the conductors are provided at each end of the coil. Three square-headed substantial binding screws are supplied which clamp the conductors in position. A strain insulator is so arranged within the coil at its axis, that it assumes the mechanical tension transmitted from the conductors. No mechanical tension reaches the turns of the choke coil proper.

Connections—The coils are entirely symmetrical so that it is immaterial which end is connected to the line or to the apparatus.



LINE SUSPENSION CHOKE COIL

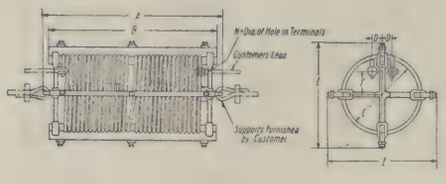
CHOKE COILS—Continued

Line Suspension Indoor or Outdoor Choke Coils
For All Voltages Up to 220,000 Volts Normal

Style No.	Amperes	Approx. Wt., Lb. Net	Approx. Wt., Lb. Boxed	List Price
		Type D-9		
236447	200	33	93	$ 65 50
236449	400	47	111	87 00
236450	600	106	136	150 00
		Type D-15		
121727	200	45	105	90 00
164463	400	66	130	130 00
236446	600	167	198	192 50

Order by Style Number

Approximate Dimensions



Type	Amperes	Dimensions in Inches A	B	C	D	E	F	H
D- 9	200	27 3/8	25 5/16	8 9/16	1½	12¾	1⅞	½
D- 9	400–600	32¼	29⅞	8⅜	1½	12¾	1⅞	11/16
D-15	200	27⅞	25 5/16	14 9/16	1½	18¾	4½	½
D-15	400–600	32¼	29⅞	14⅜	2	18¾	4	11/16

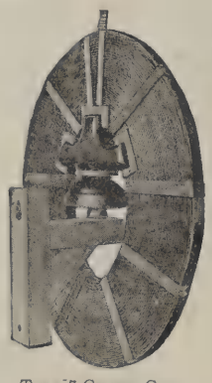
These dimensions are for reference only.
For official dimensions apply to the nearest district office.

TYPE 7 CHOKE COILS
For Voltages Up to 25,000 Maximum

The Westinghouse type 7 choke coils are of the flat or "pan-cake" type and are wound, without iron cores, on circular or elliptical center blocks. They have a large number of layers and few turns per layer; (excepting those made for small currents, they usually have one turn per layer), which gives at once the best condition for insulating and cooling. They are divided into two lines, one of which includes coils of approximately the same impedance as the type D-15 coils, and which is intended for the protection of transformers where the customer prefers this type of coil and mounting, while the other has a much higher impedance and is intended for the protection of generators and motors or wherever else a larger impedance is desired.

All coils are air cooled and a separate coil is used for each line wire. The coils are heavily insulated and have the line lead at the top.

Voltages—These coils are arranged for all voltages up to 25,000.



Type 7 Choke Coil

Mounting—Type 7 choke coils are arranged for ready mounting directly on the wall of the station. This is usually the most convenient location since the line wires on entering the building should go directly to the choke coils after connection to the lightning arresters. The method of mounting gives an excellent insulation and a ready dissipation of heat.

Prices
Type 7 Indoor Choke Coils For Voltages Up to 25,000 Maximum

Amperes Rating	For Use With Generators and Transformers — Style No.	Approx. Wt., Lb. Net	Approx. Wt., Lb. Shipping	List Price	For Use With Transformers Only — Style No.	Approx. Wt., Lb. Net	Approx. Wt., Lb. Shipping	List Price
9	243608	27	42	$ 68 00	243622	31	46	$ 53 50
12	243609	28	43	68 00	243623	32	47	53 50
19	243610	29	44	63 00	243624	33	48	53 50
30	243611	31	46	63 00	243625	38	53	53 50
45	243612	32	47	110 00	243626	54	84	55 00
75	243613	35	50	180 00	243627	84	129	61 00
100	243614	41	56	230 00	243628	102	152	90 00
120	243615	56	102	280 00	243629	152	252	114 00
170	243616	64	110	330 00	243630	189	289	127 00
200	243617	85	140	355 00	243631	207	307	170 00
230	243618	106	161	375 50	243632	249	349	198 50
270	243619	179	254	420 00	243633	244	344	340 00
300	243620	194	270	427 50	243634	266	366	360 00
345	243621	267	367	437 50	243635	283	383	440 00

Order by Style Number

CHOKE COILS—Continued

Approximate Dimensions

Type 7 Choke Coils

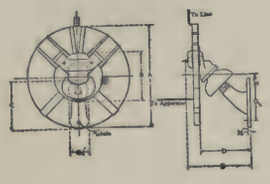


FIG. 1

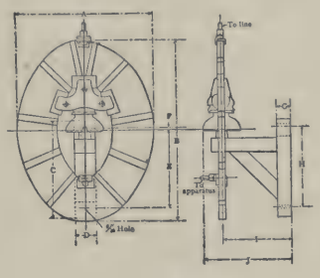


FIG. 2

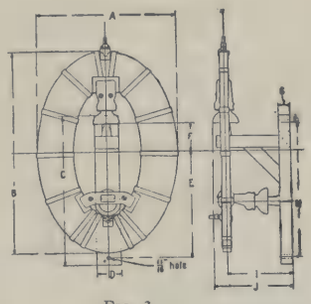


FIG. 3

Style No.	Fig.	Center Block	Dimensions in Inches A	B	C	D	E	F	G	H	I	J	Weight Lbs.
243608	1	.....	15¾	5	8⅛	8¼	10½	1⅞	6	....	....	....	...
243609	1	.....	16½	5	8⅛	8¼	10½	1⅞	6	....	....	....	...
243610	1	.....	15¾	5	8⅛	8¼	10½	1⅞	6	....	....	....	...
243611	1	.....	16½	5	8⅛	8¼	10½	1⅞	6	....	....	....	39
243612	1	.....	22½	5	8⅛	8¼	10½	1⅞	6	....	....	....	39
243613	2	9x18	24	34	26½	3	20⅞	3½	2	23	19½	22¼	46
243614	3	14x27	29¾	42¾	31	5	22⅛	5⅞	2½	28	18½	21¼	48
243615	3	14x27	30¾	43¾	31	5	22⅛	5⅞	2½	28	18½	21¼	74
243616	3	14x27	30¼	43¼	31	5	22⅛	5⅞	2½	28	18½	21¼	86
243617	3	14x27	30¼	43¼	31	5	22⅛	5⅞	2½	28	18¾	21½	125
243618	3	14x27	30¼	43¼	31	5	22⅛	5⅞	2½	28	18¾	21½	145
243619	3	14x27	30¼	43¼	31	5	22⅛	5⅞	2½	28	18¾	21½	256
243620	3	14x27	30¼	43¼	31	5	22⅛	5⅞	2½	28	18¾	21½	287
243621	3	14x27	30¼	43¼	31	5	22⅛	5⅞	2½	28	18¾	21½	430
243622	1	.....	12½	5	8⅛	8¼	10½	1⅞	6	....	....	....	51
243623	1	.....	12¾	5	8⅛	8¼	10½	1⅞	6	....	....	....	83
243624	1	9x18	12¼	5	8⅛	8¼	10½	1⅞	6	....	....	..	130
243625	1	.....	12¼	5	8⅛	8¼	10½	1⅞	6	....	....	..	...
243626	1	.....	12¼	5	8⅛	8¼	10½	1⅞	6	....	....	....	...
243627	1	.....	15½	8⅛	8⅛	8¼	10½	1⅞	6	....	....	....	...
243628	2	8x14	15⅛	21⅛	15¾	3	13¼	5¼	2	13½	11½	14¼	100
243629	2	8x14	18½	24½	15¾	3	13¼	5¼	2	13½	11½	14¼	222
243630	2	8x14	18	24	15¾	3	13¼	5¼	2	13½	11½	14¼	280
243631	2	9x18	20½	29½	19¾	3	13⅛	3⅛	2	16¼	12½	15¼	310
243632	2	9x18	20¾	29¾	19¾	3	13⅛	3⅛	2	16¼	12½	15¼	250
243633	3	12x23	26½	37½	25½	5	18⅝	3⅞	2½	22½	14 1/16	17 3/16	212
243634	3	14x27	28⅛	41⅛	31	5	22⅛	5⅞	2½	28	13¾	16½	390
243635	3	14x27	31⅞	44⅞	31	5	22⅛	5⅞	2½	28	18¾	16½	428

Dimensions given are for reference only. For official dimensions apply to the nearest district office.

TYPE O.I.S.C. CHOKE COILS

For Voltages Up to 66,000 Normal

On circuits of voltages above 25,000, choke coils immersed in oil, as are transformer coils, have advantages in that the coil is insulated not only from the ground but against side flash, and that copper of comparatively small section may be used without undue heating. The Westinghouse "oil-insulated self-cooling" choke coil affords abundant capacity for high potentials and at the same time does not interfere with good voltage regulation.

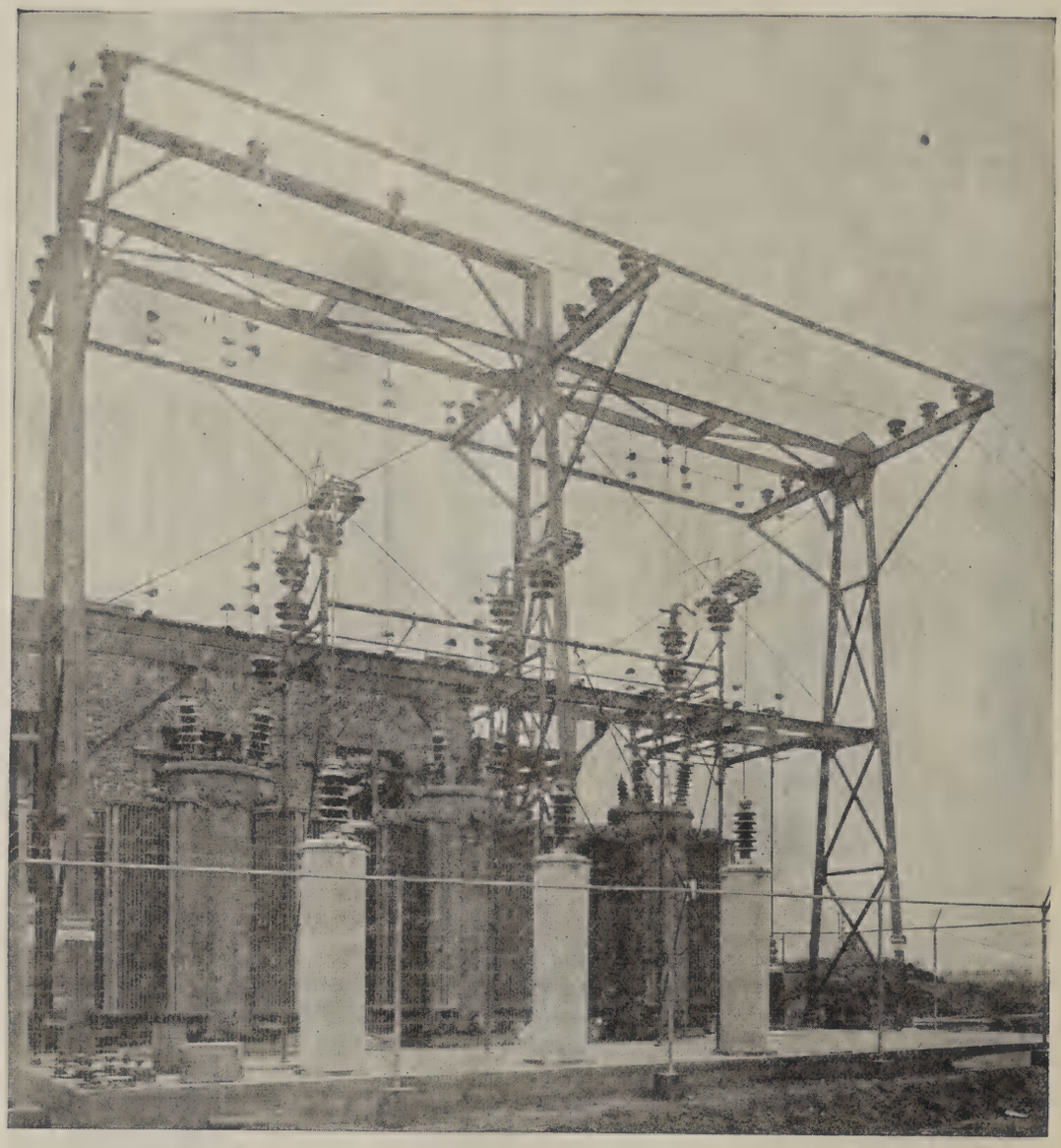
General Construction—This style consists of the coil proper mounted on a U-shaped wooden frame immersed in oil within a boiler-iron tank. The leads from the coil are brought out at the top of the tank through porcelain bushings. The tank is fitted with a draining valve at the bottom and with an oil gauge and thermometer.

Coils—The oil-insulated coils are similar in construction to those of air-insulated type 7. The number of turns in the oil-insulated coils, however is usually larger than in the type 7 and the size of wire smaller. The impedance of the high voltage coils of this type is much greater than that of the coils for the lower voltage service. At the same time the amount of copper and per cent of voltage drop is much less.

Prices and dimensions for type OISC choke coils will be furnished upon application, to the nearest district office.

O.I.S.C. CHOKE COIL

1019-9A



Type AL Impulse-Gap Electrolytic Lightning Arrester Installed at a 48,000-Volt Station.

FUSE WIRE, FUSE RIBBON, AND LINK FUSES

ALUMINUM WIRE

For high-voltage fused circuit-breakers and bomb-type expulsion fuse blocks, the following fuse wire should be used enclosed in asbestos sleeving listed in catalogue on "Insulating Materials and Supplies." Asbestos sleeving should enclose the entire length of fuse wire except at terminal ends in expulsion-type fuse tubes, and all of the lengths within the tube arm of fuse-type circuit-breakers.

B. & S. Gauge	Continuous Carrying Capacity, Amperes	Approx. No. of Feet Per Lb.	Net Weight of Standard Package (Spools), Lb.	List Price Per Lb.
11	81	135	1	$1 85
12	72	165	1	1 85
13	63	208	1	1 95
14	54	264	1	1 95
15	47	332	1	2 10
16	40	420	1	2 10
17	35	528	1	2 25
18	30	688	1	$2 25
19	26	835	1	2 50
20	22	1050	1	2 50
21	18	1350	1	2 75
22	15	1680	1	3 00
23	12	2150	1	3 35
24	10	2670	1½	3 85

NICKEL SILVER WIRE (18 per cent)

B. & S. Gauge	Continuous Carrying Capacity, Amperes	Approx. No. of Feet Per Lb.	Net Weight of Standard Package (Spools), Lb.	List Price Per Lb.
26	3.75	1300	½	$2 40
30	1.13	3288	½	2 75
36	0.50	13217	¼	$6 75

ALLOY FUSE WIRE

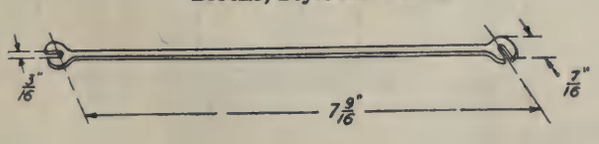
Continuous Carrying Capacity Amperes	Best Lengths To Use Inches	Approx. No. of Feet Per Lb.	Net Wt. of Standard Package (Spools), Lb.	List Price Per Lb.
1	1½	670	½	$1 10
2	1½	430	½	1 05
3	1½	370	½	1 00
4	1½	300	1	1 00
5	2	220	1	1 00
6	2	185	1	85
7	2	140	1	85
8	2	120	1	80
9	2	93	1	80
10	2	80	1	80
12	3	70	1	80
14	3	60	1	80
15	3	52	1	75
16	3	49	1	75
18	3	43	1	075
20	4	36	1	75
25	4	32	1	75
30	4	26	1	75
35	4	22	1	75
40	4	18	2	75
45	4	17	2	75
50	4	12.5	2	75
60	5	10.3	2	70
70	5	9	2	70
75	5	8.3	2	70
80	5	7.5	2	70
90	5	6.7	2	70
100	5	5.5	2	70

ALLOY FUSE RIBBON

Continuous Carrying Capacity, Amperes	Best Lengths To Use, In.	Size in Inches	Approx. No. of Ft. Per Lb.	Net Weight of Standard Package (Spools), Lb.	List Price Per Lb.
50	4	.36 x .047	13	2½	$0 60
60	4	.44 x .047	10	2½	60
70	4	.47 x .047	9.55	2½	60
75	4	.50 x .047	9.1	2½	60
80	4	.375 x .078	7.1	2½	60
90	4	.44 x .078	6.1	2½	60
100	4	.44 x .094	5.2	2½	50
115	4	.375 x .125	4.4	2½	50
125	4	.50 x .094	4.4	2½	50
150	4	.57 x .094	4.	2½	50
175	4	.64 x .094	3.5	5	50
190	4	.75 x .094	3.	5	50
200	4	.875 x .094	2.6	5	$ 050
225	4	1. x .094	2.2	5	50
250	4½	1. x .110	1.9	5	50
275	4½	1. x .130	1.65	5	50
300	4½	1. x .150	1.4	5	50
350	4½	1.94 x .075	1.43	5	50
400	4½	1. x .20	1.1	5	50
450	4½	1.125 x .20	.97	5	50
500	4½	1.25 x .20	.85	5	50
550	4½	1.37 x .20	.78	10	50
600	4½	1.50 x .20	.70	10	50

LINK FUSES

Fuses for Use in Plug-Type Transformer Fuse Blocks, Style No. 147190



Continuous Capacity Amps.	Standard Package Quantity	Style No.	List Price Per 100
1	100	224172	$ 3 35
2	100	224173	3 35
3	100	224174	3 35
5	100	224175	3 35
10	100	224176	3 35
15	100	224177	3 35
20	100	224178	3 35
25	100	224179	3 35
30	100	224180	3 35

Order by Style Number

ENCLOSED CARTRIDGE FUSES WITH INDICATORS

For Voltages up to 25,000

APPLICATION

These fuses meet the demand for reliable and accurate devices that will carry their rated current and can be depended upon to open the circuit when the specified overload is attained.

On large systems the circuit characteristics should be such as to limit the maximum overload power passing through the fuse to approximately 10,000 kilovoltamperes except where further limited by the requirements of the National Electrical Code. Circuit-breakers are recommended instead of enclosed fuses where the rated capacity of the generators supplying the circuit on which they are directly installed exceeds 2000 kilovoltamperes, as fuses are not suitable for such circuits (except where fuses are used for protection of potential transformers. See pages on "Limiting Resistors for Potential Transformer Fuses").

FIG. 1—STYLE NO. 37171

Approval—All of the fuses listed herein conform to the requirements of the "National Electrical Code," for the sizes covered, and are included in the "List of Approved Fittings" issued by the National Board of Fire Underwriters.

CONSTRUCTION

Indicators—Each fuse is provided with a simple but reliable device which indicates whether the fuse has blown or is still intact. This indicator is in plain view so that the condition of the fuse can be determined at a glance.

FIG. 2—STYLE NO. 37153

Dimensions—The 250-volt and 600-volt fuses have the "National Electrical Code Standard" dimensions and may be used in any "National Electrical Code Standard" fuse blocks of corresponding capacities.

Finish—The finish of the metal parts is cleaned and lacquered brass on the ferrule type and cleaned and lacquered copper on the knife-blade type.

Mounting—For fuse block on which these enclosed fuses may be mounted, see pages on "Fuse Blocks for Enclosed Cartridge Fuses."

REFILLING

The Westinghouse Electric & Manufacturing Company is prepared to refill any of its knife-blade-contact enclosed fuses, provided the cases are returned to the Works in good condition, transportation prepaid, in not less than standard package quantities. Complete return shipping directions should accompany each order for fuses to be refilled. Refilling list prices are given on the following pages, opposite the style numbers of all fuses which will be refilled.

The company will refill fuses only when the cases are returned to the Works, and under no circumstances will refilling material be furnished.

When cases are to be returned for refilling, the nearest district office should be consulted for shipping directions.

SHIPMENT

Fuses should be ordered in standard package quantities whenever possible. Standard package quantities cannot be made up by combining different capacities.

FOR VOLTAGES UP TO 250

Ampere Carrying Capacity	Standard Package Quantity	Carton Quantity	Approx. Net* Wt. of Carton, Lb.	Style No.	List Price Each	Refilling List Price Each
Ferrule Contacts						
1	100	25	1	37153	$0 25	
2	100	25	1	37154	25	
3	100	25	1	37155	25	
4	100	25	1	37156	25	
5	100	25	1	37157	25	
6	100	25	1	37158	25	
8	100	25	1	37159	25	
10	100	25	1	37160	25	
12	100	25	1	37161	25	
15	100	25	1	37162	25	
20	100	25	1	37163	25	
25	100	25	1	37164	25	Cannot be refilled
30	100	25	1	37165	25	
35	100	25	2½	37166	35	
40	100	25	2½	37167	35	
45	100	25	2½	37168	35	
50	100	25	2½	37169	35	
55	100	25	2½	184110	35	
60	100	25	2½	37170	35	
Knife-Blade Contacts						
65	50	10	3	184111	90	$0 60
70	50	10	3	184112	90	60
75	50	10	3	37171	90	60

Ampere Carrying Capacity	Standard Package Quantity	Carton Quantity	Approx. Net* Wt. of Carton, Lb.	Style No.	List Price Each	Refilling List Price Each
Knife-Blade Contacts—Continued						
80	50	10	3	184113	$0 90	$0 60
85	50	10	3	37172	90	60
90	50	10	3	184114	90	60
95	50	10	3	184115	90	60
100	50	10	3	37173	90	60
110	25	5	4½	184116	2 00	90
120	25	5	4½	184117	2 00	90
125	25	5	4½	37174	2 00	90
150	25	5	4½	37175	2 00	90
175	25	5	4½	37176	2 00	90
200	25	5	4½	37177	2 00	90
225	25	1	1¾	37178	3 60	1 50
250	25	1	1¾	37179	3 60	1 50
275	25	1	1¾	184118	3 60	1 50
300	25	1	1¾	37180	3 60	1 50
325	25	1	1¾	184119	3 60	1 50
350	25	1	1¾	37181	3 60	1 50
375	25	1	1¾	184120	3 60	1 50
400	25	1	1¾	37182	3 60	1 50
450	10	1	3½	184121	5 50	2 00
500	10	1	3½	37183	5 50	2 00
550	10	1	3½	184122	5 50	2 00
600	10	1	3½	37184	5 50	2 00

*For shipping weight add 10 per cent. for boxing.

Order by Style Number

ENCLOSED CARTRIDGE FUSES WITH INDICATORS—Continued

FIG. 3—STYLE NO. 37185

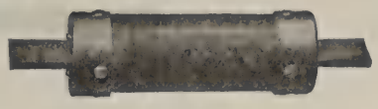


FIG. 4—STYLE NO. 37203

FOR VOLTAGES UP TO 600

Ampere Carrying Capacity	Standard Package Quantity	Carton Quantity	Approx. Net* Wt. of Carton, Lb.	Style No.	List Price Each	Refilling List Price Each
Ferrule Contacts						
1	100	25	3¼	37185	$0 40	
2	100	25	3¼	37186	40	
3	100	25	3¼	37187	40	
4	100	25	3¼	37188	40	
5	100	25	3¾	37189	40	
6	100	25	3¼	37190	40	
7	100	25	3¼	184123	40	
8	100	25	3¼	37191	40	
9	100	25	3¼	184124	40	
10	100	25	3¼	37192	40	
12	100	25	3¼	37193	40	
15	100	25	3¼	37194	40	
20	100	25	3¼	37195	40	
25	100	25	3¼	37196	40	
30	100	25	3¼	37197	40	
35	100	25	5¼	37198	60	
40	100	25	5¼	37199	60	
45	100	25	5¼	37200	60	
50	100	25	5¼	37201	60	
55	100	25	5¼	184125	60	
60	100	25	5¼	37202	60	
Knife-Blade Contacts						
65	50	5	2¼	184126	1 50	$0 80
70	50	5	2¼	184127	1 50	80

Cannot be refilled

Ampere Carrying Capacity	Standard Package Quantity	Carton Quantity	Approx. Net* Wt. of Carton, Lb.	Style No.	List Price Each	Refilling List Price Each
Knife Blade Contacts—Continued						
75	50	5	2¼	37203	$1 50	$0 80
80	50	5	2¼	184128	1 50	80
85	50	5	2¼	37204	1 50	80
90	50	5	2¼	184129	1 50	80
95	50	5	2¼	184130	1 50	80
100	50	5	2¼	37205	1 50	80
110	25	1	1½	184131	2 50	1 20
120	25	1	1½	184132	2 50	1 20
125	25	1	1½	37206	2 50	1 20
150	25	1	1½	37207	2 50	1 20
175	25	1	1½	37208	2 50	1 20
200	25	1	1½	37209	2 50	1 20
225	25	1	3½	37210	5 50	2 00
250	25	1	3½	37211	5 50	2 00
275	25	1	3½	184133	5 50	2 00
300	25	1	3½	37212	5 50	2 00
325	25	1	3½	184134	5 50	2 00
350	25	1	3½	37213	5 50	2 00
375	25	1	3½	184135	5 50	2 00
400	25	1	3½	37214	5 50	2 00
450	10	1	5½	184136	8 00	3 00
500	10	1	5½	37215	8 00	3 00
550	10	1	5½	184137	8 00	3 00
600	10	1	5½	37216	8 00	3 00

FOR VOLTAGES UP TO 2500

Ampere Carrying Capacity	Standard Package Quantity	Carton Quantity	Approx. Net* Wt. of Carton, Lb.	Style No.	List Price Each	Refilling List Price Each
Ferrule Contacts						
1½	100	5	¾	32304	$0 46	
2	100	5	¾	32305	46	
3	100	5	¾	32306	46	
4	100	5	¾	32307	46	
6	100	5	¾	32308	46	
10	100	5	¾	32309	46	
15	100	5	¾	32310	46	
20	100	5	1¼	32311	60	
25	100	5	1¼	32312	60	
30	100	5	1¼	32313	60	
40	100	5	2¼	32314	75	

Cannot be refilled

Ampere Carrying Capacity	Standard Package Quantity	Carton Quantity	Approx. Net* Wt. of Carton, Lb.	Style No.	List Price Each	Refilling List Price Each
Ferrule Contacts—Continued						
50	100	5	2¼	32315	$0 75	Can't be
60	100	5	2¼	32316	75	Refilled
Knife-Blade Contacts						
70	50	1	¾	37958	2 40	$1 20
80	50	1	¾	37959	2 40	1 20
90	50	1	¾	37960	2 40	1 20
100	50	1	¾	37961	2 40	1 20
125	25	1	1¼	37935	4 50	2 20
150	25	1	1¼	37936	4 50	2 20
175	25	1	1¼	37944	4 50	2 20
200	25	1	1¼	37945	4 50	2 20

FOR VOLTAGES UP TO 3500

Ampere Carrying Capacity	Standard Package Quantity	Carton Quantity	Approx. Net* Wt. of Carton, Lb.	Style No.	List Price Each	Refilling List Price Each
Ferrule Contacts						
1½	100	5	1	42300	$0 55	
2	100	5	1	42301	55	
3	100	5	1	42302	55	
4	100	5	1	42303	55	
6	100	5	1	42304	55	
10	100	5	1	42305	55	
15	100	5	1	42306	55	
20	100	5	1½	42307	70	
25	100	5	1½	42308	70	
30	100	5	1½	42309	70	

Cannot be refilled

Ampere Carrying Capacity	Standard Package Quantity	Carton Quantity	Approx. Net* Wt. of Carton, Lb.	Style No.	List Price Each	Refilling List Price Each
Ferrule Contacts—Continued						
40	100	5	3	42310	$1 30	Can't
50	100	5	3	42311	1 30	be
60	100	5	3	42312	1 30	Refilled
Knife-Blade Contacts						
70	50	1	1	42313	3 00	$1 25
80	50	1	1	42314	3 00	1 25
90	50	1	1	42315	3 00	1 25
100	50	1	1	42316	3 00	1 25
125	25	1	1	42317	5 50	2 65
150	25	1	1	42318	5 50	2 65

FIG. 5—STYLE NO. 32304

FIG. 6—STYLE NO. 42300

*For shipping weight add 10 per cent for boxing.

Order by Style Number

ENCLOSED CARTRIDGE FUSES WITH INDICATORS—Continued

FIG. 7—STYLE NO. 37219

Ampere Carrying Capacity	Standard Package Quantity	Carton Quantity	Approx. Net* Wt. of Carton, Lb.	Style No.	List Price Each	Refilling List Price Each	Ampere Carrying Capacity	Standard Package Quantity	Carton Quantity	Approx. Net* Wt. of Carton, Lb.	Style No.	List Price Each	Refilling List Price Each
FOR VOLTAGES UP TO 7500—With Combination Ferrule and Knife-Blade Contacts													
¾	25	5	2	37218	$1 30	$1 05	7	25	5	2½	37225	$1 30	$1 05
1½	25	5	2	37219	1 30	1 05	10	25	5	2½	37226	1 30	1 05
2	25	5	2	37220	1 30	1 05	15	25	5	2½	37227	1 30	1 05
3	25	5	2	37221	1 30	1 05	20	25	5	3	61062	7 50	4 00
4	25	5	2	37222	1 30	1 05	25	25	5	3	61063	7 50	4 00
5	25	5	2	37223	1 30	1 05	30	25	5	3	61064	7 50	4 00
6	25	5	2½	37224	1 30	1 05							
FOR VOLTAGES UP TO 15000—With Combination Ferrule and Knife-Blade Contacts													
¾	25	5	2	37228	2 50	1 30	6	25	5	2	38711	2 50	1 30
1½	25	5	2	37229	2 50	1 30	7	25	5	2	38712	2 50	1 30
2	25	5	2	37230	2 50	1 30							
3	25	5	2	37231	2 50	1 30	10	25	5	3	61057	2 50	1 30
4	25	5	2	37232	2 50	1 30	12	25	5	3	61059	2 50	1 30
5	25	5	2	38710	2 50	1 30	15	25	5	3	61058	2 50	1 30
FOR VOLTAGES UP TO 25000—With Combination Ferrule and Knife-Blade Contacts													
¾	25	5	3	42970	3 50	1 65	3	25	5	3	42973	3 50	1 65
1½	25	5	3	42971	3 50	1 65	4	25	5	3	42974	3 50	1 65
2	25	5	3	42972	3 50	1 65	5	25	5	3	42975	3 50	1 65

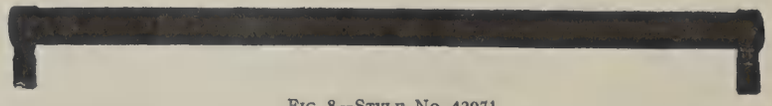


FIG. 8—STYLE NO. 42971

TONGS FOR HANDLING ENCLOSED FUSES FOR 7500 VOLTS AND ABOVE

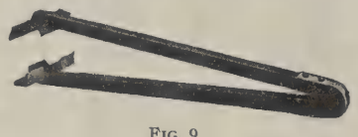


FIG. 9

Style No.	Standard Package Quantity	List Price Each
30933-A	6	$6 00

*For shipping weight add 10 per cent. for boxing.

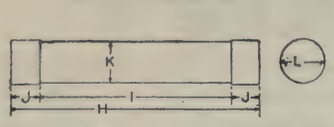
Order by Style Number

To be sure of protection by the fuses on your circuits—

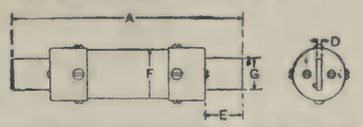
Be sure they are Westinghouse

ENCLOSED CARTRIDGE FUSES WITH INDICATORS—Continued

OUTLINE DIMENSIONS



FERRULE CONTACTS 1 TO 60 AMPS.



KNIFE-BLADE CONTACTS 61 TO 600 AMPS.

FIG. 10

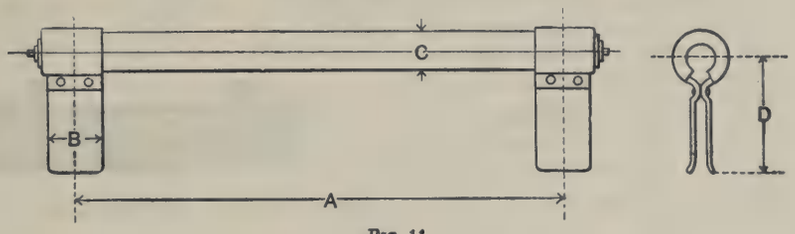


FIG. 11

Ampere Carrying Capacity	Fig.	Dimensions in Inches A	D	E	F	G	H	I	J	K	L
FOR VOLTAGES UP TO 250											
1– 30	10	....	..	...	...	...	2	1	½	½	9/16
35– 60	10	....	..	...	...	...	3	1¾	5/8	¾	11/16
65–100	10	5⅞	1/8	1	1	¾	...	...	..	...	...
110–200	10	7⅛	3/16	1⅜	1½	1⅛	...	...	..	...	...
225–400	10	8⅝	¼	1⅞	2	1⅝	...	...	..	...	...
450–600	10	10⅜	¼	2¼	2½	2	...	...	..	...	...
FOR VOLTAGES UP TO 600											
1– 30	10	....	..	...	...	...	5	4	½	¾	13/16
35– 60	10	....	..	...	...	...	5½	4¼	5/8	1	1 1/16
65–100	10	7⅞	1/8	1	1¼	¾	...	...	..	...	...
110–200	10	9⅝	3/16	1⅜	1¾	1⅛	...	...	..	...	...
225–400	10	11⅝	¼	1⅞	2½	1⅝	...	...	..	...	...
450–600	10	13⅜	¼	2¼	3	2	...	...	..	...	...
FOR VOLTAGES UP TO 2500											
1½– 15	10	....	..	...	...	...	5½	4½	½	¾	13/16
20– 30	10	....	..	...	...	...	6	4¾	5/8	1	1 1/16
40– 60	10	....	..	...	...	...	6½	5	¾	1¼	1 1/16
70–100	10	10⅜	1/8	1	1½	¾	...	...	..	...	...
125–200	10	11⅝	3/16	1⅜	2	1⅛	...	...	..	...	...
FOR VOLTAGES UP TO 3500											
1½– 15	10	....	..	...	...	...	7½	6⅜	½	¾	13/16
20– 30	10	....	..	...	...	...	8	6⅝	5/8	1	1 1/16
40– 60	10	....	..	...	...	...	8½	6⅞	¾	1½	1 9/16
70–100	10	11⅞	1/8	1	1¾	¾	...	...	..	...	...
125–150	10	14⅝	3/16	1⅜	2	1⅞	...	...	..	...	...

FOR VOLTAGES UP TO 25000

Voltage	Ampere Capacity	Fig.	Dimensions in Inches A	B	C	D
7500	¾ to 4	11	13	¾	5/8	1⅝
	5 to 15		13	¾	¾	1⅝
	20 to 30		13	¾	1½	2 3/32
15000	¾ to 7	11	18	¾	¾	1⅝
	10 to 15		18	¾	1	1¾
25000	¾ to 5	11	20	¾	1	1¾

FUSE BLOCKS AND FUSE HOLDERS

FOR ENCLOSED CARTRIDGE FUSES

For Voltages up to 3500
Front and Rear Connected

These fuse blocks are used for mounting on the wall or on switchboard panels. The fuse blocks are of a rugged and substantial construction but, at the same time, present a neat and pleasing appearance, enabling them to match in appearance other apparatus with which they may be mounted.

Ratings—The fuse blocks as listed are rated according to the ampere and voltage capacities of standard cartridge fuses with which they are designed to be used, and the ratings apply to either direct or alternating current.

Approval—All of the 250-volt fuse blocks and all of the 600-volt fuse blocks up to and including 400-amperes conform to the requirements of the National Electrical Code and are included in the List of Approved Fittings issued by the National Board of Fire Underwriters.

Fuses—The fuses for use with these blocks are listed on pages on "Enclosed Cartridge Fuses with Indicators."

Dimensions—The 250-volt and 600-volt fuse blocks have the National Electrical Code Standard dimensions and will receive any cartridge fuses of corresponding ampere capacities conforming thereto.

Shipment—The number of fuse blocks and fuse holders included in a standard package and the net weight of each are given opposite each style number.

FIG. 1—30-AMPERE, FRONT-CONNECTED FUSE BLOCK

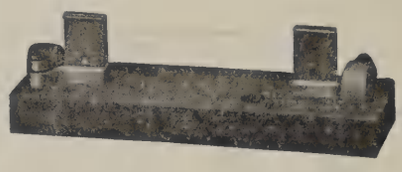
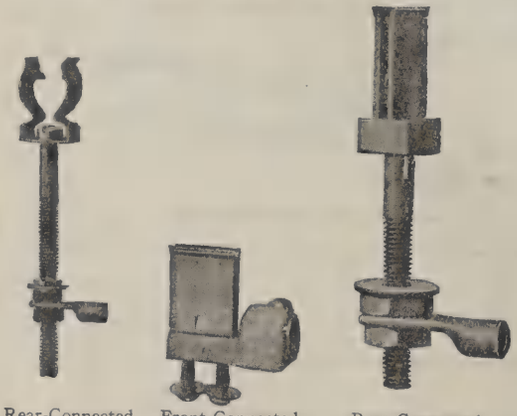


FIG. 2—100-AMPERE, FRONT-CONNECTED FUSE BLOCK

Instructions for Ordering—Whenever possible, fuse blocks and fuse holders should be ordered in standard package quantities. Standard package quantities cannot be made up by combining different capacities.

FUSE BLOCKS WITH INSULATING BASES

Single-Pole Front-Connected—Single-pole front-connected blocks are listed for use with the standard cartridge fuses for voltages up to 3500.



Rear-Connected 1-60 Amperes | Front-Connected 65-600 Amperes | Rear-Connected 65-600 Amperes

FIG. 3—FUSE HOLDERS WITHOUT BASES

Rear-connected—As the switchboard panel is generally the only place on which it is desired to mount rear-connected fuse holders, these are not listed with bases. (See "Fuse Holders").

Bases—The 250-volt and 600-volt fuse blocks up to and including 60-ampere capacity have porcelain bases; the single-pole 100-ampere and 200-ampere, 250-volt fuse blocks have either porcelain or slate bases; while all other 250-volt and 600-volt fuse blocks have slate bases. The 2500-volt and 3500-volt fuse blocks have black-marine-finish marble bases.

Contacts—The fuse blocks of capacities up to and including 60 amperes have ferrule contacts, and those of greater capacity have knife-blade contacts. The contacts are securely fastened to the bases so as to prevent any possibility of turning or getting out of alignment.

Connections to fuse blocks of 30 amperes capacity are made by means of a screw and washer. For larger capacities the fuse holders are equipped with terminal lugs into which the connecting wires must be soldered.

Fuse Holders Without Bases

Fuse holders are listed for mounting directly on the panels or other insulating support, bases not being supplied.

Front-connected fuse holders are the same as those supplied on the "fuse blocks with insulating bases" described above. Small screws are supplied for mounting on blocks.

Rear-connected fuse holders are similar to the front-connected except that they are supplied with studs, terminal lugs, and clamping nuts.

FUSE BLOCKS AND FUSE HOLDERS—Continued

PRICES—FUSE BLOCKS WITH INSULATING BASES
Single-Pole Front-Connected

Style number and list price include insulating base and fuse holders with terminal lug details but without fuse.

Capacity Range Amperes	Base	Contacts	Approx. Net *Weight, Lb.	Approx. Dimensions, Inches — Base — Length	Width	Height over Base	Standard Package Quantity	Style No.	List Price Each
For Voltages up to 250									
1 –30	Porcelain	Ferrule	¾	5½	1½	⅞	50	32481	$ 40
35 –60	Porcelain	Ferrule	¾	5½	1½	⅞	50	32482	65
65 –100	Porcelain	Knife	1¾	7¾	2	1 1/16	50	124397	1 40
65 –100	Slate	Knife	2	7¾	2	⅞	50	124389	90
110 –200	Porcelain	Knife	2½	9⅝	2¼	1 1/16	50	124398	2 75
110 –200	Slate	Knife	3½	9⅝	2¼	1	50	124390	2 10
225 –400	Slate	Knife	6	11¾	3	1	25	124391	5 25
450 –600	Slate	Knife	10¼	14	3½	1¼	10	124392	7 20
For Voltages up to 600									
1 –30	Porcelain	Ferrule	¾	7	1½	⅞	50	32485	60
35 –60	Porcelain	Ferrule	1	7⅝	1¾	⅞	50	32486	90
65 –100	Slate	Knife	2½	9¾	2	⅞	50	124393	1 32
110 –200	Slate	Knife	6	12⅛	2¼	1	50	124394	2 30
225 –400	Slate	Knife	9	14¾	3	1	25	124395	6 00
450 –600	Slate	Knife	12	17	3½	1¼	10	124396	7 80
For Voltages up to 2500									
1½–15	Marble	Ferrule	2	12¾	2¼	1	50	32495	2 25
20 –30	Marble	Ferrule	3	13 3/16	2	1	50	32496	2 25
40 –60	Marble	Ferrule	5	14¼	2¼	1	50	32497	2 50
70 –100	Marble	Knife	8	18½	4	1	50	124399	2 75
125 –200	Marble	Knife	15	20¼	4¼	1	50	124400	5 25
For Voltages up to 3500									
1½–15	Marble	Ferrule	3¼	17	1¾	1	50	42320	2 30
20 –30	Marble	Ferrule	3¾	17⅝	2	1	50	42321	2 40
40 –60	Marble	Ferrule	6½	19⅛	2¼	1	50	42322	2 75
70 –100	Marble	Knife	11	22¼	4	1	50	145121	4 35
125 –150	Marble	Knife	17	25½	4½	1¼	50	145122	6 20

*For shipping weight add 10 per cent for boxing.

PRICES—FUSE HOLDERS WITHOUT BASES

Style number and list price include one fuse holder complete with connecting terminals (two are required for a complete block). The front-connected include mounting screws of proper length for the standard fuse blocks listed. The rear-connected include terminal lug and clamping nuts. The studs are of sufficient length for mounting on panels 1 to 2 inches thick.

Capacity Range, Amperes	Maximum Voltage	Front-Connected: Standard Package	Front-Connected: Approx. Net *Wt. Lb.	Front-Connected: Style No.	Front-Connected: List Price Each	Rear-Connected: Approx. Net *Wt. Lb.	Rear-Connected: Style No. For 1-, 1¼-, or 1½-Inch Panel	Rear-Connected: Style No. For 2-Inch Panel	Rear-Connected: List Price Each
1 –30	250	100	⅛	32488	$ 10	⅛	229235	229228	$ 25
1 –30 / 1½–15	600 / 2500–3500	100	⅛	32492	14	⅛	229237	229230	30
20 –30	2500–3500	100	⅛	32499	20	⅛	229239	229232	45
35 –60	250	100	⅛	32489	20	¼	229236	229229	44
35 –60	600	100	⅛	32493	24	¼	229238	229231	50
40 –60	2500	100	⅛	32500	30	¼	229240	229233	60
40 –60	3500	100	⅛	57965	36	...	229241	229234	.....
65 –100	250 to 3500	100	⅛	124403	50	¾	289464	289464	2 00
110 –200	250 to 2500	100	½	124404	1 10	1¾	289465	289465	3 40
125 –150 / 226 –400	3500 / 250–600	50	1¼	124405	3 00	2½	289466	289466	6 00
450 –600	250–600	20	2	124406	5 00	5	289467	289467	10 00

Fuse blocks and fuse holders should be ordered in standard package quantities whenever possible. Standard package quantities cannot be made up by combining different capacities. *For shipping weight add 10 per cent for boxing.

Order by Style Number

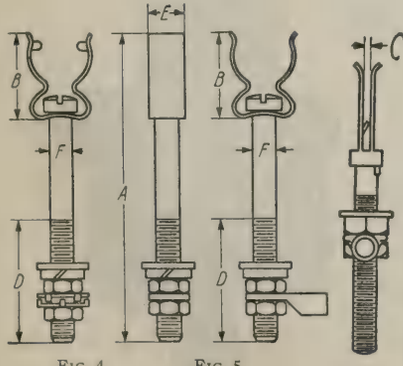


FIG. 4 FIG. 5

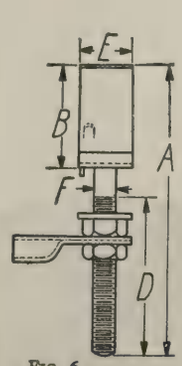


FIG. 6

OUTLINE DIMENSIONS
Fuse Holders Without Bases

Style No.	Fig.	Dimensions in Inches A	B	C	D	E	F
229228	4	3½	13/16	..	1⅞	½	¼
229229	5	3¾	1 13/32	..	1⅞	5/8	5/16
229230	4	3¾	1 1/4	..	1⅞	½	¼
229231	5	4	1 3/32	..	1⅞	5/8	5/16
229232	5	4	1 3/32	..	1⅞	5/8	¼
229233	5	4¼	1 5/32	..	1⅞	¾	5/16
229234	5	4½	1 11/32	..	1⅞	¾	5/16
229235	4	3	13/16	..	1⅝	½	¼
229236	5	3¼	1 3/32	..	1⅝	5/8	5/16
229237	4	3¼	1 1/4	..	1⅝	½	¼
229238	5	3½	1 3/32	..	1⅝	5/8	5/16
229239	5	3½	1 3/32	..	1⅝	5/8	¼
229240	5	3¾	1 5/32	..	1⅝	¾	5/16
229241	5	4	1 11/32	..	1⅝	¾	5/16
289464	6	4 11/16	1 11/16	1/8	2½	⅞	5/8
289465	6	5 1/16	2 1/16	5/16	2½	1¼	½
289466	6	6¾	3	1/4	3	1¾	5/8
289467	6	7 13/16	3 5/16	1/4	3½	2⅛	¾

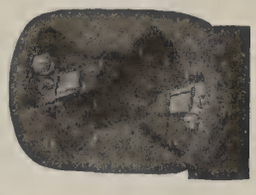
These dimensions are for reference only. For official dimensions apply to the nearest district office of the Company.

TRANSFORMER FUSE BLOCKS AND BOXES

Single-Pole—For Outdoor Mounting
For Voltages Up To 7500

PLUG-TYPE
For Use on Circuits Up To 2500 Volts

PLUG, STYLE NO. 30550



RECEPTACLE, STYLE NO. 30549

BLOCK COMPLETE, STYLE NO. 29865

Fuse block **Style No. 29865,** with the exception of the contact clips, is made entirely of porcelain with a black enamel finish. It is entirely weatherproof and may readily be mounted on a cross arm or any location convenient to the transformers by screws placed through the holes in the sides (see illustration).

The contacts for the line wires are deeply recessed in the porcelain and well separated from each other, thus protecting them from the weather and accidental contact, and also from any possibility of arcing across the terminals. Connections to the contacts are made by inserting the wires through holes in the sides of the porcelain and securing them to the contact posts by means of set screws. The hole in the binding post and the set screw is of ample proportions to render the connection of the block to the circuit a simple and easy matter.

The plug is inserted in the receptacle and given a partial turn which locks it securely in position and prevents any possibility of the plug being blown out of the receptacle due to a short-circuit or heavy overload. The construction of the contact clips is such that good contact is insured on inserting the plug and giving it a slight twist, as described above.

The fuse wire is placed in a groove that has rounded edges throughout its entire length, thus preventing any possibility of the fuse wire being cut.

Parallel to the groove is a rib which absorbs the shock incident to the insertion of the plug, and, thereby, greatly reduces possibility of breakage due to handling.

The plug terminates in a knob for handling. The surface of this knob has a number of indentations that enable the hand to secure a good grip. Immediately above the knob is a shield of ample area to provide protection for the hand of the operator.

Fuse block **Style No. 147190,** has a glazed exterior finish of a dark brown color. Except for the con-

PLUG, STYLE NO. 166277

RECEPTACLE, STYLE NO. 166276

BLOCK COMPLETE, STYLE NO. 147190

TRANSFORMER FUSE BLOCKS—Continued

tacts its design embodies the same general features of construction as Style No. 29865, previously described. The contacts are formed by spring clips; the plug is pushed straight into the receptacle and held therein by the pressure exerted by the clips. In addition, each contact is fitted with a spring latch which engages an offset on the plug, thus obtaining a more secure contact and preventing the plug from falling to the ground when the fuse blows. The plug contact rolls on the stationary contact, making a tight connection. The roll-contact feature also makes this type of block interchangeable with a number of blocks of other manufacture. Contacts of both receptacle and plug are recessed into the porcelain, thus preventing loosening and twisting.

The interrupting capacity of these fuse blocks when used one per wire, is approximately 400 amperes at 2500 volts.

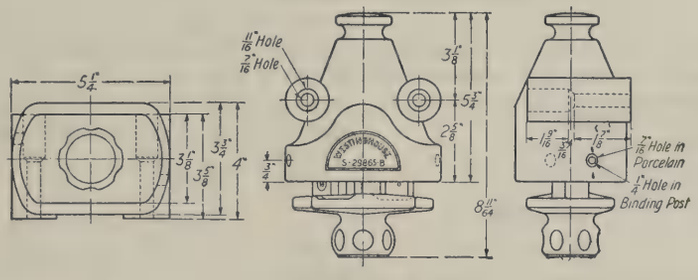
Style number and list price of the complete block include lag screws for mounting, but do not include fuse wire which must be ordered separately; see pages of this catalogue on "Fuse Wire." The length of the wire required for each fuse of Style No. 29865 is 11 inches; and of 147190 is 9 inches.

Max. Amps.	Max. Volts	Description	*Net Wt. Pounds	Style No.	List Price
30	2500	Fuse block complete	5¼	29865	$2 40
30	2500	Receptacle only	4	30549	1 55
30	2500	Plug only	1¼	30550	85
30	2500	Fuse block complete	5¼	147190	2 40
30	2500	Receptacle only	4	241509	1 55
30	2500	Plug only	1¼	241510	85

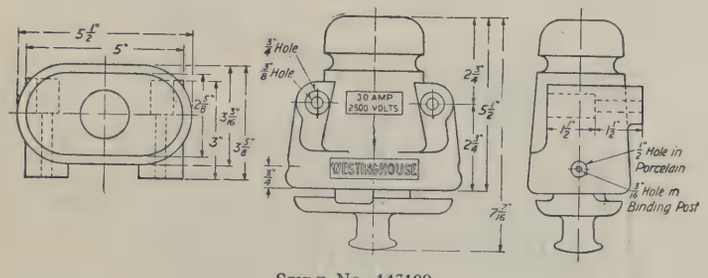
*Shipping weight in quantities is approximately 10 per cent greater.

Order by Style Number

OUTLINE DIMENSIONS



STYLE NO. 29865



STYLE NO. 147190

EXPULSION-TYPE

For Use on Circuits Up To 7500 Volts

The expulsion type fuse box is made for mounting on a pole. It has a greater voltage and capacity range than the porcelain fuse blocks previously described.

The device consists of a wooden box having mounted therein an expulsion tube within which is placed the fuse wire. The box is built of well-seasoned wood, is entirely weatherproof, and is thoroughly insulated from live parts of the circuit. It has a hinged door which permits easy access for the purpose of inspection or replacement of the fuse.

The fuse tube is composed of fibre with an expulsion chamber of brass. This tube is mounted on porcelain insulators in such a manner that the gases resulting from the blowing of the fuse are expelled through a hole in the box provided for that purpose.

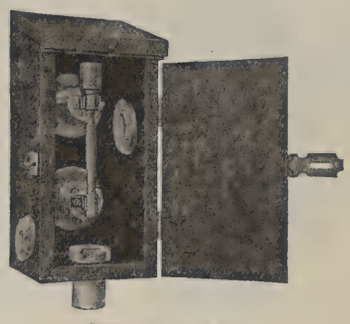
The two holes provided for the line wires in the sides of the box and the hole for the expulsion of the gases, are provided with porcelain bushings.

The fuse tube is readily removable and renders the insertion of a new fuse wire a very simple operation. It should be removed by a hook, one of which should be supplied for each installation.

The interrupting capacity of this box when used one per wire is approximately 500 amperes at 7500 volts and proportionately greater or less at either lower or higher voltages.

Standard aluminum or Nickel Silver fuse wire is used but is not included in the **style number** and **list price,** which include the box complete ready for installation.

Before inserting the fuse wire in the fuse tube, the wire should be enclosed in asbestos sleeving. The asbestos sleeving prevents the gradual charring of the inside of the fuse tube by the overheated fuse and thereby eventually lengthens the life and prevents a burning out of the fuse tube. For asbestos sleeving, see catalogue on "Insulation and Supplies." For data and prices on fuse wire see pages of this catalogue on "Fuse Wire." The length of wire required for each fuse is 10 inches.

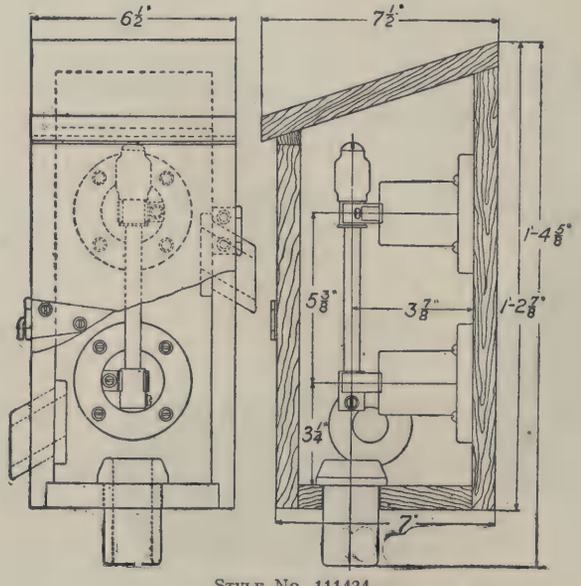


STYLE No. 111424

Amperes	Max. Volts	Description	Approx. Weight, Pounds Net	Approx. Weight, Pounds Shipping	Style No.	List Price
30 60 60	7500 3500 2500	Box complete	18	25	111424	$15 00
..	7500	Fuse tube complete	1½	1	165477	*
..	7500	Hook	1	1	156944	5 00

*See price under "Type OD Safety-First Fuse Boxes" on a following page.

Order by Style Number



STYLE No. 111424

TYPE OD SAFETY-FIRST FUSE BOXES

For Use on Circuits up to 7500 Volts—Single-Pole

The ideal fuse box for the protection of outdoor distributing transformers is a box that can be depended upon to operate on an overload, one that is easily re-fused and quickly put back into service, one that is safe; and by being safe is not meant just partially safe against accidental contact by the attendant, but one hundred per cent safe under all possible conditions except the actual intent to touch a live part. The Westinghouse type OD safety-first fuse box meets all these conditions. Complete separation of those parts to be handled from all live parts is accomplished automatically by opening the door. This method of isolation has proved successful in the Westinghouse type CR lightning arresters, which are also used for the protection of distributing transformers (see pages on "Lightning Arresters").

30-AMPERE BOX, CLOSED

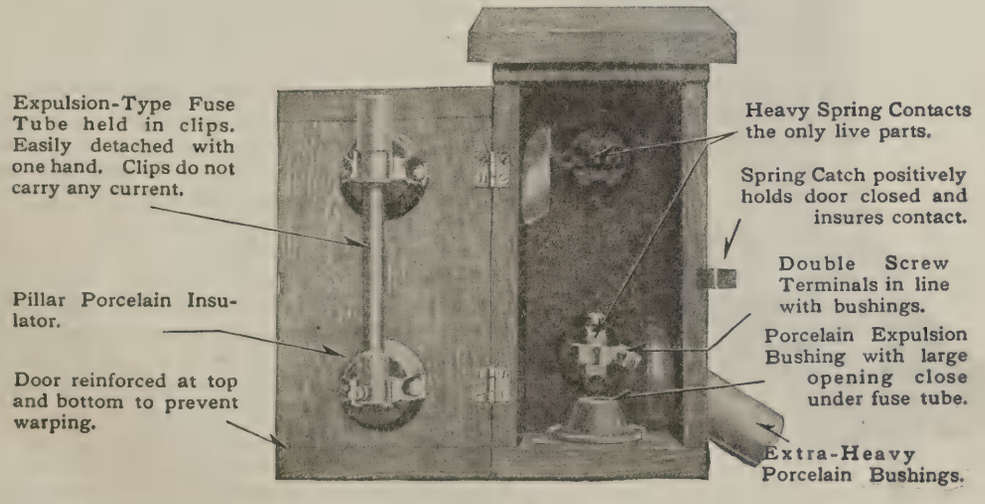
Installation—No tools other than a screw-driver are necessary. The box is supported by a strap hanger-iron screwed to the cross-arm. The line connections are made by two-screw terminals mounted on the spring contact fingers directly in line with the entrance bushings; the bared ends of the leads will push directly into the terminals and can be securely held by the two screws without any soldering.

OPERATION

Expulsion Principle—The fuse tube is open at the bottom and is provided with a closed expulsion chamber at the top. Upon the blowing of a fuse, the gases are therefore expelled from the bottom of the tube through a porcelain bushing in the bottom of the box; the bushing is close to and directly beneath the open end of the tube. This arrangement greatly helps in the expulsion of the gases without destruction of the fuse tube or box.

Indication of Condition of Fuse—Upon a fuse blowing the gases expelled from the fuse tube puncture a piece of paper clamped under the box. The puncture can be seen from the ground by day or by night—the use of a pocket electric flash lamp makes such inspection easy at night—and is a sure indication of the condition of the fuse. It is therefore unnecessary to climb the pole and open the box while making inspection.

To Re-Fuse—No hook stick, tongs, or other tools are necessary to re-fuse this box, except a screw-


Expulsion-Type Fuse Tube held in clips. Easily detached with one hand. Clips do not carry any current.
Pillar Porcelain Insulator.
Door reinforced at top and bottom to prevent warping.
Heavy Spring Contacts the only live parts.
Spring Catch positively holds door closed and insures contact.
Double Screw Terminals in line with bushings.
Porcelain Expulsion Bushing with large opening close under fuse tube.
Extra-Heavy Porcelain Bushings.

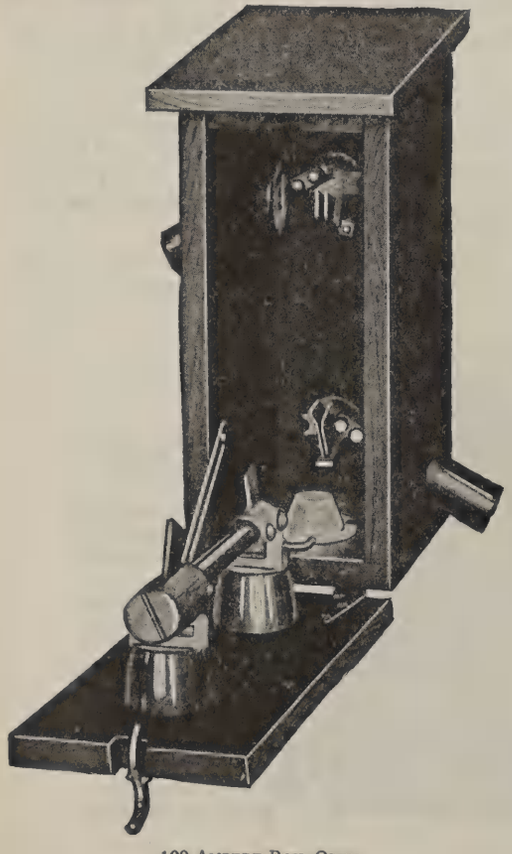
30-AMPERE BOX, OPEN

driver for clamping the fuse in the tube. When the door of the box is opened, the fuse tube—the only part requiring handling—is disconnected from the line and can therefore be safely, and easily, disengaged from its clips by one hand. The fuse tube is re-fused and, with one hand, is inserted in place and the door closed; the fuse box is again in operation. A new strip of paper should be inserted in clamps at the bottom of the fuse to serve as a new indicator.

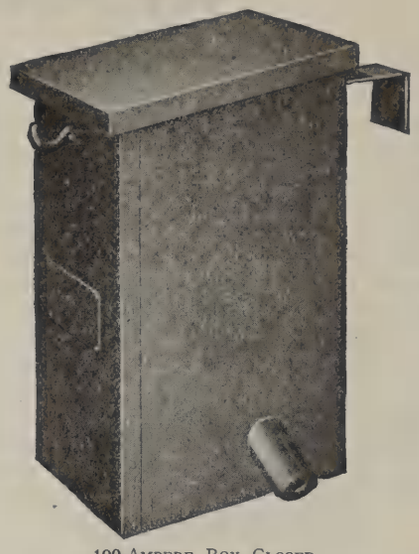
Before inserting the fuse wire in the fuse tube the wire should be enclosed in asbestos sleeving; the asbestos sleeving prevents the gradual charring of the inside of the fuse tube by the overheated fuse and thereby eventually lengthens the life and prevents a burning out of the fuse tube. For asbestos sleeving, see pages on "Insulation and Supplies."

For the aluminum or nickel silver fuse wire, used with these blocks, refer to pages on "Fuse Wire, Fuse Ribbon and Link Fuses." The fuse wire is not included in style number or list price. The length of fuse wire required for each fuse is ten inches.

Safety During Re-Fusing—Even though the box were a good conductor due to being wet, there is sufficient insulation between box and line contacts to withstand a breakdown test of 20,000 volts and, with box open, between fuse tube and contacts of 40,000 volts.



100-Ampere Box, Open



100-Ampere Box, Closed

The line contacts are 2½ inches from the front of the box with the door open and can only be touched by reaching that far inside the box.

The interrupting capacities of these fuse blocks is approximately 500 amperes at 7500 volts when used one per wire and proportionately greater or less at other lower or higher voltages.

CONSTRUCTION

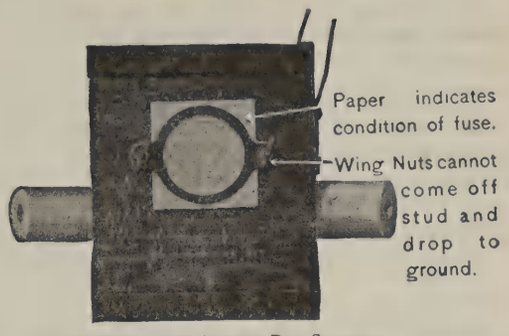
The fuse tube of the 30-ampere box is the standard heavy fibre tube used for many years in the Westinghouse expulsion-type transformer fuse box; the tube is interchangeable with that used in box style No. 111424. It is held in spring clips mounted on 7500-volt insulators on the door of the box. The clips are made light, as they carry no current, but merely hold the tube in place. Heavy spring fingers with hollow contact tips are mounted on 7500-volt insulators on the rear of the box in such a manner that contact is made between the fingers and brass ferrules on the fuse tube when the door of the box is closed. Contact above the rated capacity of the box is insured by the sheet bronze spring catch, which holds the door closed against the pressure of the spring contacts and against any internal pressure caused by short circuits that would not in other ways wreck the box. Except the fuse tube, there are no parts to wear out and to be replaced.

The fuse tube of the 100-ampere box is a heavy fibre tube similar in construction to that in the 30-ampere box. It is mounted on the 7500-volt insulators on the door of the box by dowel pins in such a manner that it can be easily removed, while being fastened firmly enough to insure good contact. Knife-blade contacts on the tube engage in jaws mounted on 7500-volt insulators on the rear of the box. The door is equipped with a spring latch, to hold it closed against any internal pressure caused by short circuits that would not in other ways wreck the box, and a hook for unlatching and opening door.

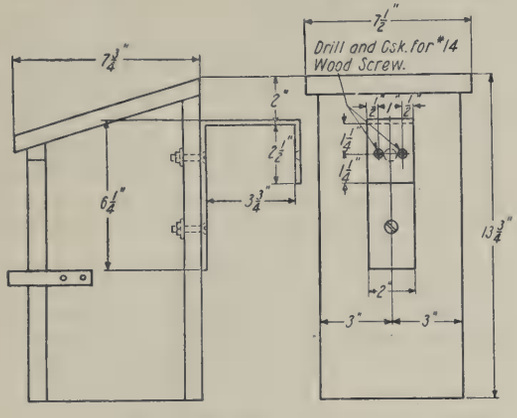
TRANSFORMER FUSE BLOCKS AND BOXES—Continued

Bushings—The line lead and the transformer lead enter the box through extra heavy porcelain bushings in the side of the box. These bushings are inclined at an angle to prevent the entrance of moisture and cannot fall out during handling although they can be easily replaced if broken.

Indicating Device—On the bottom of the box a metal clip is held by two studs with wing nuts. An ordinary piece of white paper is placed under and clamped in this clip, covering the opening for expulsion of gases, and thus acts as an indicator of the condition of the fuse (see "Operation"). The wing nuts are so arranged that they cannot be taken off the studs and dropped to the ground.



BOTTOM VIEW OF 30-AMPERE BOX SHOWING INDICATING DEVICE



APPROXIMATE OUTLINE DIMENSIONS 30-AMPERE BOX

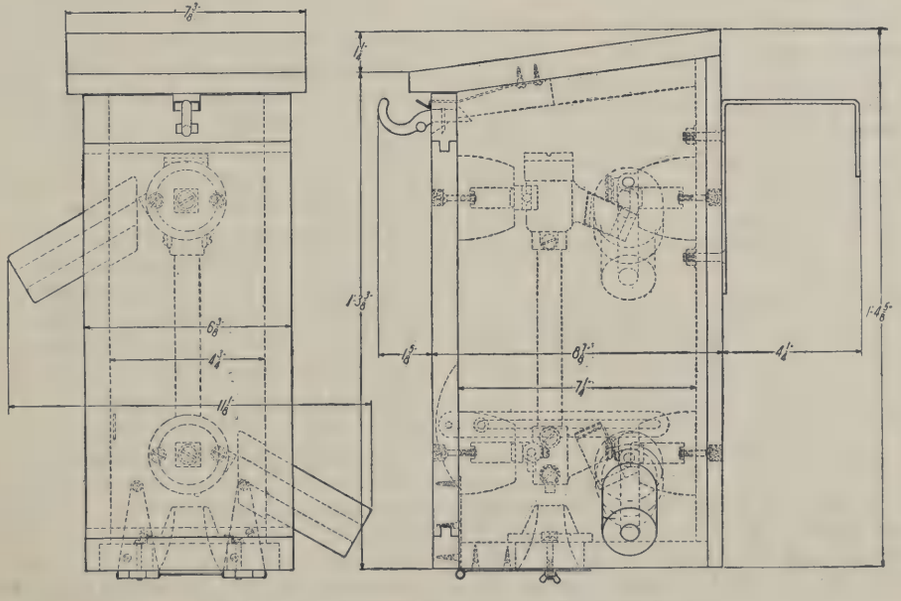
Ratings and Prices

Style number and list price include box complete except for asbestos sleeving and fuse wire, with one hanger iron for 3¾-inch cross-arms; hanger irons for 4-inch cross-arms can be supplied on special order at standard price; hanger irons for wider than 4-inch cross-arms can be supplied on special order at a slight increase in price.

Max. Amperes	Max. Volts	Description	Approx. Net*Wt. Pounds	Style No.	List Price
30	7500	Box complete	10	258592	$15 00
30	7500	Fuse Tube	..	165477	2 35
100	7500	Box complete	15	286996	17 25
100	7500	Fuse Tube	..	286997	5 25

*Shipping weight in quantities is approximately 20 per cent greater.

Order by Style Number



APPROXIMATE OUTLINE DIMENSIONS—100-AMPERE BOX

KNIFE SWITCHES

Westinghouse Knife Switches are simple in design, substantial in construction and neat in appearance.

The current-carrying parts consist of a high grade drawn copper of a guaranteed conductivity. The sectional areas and contact faces on all sliding and stationary parts have been calculated in accordance with the best practice and a liberal allowance has been made for overloads.

Two types of knife switches are listed: Types A and C.

Approval—All of the switches listed conform to the requirements of the "National Electrical Code" and are included in the "List of Approved Fittings" issued by the NATIONAL BOARD OF FIRE UNDERWRITERS. When operating under normal conditions and within their rated capacities, the temperature rise of these switches is well within the limits specified by the Underwriters.

Temperature—The current-carrying parts adjacent to the contacts will carry their full rated current continuously with a maximum temperature rise of either 20 or 30 degrees Centigrade above the temperature of the surrounding atmosphere, depending upon the class of service mentioned below into which the switches are placed.

It is necessary that adjacent apparatus does not heat the switch; that conductors to the switch are ample to carry the current with a temperature rise not exceeding that of the switch; that reasonable ventilation is provided; that connections are clean and tight; and that the break jaw blades make good contact with the switch blade.

The 20-degree rise basis is recommended when the maximum temperature of the air, where the switch is located, may be approximately 40 degrees Centigrade and the load practically continuous as on the generator, rotary or transformer systems.

The 30-degree rise basis is recommended where the maximum temperature of the air, where the switch is located, may approximate 30 degrees Centigrade or less, and the load is intermittent, as on feeder circuits.

Switches of 1,200-ampere capacity and larger are given at lower rating for alternating current than for direct current and are not guaranteed to carry more than their rated current.

Momentary Current—The maximum momentary current passing through knife switches should not be greater, owing to mechanical and electrical limitations, than 50 times their normal 60-cycle, 20-degree ampere rating for one second. If the switches will be subjected to greater current momentarily then this, a switch of larger normal rating (amperes) should be used, as they are both mechanically and electrically stronger.

Finish—Types A and C front-connected switches have plain finish. They can also be furnished with satin finish or polished finish at an increase in price.

Type A rear-connected switches have satin finish. They can also be furnished with plain finish at a reduction in price, or with polished finish at an increase in price.

Handles—Spade handles are regularly furnished on all four-pole switches and on all three-pole switches above 600-ampere capacity. All other switches have straight handles. Switches shipped with straight handles do not have the cross bar drilled for the mounting screws of the spade handles. If spade handles are later supplied arrangements should be made for drilling the cross bars to accommodate the spade handles.

Fuses—Fused switches are arranged for National Electrical Code Standard Enclosed Fuses.

High Jaws—All switches that are fused on the hinge jaws have high jaws to allow the switch handle and blades, when in the open position, to **lie flat** over the fuses. All switches that are fused on the break jaws have high break jaws to allow clearance between the switch handle and the fuses.

Bases—Types A and C front-connected switches are furnished mounted on high-grade slate bases with oil finish. They can also be furnished without bases at a reduction in price.

Type A rear-connected switches are furnished without bases. They can also be furnished with wood templates or slate or marble bases at an increase in price.

Type A Switches

Construction—Type A switches have milled jaws and are of the highest grade of construction.

Front-Connected — Type A front-connected switches are listed up to 1,200 amperes; for maximum voltages of 250 D.C. or A.C. or 500 A.C.; and up to 600 amperes for maximum voltage of 600 D.C. or A.C.; fused or not fused; with or without quick-break blades; single or double-throw.

Rear-Connected with Round Studs—Type A rear-connected switches with round studs are listed in capacities up to 2,000 amperes not fused or 1,200 amperes fused; for maximum voltages of 250 D.C. or A.C. or 500 A.C.; and up to 2,000 amperes not fused or 600 amperes fused for maximum voltage of 600 D.C. or A.C.; with or without quick-break blades; single or double-throw.

Rear-Connected with Laminated Studs—Type A rear-connected switches with laminated studs are furnished with the conductor slots in the studs horizontal. They are listed in capacities from 1600 amperes to 6000 amperes, not fused; for maximum voltages of 250 D.C. or 500 A.C. and 600 D.C. or A.C.; without quick-break blades; single or double-throw.

Type C Switches

Construction—Type C switches have punched jaws. This is the chief difference in the construction between the types C and A switches and it results in a lower cost for the type C switch.

Front-Connected—Type C switches are supplied in front-connection only. They are listed up to 200 amperes, fused or not fused; for maximum voltages of 250 D.C. or A.C., 500 A.C., and 600 D.C. or A.C., with or without quick-break blades; single or double-throw.

Instructions for Ordering

Style number and list price of types A and C **front-connected** switches include switch with plain finish, complete with terminals and slate base with oil finish, but without fuses.

Style number and list price of type A **rear-connected switches** with **round studs** include switch with satin finish without base or fuses; complete with sufficient nuts on each stud to clamp the switch and to make connections to carry the rated current; with terminals on one stud per pole on single-throw and on two studs per pole on double-throw switches rated 800 amperes and below, and without terminals on switches rated above 800 amperes. If terminals are specified at time of entry of order, one stud per pole on single-throw and two studs per pole on double-throw switches, rated 1000 and 1200 amperes, will be supplied with terminals at the regular list price.

Style number and list price of type A **rear-connected switches** with **laminated studs** include switch with satin finish without base or terminals.

When fuses are required with switches, they should be ordered as separate items—see pages listing "Fuses."

When terminals, other than those included in the style number are required, they should be ordered as separate items—see pages listing "Terminals" under "Switchboard Details."

When extra nuts are required, they should be ordered as separate items—see pages on "Nuts" under "Switchboard Details."

When spade handles are required with switches other than four-pole or three-pole above 600-ampere capacity, the switches should be ordered by referring to the style number and stating: "Same as style number ..... except to have space handle."

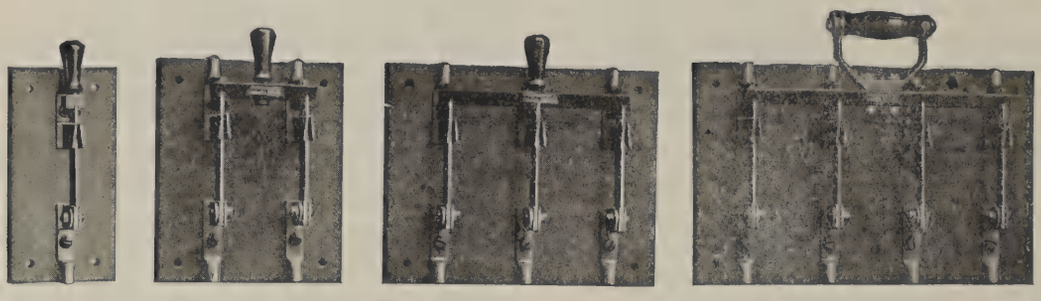
When rear-connected switches with bases are required, they should be ordered by referring to the style number and stating "Same as style number ..... except mounted on ..... (giving the kind of base.)" Wood templates, slate or black marine marble bases of standard sizes, as shown in the tables of dimensions, can be supplied at the increase in price as shown in the price tables. If other than standard size bases are required or if marble bases with special finishes are required, they will be supplied at special prices.

KNIFE SWITCHES—Continued

TYPE A FRONT-CONNECTED SWITCHES

250 Volts D. C. or 500 Volts A. C.

SINGLE-THROW — NOT FUSED



Max. Amperes‡ D. C.	Max. Amperes‡ A.C.,60 Cycle	Weight, Pounds Net	Weight, Pounds Boxed	Style No.	List Price	Weight, Pounds Net	Weight, Pounds Boxed	Style No.	List Price
Without Quick-Break Blades									
		Single-Pole					**Three-Pole**		
30*	30*	2	3	227876	0 80	3	4½	227898	$1 80
30	30	2	3	257199	1 15	4½	6½	227899	2 48
60	60	2	3	227877	1 20	4½	6½	227900	2 68
100	100	2¾	3½	227878	2 25	8½	12½	227901	5 08
200	200	4½	7	227879	3 48	15½	22½	227902	7 80
400	400	10	15½	227881	8 14	30	43½	227904	18 30
600	600	15	23	227882	11 54	35	51	227905	25 96
800	800	24	37	227883	20 00	58	84	227906	45 00
1000	1000	26	40½	227884	22 68	65	94	227907	51 00
1200	1100	29	45	227885	27 34	75	109	227908	61 50
		Double-Pole					**Four-Pole**		
30*	30*	2½	3¾	227886	1 20	4	5	227911	2 40
30	30	3¼	4¾	257200	1 64	8	13	227912	3 30
60	60	3¼	4¾	227887	1 78	8	13	227913	3 56
100	100	5¾	8¾	227888	3 38	12½	20¼	227914	6 76
200	200	10½	16	227889	5 20	20	33	227915	10 40
400	400	19	29	227891	12 20	34	56	227917	25 94
600	600	24	37	227892	17 30	48	78	227918	36 78
800	800	41	63	227893	30 00	76	124	227919	60 00
1000	1000	45	69	227894	34 00	84	137	227920	68 00
1200	1100	50	76½	227895	41 00	96	157	227921	82 00
With Quick-Break Blades									
		Single-Pole					**Three-Pole**		
30†	30†	2	3	257191	1 50	4½	6½	257193	3 56
60	60	2	3	255288	1 58	4½	6½	255290	3 82
100	100	2¾	4	255296	2 65	8½	12½	255298	6 28
200	200	4½	7	255304	3 94	15½	22½	255306	9 18
400	400	10	15½	255312	8 94	31	45	255314	20 70
600	600	15	33½	255320	12 46	36	52	255322	28 72
800	800	24	37½	262076	21 09	59	85½	262078	48 30
1000	1000	27	42	262084	24 00	67	97	262086	54 94
		Double-Pole					**Four-Pole**		
30†	30†	3¼	5	257192	2 36	8	13	257194	4 74
60	60	3¼	5	255289	2 54	8	13	255291	5 08
100	100	5¾	8¾	255297	4 18	12½	20	255299	8 36
200	200	10½	16	255305	6 12	20	33	255307	12 24
400	400	19	29	255313	13 80	35	57	255315	29 14
600	600	24½	37½	255321	19 14	50	81½	255323	40 46
800	800	42	64½	262077	32 18	78	137	262079	64 68
1000	1000	46	70½	262085	36 63	86	140	262087	73 25

*For 250 volts only.
†For 500 volts A. C. only.
‡For 1000 amperes and below, the ratings are the same on both the 20-degree and 30-degree rise basis. Above 1000 amperes, the ratings given are on the basis of 30 degrees rise.

Style number and list price include switch with plain finish, without fuses; complete with base, terminals; spade handles on all four-pole switches and all three-pole switches above 600 amperes and straight handles on all other switches.

For additional prices for switches with satin or polished finish, refer to the discount sheet, Catalog 1-B, Part 1.

For switches without bases deduct 10 per cent from the list price.

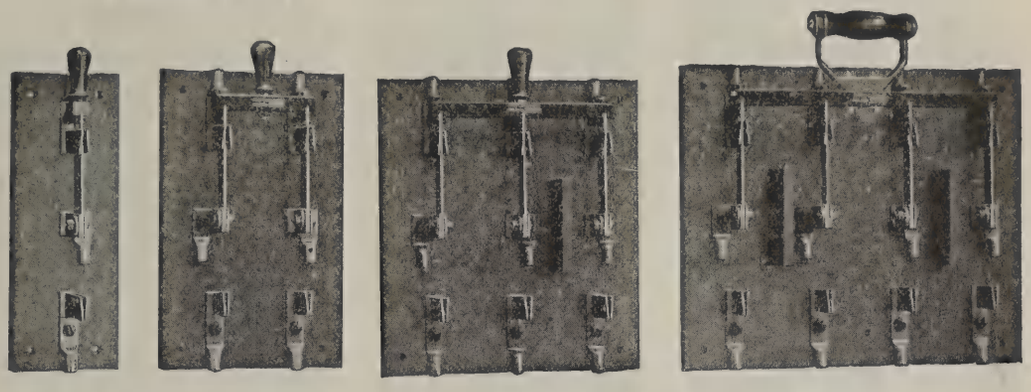
For special spade handles refer to the list at the end of the knife switch tables.

KNIFE SWITCHES—Continued

TYPE A FRONT-CONNECTED SWITCHES

250 Volts D. C. or 500 Volts A. C.

DOUBLE-THROW **NOT FUSED**



Max. Amperes‡ D. C.	Max. Amperes‡ A.C., 60 Cycle	Weight, Pounds Net	Weight, Pounds Boxed	Style No.	List Price	Weight, Pounds Net	Weight, Pounds Boxed	Style No.	List Price
Without Quick-Break Blades									
				Single-Pole				**Three-Pole**	
30*	30*	2¼	3½	227924	$ 1 18	4	6	227946	$ 2 64
30	30	2¼	3½	257201	1 58	8	12	227947	3 40
60	60	2¼	3½	227925	1 74	8	12	227948	3 90
100	100	3¾	6	227926	3 34	13	19	227949	7 50
200	200	6	9½	227927	5 34	23	33	227950	12 00
400	400	13	20	227929	12 54	46	66	227952	28 20
600	600	22	35	227930	17 34	54	78	227953	39 00
800	800	36	56	227931	28 00	94	137	227954	63 00
1000	1000	39	61	227932	31 68	105	152	227955	71 25
1200	1100	44	79	227933	40 00	125	181	227956	90 00
				Double-Pole				**Four-Pole**	
30*	30*	5	7½	227934	1 76	6	10	227959	3 52
30	30	6	9¼	257202	2 26	13	21	227960	4 60
60	60	6	9¼	227935	2 60	13	21	227961	5 20
100	100	9½	14½	227936	5 00	19	31	227962	10 00
200	200	16½	25	227937	8 00	30	49	227963	16 00
400	400	26	40	227939	18 80	54	88	227964	37 60
600	600	35	56½	227940	26 00	74	121	227966	52 00
800	800	65	99½	227941	42 00	115	188	227967	84 00
1000	1000	72	110	227942	47 50	128	208	227968	95 00
1200	1100	78	120	227943	60 00	150	245	227969	120 00
With Quick-Break Blades									
				Single-Pole				**Three-Pole**	
30†	30†	2¼	3¼	257195	2 30	8	11½	257197	5 56
60	60	2¼	3¼	255292	2 50	8	11½	255294	6 18
100	100	3¾	6	255300	4 16	13	19	255302	9 96
200	200	6	9½	255308	6 28	23	33	255310	14 82
400	400	13	20	255316	14 14	47	68	255318	33 00
600	600	22½	35	255324	19 18	56	81	255326	44 52
800	800	36	56	262080	30 18	95	138	262082	69 57
1000	1000	40	62½	262088	36 31	107	155	262090	79 13
				Double-Pole				**Four-Pole**	
30†	30†	6	9¼	257196	3 70	13	21	257198	7 48
60	60	6	9¼	255293	4 12	13	21	255295	8 24
100	100	9½	14½	255301	6 64	19	31	255303	13 28
200	200	16½	25	255309	9 88	30	49	255311	19 76
400	400	26½	40½	255317	22 00	56	91	255319	44 00
600	600	36	55	255325	29 68	77	125	255327	59 36
800	800	66	101	262081	46 39	117	190	262083	92 78
1000	1000	73	112	262089	52 75	130	212	262091	105 50

*For 250 volts only.

†For 500 volts A. C. only.

‡For 1000 amperes and below, the ratings are the same on both the 20-degree and 30-degree rise basis. Above 1000 amperes the ratings given are on the basis of 30 degrees rise.

Style number and list price include switch with plain finish, without fuses; complete with base, terminals, spade handles on all four-pole switches and all three-pole switches above 600 amperes and straight handles on all other switches.

For additional prices for switches with satin or polished finish, refer to the discount sheets, Catalog 1-B, Part 1.

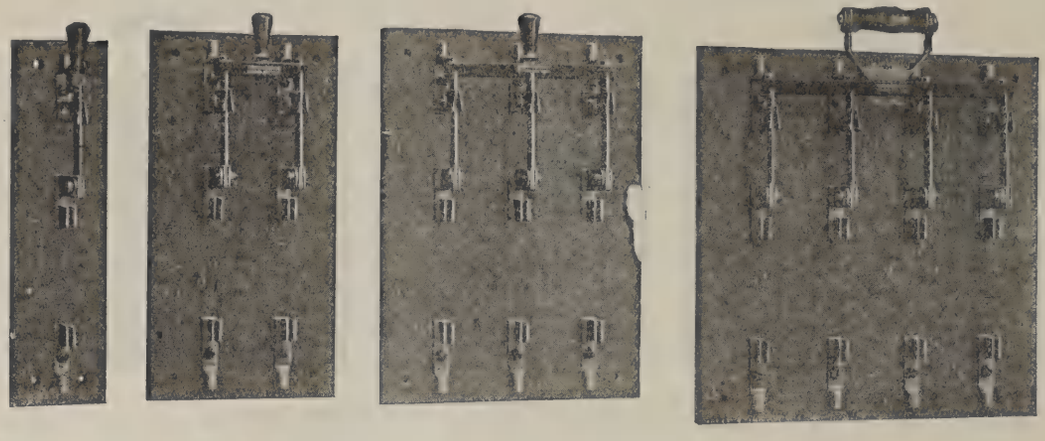
For switches without bases deduct 10 per cent from the list price.

For special spade handles refer to the list at the end of the knife switch tables.

TYPE A FRONT-CONNECTED SWITCHES

250 Volts D. C. or A. C.

SINGLE-THROW FUSED AT BOTTOM



Max. Amperes‡ D.C.	Max. Amperes‡ A.C., 60 Cycle	Wt., Pounds Net	Wt., Pounds Boxed	Style No.	List Price	Wt., Pounds Net	Wt., Pounds Boxed	Style No.	List Price
Without Quick-Break Blades									
		Single-Pole					**Three-Pole**		
30	30	2	3	227972	$ 1 18	4	5¾	227990	$ 2 64
60	60	3¾	6	227973	1 74	6½	9½	227991	3 90
100	100	5½	8½	227974	3 34	14	20	227992	7 50
200	200	9	18	227975	5 14	24	35	227993	11 56
400	400	16	25	227976	11 64	48	69½	227994	26 20
600	600	22	34½	227977	16 34	60	87	227995	36 75
800	800	36	56	227978	26 34	100	145	227996	59 25
1000	1000	40	62½	227979	30 34	110	160	227997	68 25
1200	1100	45	70	227980	35 68	122	177	227998	80 25
		Double-Pole					**Four-Pole**		
30	30	2½	3¾	227981	1 76	6¾	10	227999	3 52
60	60	4½	6½	227982	2 60	10	18	228000	5 20
100	100	9	14	227983	5 00	21	34	228001	10 00
200	200	17	26	227984	7 70	37	60	228002	15 40
400	400	29	44½	227985	17 46	67	109	228003	37 10
600	600	44	67	227986	24 50	88	144	228004	52 06
800	800	65	99½	227987	39 50	130	212	228005	79 00
1000	1000	72	110	227988	45 50	144	235	228006	91 00
1200	1100	80	122	227989	53 50	160	265	228007	107 00
With Quick-Break Blades									
		Single-Pole					**Three-Pole**		
60	60	3¾	5¾	255368	2 12	6½	9½	255370	5 04
100	100	5½	8½	255380	3 74	14	20	255382	8 70
200	200	9	14	255392	5 60	24	35	255394	12 94
400	400	16	25	255404	12 44	49	71	255406	28 60
600	600	22	34½	255416	17 26	61	88½	255418	39 51
800	800	36	56	252100	27 43	101	146	262102	61 55
1000	1000	41	64	252112	31 66	112	162	262114	71 19
		Double-Pole					**Four-Pole**		
60	60	4½	7	255369	3 36	10¾	17½	255371	6 72
100	100	9	13¾	255381	5 80	21	34	255383	11 60
200	200	17	26	255393	8 62	38	62	255395	17 24
400	400	30	46	255405	19 06	69	113	255407	40 30
600	600	45	69	255417	26 34	90	147	255419	55 74
800	800	66	101	262101	41 68	132	212	262103	83 68
000	1000	73	112	262113	48 13	147	239	262115	96 25

‡For 1000 amperes and below, the rating are the same on both the 20-degree and 30-degree rise basis. Above 1000 amperes the ratings given are on the basis of 30-degrees rise.

Style number and list price include switch with plain finish, without fuses; complete with base, terminals, spade handles on all four-pole switches and all three-pole switches above 600 amperes and straight handles an all other switches.

For additional prices for switches with satin or polished finish, refer to the discount sheets, catalog 1-B, part 1.

For switches without bases deduct 10 per cent from the list price.

For special spade handles refer to the list at the end of the knife switch tables.

Switches fused at the top can be supplied on special request.

KNIFE SWITCHES—Continued

TYPE A FRONT-CONNECTED SWITCHES
250 Volts D. C. or A. C.

DOUBLE-THROW **FUSED AT BOTH ENDS**

Max. Amperes‡ D. C.	Max. Amperes‡ A.C., 60 Cycle	Wt., Pounds Net	Wt., Pounds Boxed	Style No.	List Price	Wt., Pounds Net	Wt., Pounds Boxed	Style No.	List Price
Without Quick-Break Blades									
			Single-Pole				**Three-Pole**		
30	30	3	4¾	228044	$ 2 28	7	13	228062	$ 5 10
60	60	6	9½	228045	3 08	13	19	228063	6 90
100	100	9½	14¾	228046	5 20	26	38	228064	13 96
200	200	15	23	228047	9 34	46	86½	228065	21 00
400	400	29	45	228048	18 68	88	128	228066	42 00
600	600	35	55	228049	27 68	117	170	228067	62 25
800	800	60	93½	228050	42 68	145	210	228068	96 00
1000	1000	72	109	228051	50 68	160	232	228069	114 00
1200	1100	80	125	228052	58 68	175	254	228070	132 00
			Double-Pole				**Four-Pole**		
30	30	5	7½	228053	3 40	12	19½	228071	4 00
60	60	8	12½	228054	4 60	19	31	228072	9 20
100	100	15	23	228055	9 30	40	65	228073	18 60
200	200	25	38	228056	14 00	67	109	228074	28 00
400	400	49	75	228057	28 00	117	191	228075	56 00
600	600	74	142	228058	41 50	166	280	228076	83 00
800	800	105	168	228059	64 00	200	326	228077	128 00
1000	1000	130	200	228060	76 00	216	352	228078	152 00
1200	1100	150	230	228061	88 00	240	398	228079	176 00
With Quick-Break Blades									
			Single-Pole				**Three-Pole**		
60	60	6	9½	255376	3 84	13	19	255378	9 [illegible]
100	100	9	14	255388	7 02	27	40½	255390	16 42
200	200	15	23	255400	10 28	48	69½	255402	23 [illegible]
400	400	29	45	255412	20 28	90	130	255414	46 80
600	600	35	54¾	255424	29 52	120	174	255426	67 77
800	800	61	95	262108	44 86	147	214	262110	102 57
1000	1000	73	114	262120	55 31	162	233	262122	121 88
			Double-Pole				**Four-Pole**		
60	60	8	12	255377	8 12	19	31	255379	12 24
100	100	15	23	255389	10 94	41	67	255391	21 [illegible]
200	200	26	40	255401	15 88	69	113	255403	31 76
400	400	51	78	255413	31 20	120	195	255415	62 40
600	600	76	116	255425	45 18	170	277	255427	90 36
800	800	106	162	262109	68 39	200	326	262111	136 78
1000	1000	122	187	262121	81 25	219	357	262123	162 50

‡For 1000 amperes and below, the ratings are the same on both the 20-degree and 30-degree rise basis. Above 1000 amperes the ratings given are on the basis of 30-degrees rise.

Style number and list price include switch with plain finish, without fuses; complete with base, terminals, spade handles on all four-pole switches and all three-pole switches above 600 amperes, and straight handles on all other switches.

For additional prices for switches with satin or polished finish, refer to the discount sheets, Catalog 1-B, Part 1.

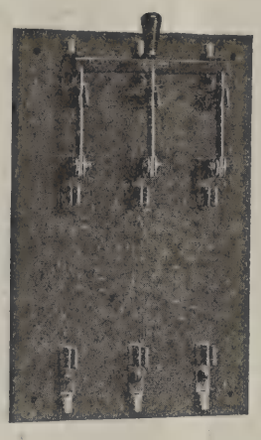
For switches without bases deduct 10 per cent from the list price.

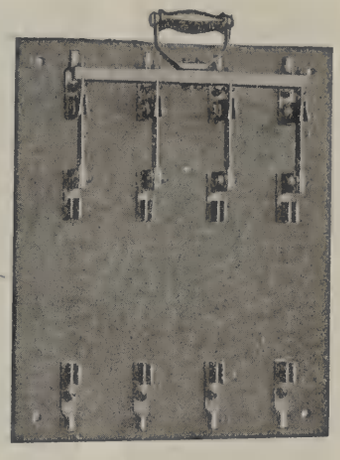
For special spade handles refer to the list at the end of the knife switch tables.

TYPE A FRONT-CONNECTED SWITCHES

500 Volts A. C.

SINGLE-THROW FUSED AT BOTTOM





Max. Amperes‡ D.C.	A.C., 60 Cycle	Weight, Pounds Net	Boxed	Style No.	List Price	Weight, Pounds Net	Boxed	Style No.	List Price
Without Quick-Break Blades									
Single-Pole						**Three-Pole**			
30	30	2	3	255252	1 75	7½	13¾	228080	$ 4 00
60	60	3¾	5¾	255258	2 05	8¾	15½	228081	4 60
100	100	6½	10	255264	3 60	17	25	228082	8 20
200	200	10	15½	255270	5 80	25	36	228083	13 10
400	400	18	28	255276	12 65	50	72½	228084	28 50
600	600	25	39	255282	17 75	65	94	228085	40 00
800	800	38	59½	262040	27 50	108	157	228086	62 00
1000	1000	45	70	262052	31 05	120	174	228087	70 00
1200	1100	49	76½	262064	37 25	130	188	228088	84 00
Double-Pole						**Four-Pole**			
30	30	3	4½	255253	2 65	12	17½	228089	5 34
60	60	4¾	7¼	255259	3 05	19	27½	228090	6 14
100	100	10	15	255265	5 45	27	39	228091	10 94
200	200	19	29	255271	8 70	42	61	228092	17 48
400	400	33	50	255277	19 00	72	105	228093	38 00
600	600	47	72	255283	26 65	91	132	228094	53 84
800	800	72	110	262041	41 30	140	203	228095	82 68
1000	1000	85	130	262053	46 60	155	225	228096	93 34
1200	1100	90	138	262065	55 95	170	247	228097	112 00
With Quick-Break Blades									
Single-Pole						**Three-Pole**			
30	30	2	3	255180	2 11	7½	11	255182	5 08
60	60	3¾	5¾	255192	2 43	8¾	12½	255194	5 74
100	100	6½	10	255204	4 00	17	25	255206	9 40
200	200	10	15½	255216	6 26	26	38	255218	14 48
400	400	18	28	255228	13 35	52	75½	255230	30 90
600	600	26	40½	255240	18 67	67	97	255242	42 76
800	800	38	59	262136	28 59	109	158	262138	65 30
1000	1000	46	72	262148	32 37	122	177	262150	73 94
Double-Pole						**Four-Pole**			
30	30	3	4½	255181	3 37	12	19½	255183	6 78
60	60	4¾	7¼	255193	3 81	19	31	255195	7 66
100	100	10	15	255205	6 25	28	46	255207	12 54
200	200	19	29	255217	9 62	43	70	255219	19 32
400	400	34	52	255229	20 60	74	121	255231	41 20
600	600	50	76½	255241	28 49	95	155	255243	57 02
800	800	73	112	262137	43 48	142	232	262139	87 36
1000	1000	87	133	262149	49 23	158	258	262151	98 59

‡For 1000 amperes and below, the ratings are the same on both the 20-degree and 30-degree rise basis. Above 1000 amperes the rating given are on the basis of 30-degrees rise.

Style number and list price include switch with plain finish, without fuses; complete with base, terminals, spade handles, on all four-pole switches and all three-pole switches above 600 amperes and straight handles on all other switches.

For additional prices for switches with satin or polished finish, refer to the discount sheets, Catalog 1-B, Part 1

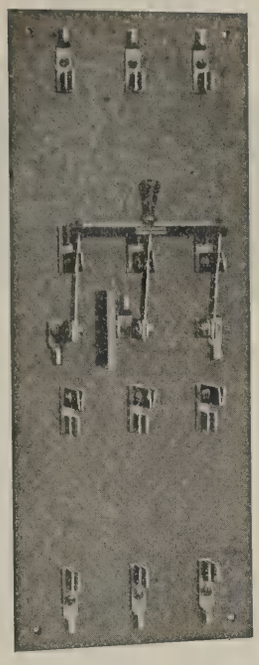
For switches without bases deduct 10 per cent from the list price.

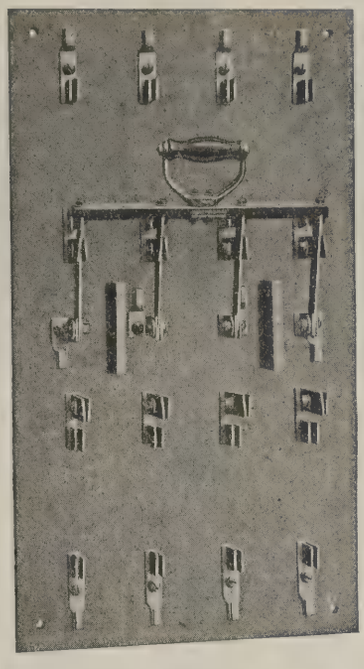
For special spade handles refer to the list at the end of the knife switch tables.

Switches fused at the top can be supplied on special request.

TYPE A FRONT-CONNECTED SWITCHES
500 Volts A. C.

DOUBLE-THROW **FUSED AT BOTH ENDS**





Max. Amperes‡ D.C.	Max. Amperes‡ A.C., 60 Cycle	Weight, Pounds Net	Weight, Pounds Boxed	Style No.	List Price	Weight, Pounds Net	Weight, Pounds Boxed	Style No.	List Price
Without Quick-Break Blades									
			Single-Pole				**Three-Pole**		
30	30	3½	5½	255256	3 35	10	14½	228116	7 50
60	60	6½	10	255262	4 00	15	22	228117	9 00
100	100	11	17	255268	7 10	27	40½	228118	16 00
200	200	17	26½	255274	10 40	49	71	228119	23 50
400	400	29	45	255280	21 30	93	135	228120	48 00
600	600	37	58	255286	31 95	127	184	228121	72 00
800	800	46	72	262048	48 80	160	232	228122	110 00
1000	1000	55	86	262060	53 20	176	255	228123	120 00
1200	1100	62	97	262072	62 10	192	278	228124	140 00
			Double-Pole				**Four-Pole**		
30	30	5	7½	255257	5 00	23	33	228125	10 00
60	60	9	13¾	255263	6 00	35	51	228126	12 00
100	100	17	26	255269	10 65	60	87	228127	21 32
200	200	27	41	255275	15 65	74	107	228128	31 32
400	400	51	78	255281	31 95	127	184	228129	60 00
600	600	77	118	255287	47 95	146	212	228130	96 00
800	800	90	138	262049	73 25	210	304	228131	146 66
1000	1000	110	168	262061	79 90	240	348	228132	160 00
1200	1100	122	187	262073	93 25	270	392	228133	186 66
With Quick-Break Blades									
			Single-Pole				**Three-Pole**		
30	30	3½	5½	255188	4 07	10	14½	255190	8 58
60	60	6½	10	255200	4 76	15	22	255202	10 14
100	100	11	17	255212	7 92	29	42	255214	17 20
200	200	17	26½	255224	11 34	51	74	255226	24 88
400	400	30	47	255236	22 90	96	139	255238	50 40
600	600	38	59	255248	33 79	132	191	255250	74 76
800	800	47	73½	262144	50 98	162	235	262146	116 57
1000	1000	57	89	262156	57 83	179	259	262158	127 88
			Double-Pole				**Four-Pole**		
30	30	5	7½	255189	6 44	23	37½	255191	11 44
60	60	9	15	255201	7 52	36	58½	255203	13 52
100	100	17	26	255213	12 29	62	102	255215	22 92
200	200	28	43	255225	17 53	76	124	255227	33 16
400	400	53	81	255237	35 15	130	212	255239	63 20
600	600	79	110	255249	51 63	150	244	255251	99 68
800	800	91	139	262145	77 64	212	344	262147	155 44
1000	1000	112	172	262157	85 15	245	400	262159	170 50

‡For 1000 amperes and below, the ratings are the same on both the 20-degree and 30-degree rise basis. Above 1000 amperes the ratings given are on the basis of 30 degrees rise.

Style number and list price include switch with plain finish, without fuses; complete with base, terminals, spade handles on all four-pole switches and all three-pole switches above 600 amperes and straight handles on all other switches.

For additional prices for switches with satin or polished finish, refer to the discount sheets, Catalog 1-B, Part 1.

For switches without bases deduct 10 per cent from the list price.

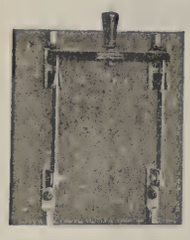
For special spade handles refer to the list at the end of the knife switch tables.

TYPE A FRONT-CONNECTED SWITCHES

600 Volts D. C. or A. C.

SINGLE-THROW NOT FUSED

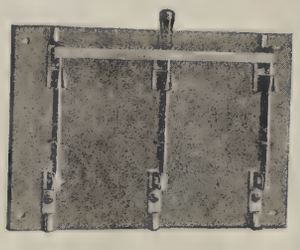
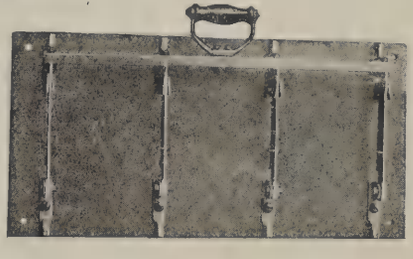
Without Quick-Break Blades



Maximum Amperes‡	Weight, Pounds Net	Weight, Pounds Boxed	Style No.	List Price
		Single-Pole		
30	2¼	3½	228141	$ 1 18
60	2½	4	228142	1 28
100	3½	8½	228143	2 20
200	6	9½	255344	3 95
400	10	15½	255352	8 55
600	14	22	255360	11 45
		Double-Pole		
30	5¼	8	228151	2 12
60	5¾	8¾	228152	2 30
100	9	13¾	228153	4 00
200	14¾	22½	255345	7 10
400	25	38	255353	15 40
600	31	47½	255361	26 65

Weight, Pounds Net	Weight, Pounds Boxed	Style No.	List Price
	Three-Pole		
7	10	228161	$ 3 40
8	11½	228162	3 68
14½	21	228163	6 40
25	36	255346	11 45
43	62½	255354	24 80
52	75½	255362	33 25
	Four-Pole		
10	16	228171	4 70
11	18	228172	5 06
20	33	228173	8 80
32	52	255347	15 75
58	95	255355	34 20
69	112	255363	45 80

With Quick-Break Blades

Maximum Amperes‡	Weight, Pounds Net	Weight, Pounds Boxed	Style No.	List Price
		Single-Pole		
30	2¼	3½	228134	$ 1 50
60	2½	3¾	228135	1 60
100	3½	5½	228136	2 76
200	6	9½	228137	4 40
400	10	15½	228139	9 36
600	14	22	228140	12 38
		Double-Pole		
30	5¼	8	228144	2 72
60	5¾	8¾	228145	3 90
100	9	13¾	228146	5 00
200	14¾	22½	228147	8 00
400	26	40	228149	17 00
600	32	49	228150	22 50

Weight, Pounds Net	Weight, Pounds Boxed	Style No.	List Price
	Three-Pole		
7	10	228154	$ 4 38
8	11½	228155	4 64
14½	21	228156	8 00
25	36	228157	12 80
45	65½	228159	27 20
54	78½	228160	36 00
	Four-Pole		
10	16	228164	6 02
11	18	228165	6 38
20	33	228166	11 00
33	54	228167	17 60
60	98	228169	37 40
72	117	228170	49 50

‡Good for either 20 degrees or 30 degrees temperature rise; D. C. or 25-cycle or 60-cycle A. C.

Style number and list price include switch with plain finish; complete with base, terminals, spade handles on all four-pole switches and straight handles on all other switches.

For additional prices for switches with satin or polished finish, refer to the discount sheets, Catalog 1-B, Part 1.

For switches without bases, deduct 10 per cent from the list price.

For special spade handles refer to the list at the end of the knife switch tables.

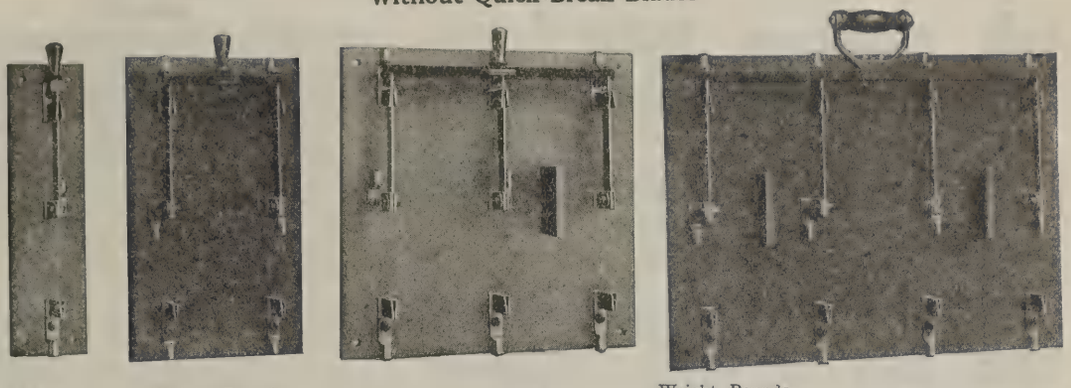
KNIFE SWITCHES—Continued

TYPE A FRONT-CONNECTED SWITCHES

600 Volts D. C. or A. C.

DOUBLE-THROW NOT FUSED

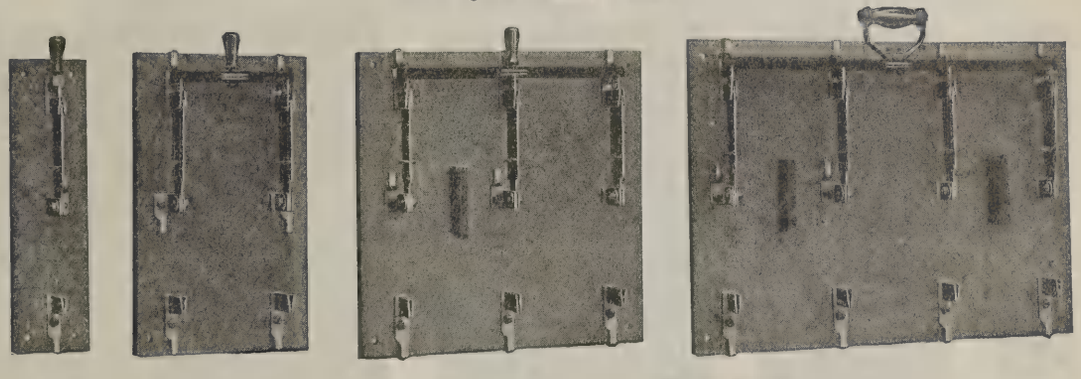
Without Quick-Break Blades



Maximum Amperes‡	Weight, Pounds Net	Weight, Pounds Boxed	Style No.	List Price
		Single-Pole		
30	2¾	4¼	228181	$ 1 36
60	3	4¾	228182	2 48
100	5	7¾	228183	3 58
200	9	14	255348	5 65
400	17	26½	255356	12 15
600	22	34	255364	15 75
		Double-Pole		
30	10	15	228191	4 26
60	11	17	228192	4 50
100	15	23	228193	6 50
200	22	34	255349	10 10
400	37	57	255357	22 00
600	48	72½	255365	28 25

Weight, Pounds Net	Weight, Pounds Boxed	Style No.	List Price
	Three-Pole		
15	22	228201	6 84
16¼	23¼	228202	7 20
24	35	228203	10 40
37	53½	255350	16 40
66	96	255358	35 25
77	112	255366	45 75
	Four-Pole		
20	32½	228211	9 42
21½	35	228212	9 90
32	52	228213	14 30
49	80	255351	22 65
87	142	255359	48 50
106	173	255367	63 00

With Quick-Break Blades



Maximum Amperes‡	Weight, Pounds Net	Weight, Pounds Boxed	Style No.	List Price
		Single-Pole		
30	2¾	4¼	228174	$ 2 64
60	3	4¾	228175	2 76
100	5	7¾	228176	4 08
200	9	14	228177	6 60
400	17	26½	228179	13 76
600	22	34	228180	17 60
		Double-Pole		
30	10	15	228184	4 76
60	11	17	228185	5 00
100	15	23	228186	7 40
200	22	34	228187	12 00
400	38	58	228189	25 00
600	50	76½	228190	32 00

Weight, Pounds Net	Weight, Pounds Boxed	Style No.	List Price
	Three-Pole		
15	22	228194	$ 7 64
16¼	23¼	228195	8 00
24	35	228196	11 84
38	55	228197	19 20
68	98½	228199	40 00
80	116	228200	51 20
	Four-Pole		
20	32½	228204	10 52
21½	35	228205	11 00
32	52	228206	16 28
51	83	228207	26 40
90	147	228209	55 00
110	169	228210	70 40

‡Good for either 20 degrees or 30 degrees temperature rise; D. C. or 25-cycle or 60-cycle A. C.

Style number and list price include switch with plain finish; complete with base, terminals, spade handles on all four-pole switches and straight handles on all other switches.

For additional prices for switches with satin or polished finish, refer to the discount sheets, Catalog 1-B, Part 1.

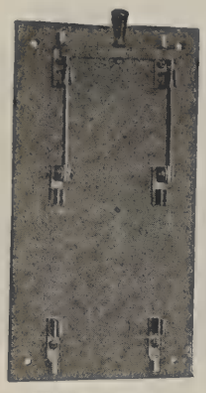
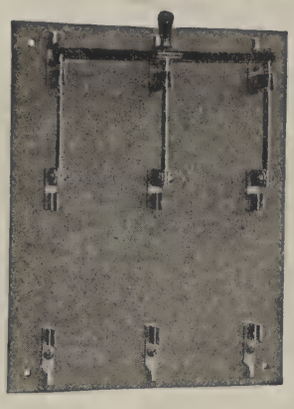
For switches without bases, deduct 10 per cent from the list price.

For special spade handles refer to the list at the end of the knife switch tables.

TYPE A FRONT-CONNECTED SWITCHES
600 Volts D. C. or A. C.

SINGLE-THROW — FUSED AT BOTTOM

Without Quick-Break Blades

Maximum Amperes*	Weight, Pounds Net	Weight, Pounds Boxed	Style No.	List Price
		Single-Pole		
30	3½	5½	228220	$ 1 84
60	4½	7	228221	3 04
100	8½	13¼	228222	3 48
200	17	26½	255144	5 63
400	28	43¾	255156	12 00
600	36	56	255168	16 36
		Double-Pole		
30	8¾	13½	228229	3 32
60	9½	14½	228230	3 70
100	19	29	228231	6 30
200	32	49	255145	10 18
400	49	75	255157	21 81
600	62	95	255169	29 58

Weight, Pounds Net	Weight, Pounds Boxed	Style No.	List Price
		Three-Pole	
15	22	228238	$ 5 34
15¾	23	228239	5 92
30	43½	228240	10 08
46	65½	255146	16 38
70	102	255158	35 08
87	126	255170	47 51
		Four-Pole	
20	32½	228247	7 34
21	34	228248	8 14
40	65	228249	13 86
62	100	255147	22 61
94	153	255159	48 32
116	189	255171	65 22

With Quick-Break Blades

Maximum Amperes*	Weight, Pounds Net	Weight, Pounds Boxed	Style No.	List Price
		Single-Pole		
30	3½	5½	228214	$ 2 18
60	4½	7	228215	2 34
100	8½	13¼	228216	3 90
200	17	26½	228217	6 16
400	28	43¾	228218	12 94
600	36	56	228219	17 34
		Double-Pole		
30	8¾	13½	228223	3 92
60	9½	14½	228224	4 26
100	19	29	228225	7 18
200	32	49	228226	11 20
400	49	75	228227	23 50
600	62	95	228228	31 50

Weight, Pounds Net	Weight, Pounds Boxed	Style No.	List Price
		Three-Pole	
15	22	228232	$ 6 30
15¾	23	228233	6 82
31	45	228234	11 36
48	69½	228235	17 92
72	105	228236	37 60
90	130	228237	50 40
		Four-Pole	
20	32½	228241	8 66
21	34	228242	9 38
41	67	228243	15 62
64	104	228244	24 64
96	156	228245	51 70
120	196	228246	69 30

*Good for either 20 degrees or 30 degrees temperature rise; D. C. or 25-cycle or 60-cycle A. C.

Style number and list price include switch with plain finish; complete with base, terminals, spade handles on all four-pole switches and straight handles on all other switches.

For additional prices for switches with satin or polished finish, refer to the discount sheets, Catalog 1-B, Part 1.

For switches without bases, deduct 10 per cent from the list price.

For special spade handles refer to the list at the end of the knife switch tables.

Switches fused at the top can be supplied on special request.

TYPE A FRONT-CONNECTED SWITCHES

600 Volts D. C. or A. C.

DOUBLE-THROW **FUSED AT BOTH ENDS**

Without Quick-Break Blades

Maximum Amperes*	Weight, Pounds Net	Weight, Pounds Boxed	Style No.	List Price	Weight, Pounds Net	Weight, Pounds Boxed	Style No.	List Price
			Single-Pole				**Three-Pole**	
30	9½	14¾	228292	$ 3 12	25	36	228310	9 40
60	10	15½	228293	3 58	26	38	228311	10 40
100	15	23	228294	6 34	50	72½	228312	18 40
200	27	42	255152	9 42	73	106	255154	27 32
400	41	64	255164	18 11	96	139	255166	52 57
600	51	79½	255176	27 78	126	183	255178	80 62
			Double-Pole				**Four-Pole**	
30	15	23	228301	5 42	34	55½	228319	12 50
60	16	24½	228302	6 00	37	60	228320	13 50
100	29	44½	228303	11 50	68	110	228321	25 30
200	48	73½	255153	16 97	98	159	255155	37 71
400	71	109	255165	32 62	131	214	255167	72 48
600	87	133	255177	49 92	168	275	255179	111 11

*Good for either 20 degrees or 30 degrees temperature rise; D. C. or 25-cycle or 60-cycle A. C.

Style number and list price include switch with plain finish; complete with base, terminals, spade handles on all four-pole switches and straight handles on all other switches.

For additional prices for switches with satin or polished finish, refer to the discount sheets, Catalog 1-B, Part 1.

For switches without bases, deduct 10 per cent from the list price.

For special spade handles refer to the list at the end of the knife switch tables.

TYPE A FRONT-CONNECTED SWITCHES

600 Volts D. C. or A. C.

DOUBLE-THROW FUSED AT BOTH ENDS

With Quick-Break Blades

Maximum Amperes*	Weight, Pounds Net	Weight, Pounds Boxed	Style No.	List Price	Weight, Pounds Net	Weight, Pounds Boxed	Style No.	List Price
		Single-Pole				**Three-Pole**		
30	9½	14¾	228286	$ 3 74	26	28	228304	$ 10 84
60	10	15½	228287	4 08	27	39	228305	11 84
100	15	23	228288	6 88	52	75½	228306	20 00
200	28	43¾	228289	10 46	76	110	228307	30 40
400	42	65½	228290	19 80	100	145	228308	57 60
600	53	82½	228291	29 70	130	189	228309	86 40
		Double-Pole				**Four-Pole**		
30	15	23	228295	6 74	35	57	228313	14 92
60	16	24½	228296	7 40	38	62	228314	16 28
100	30	46	228297	12 50	70	114	228315	27 50
200	50	76½	228298	19 00	102	189	228316	41 80
400	74	113	228299	36 00	135	255	228317	79 20
600	90	138	228300	54 00	175	286	228318	118 80

*Good for either 20 degrees or 30 degrees temperature rise; D. C. or 25-cycle or 60-cycle A. C.

Style number and list price include switch with plain finish; complete with base, terminals, spade handles on all four-pole switches and straight handles on all other switches.

For additional price for switches with satin or polished finish, refer to the discount sheets, Catalog 1-B, Part 1.

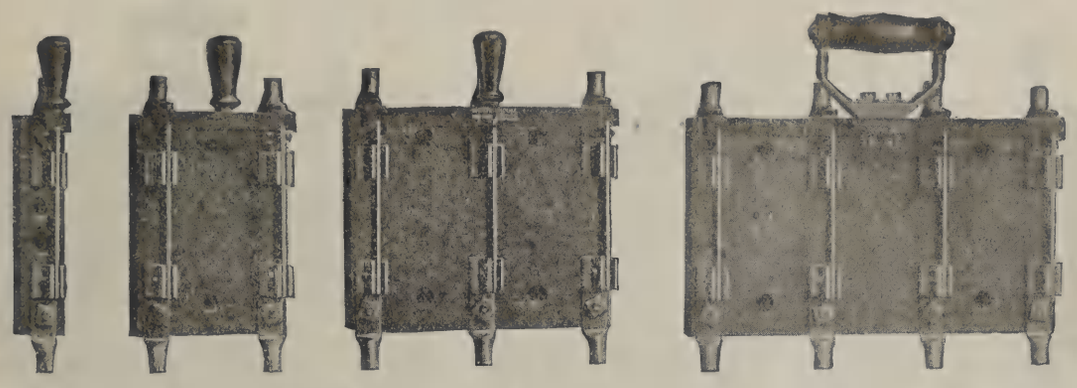
For switches without bases, deduct 10 per cent from the list price.

For special spade handles refer to the list at the end of the knife switch tables.

TYPE C FRONT-CONNECTED SWITCHES

250 Volts D. C. or 500 Volts A. C.

SINGLE-THROW **NOT FUSED**



Maximum Amperes*	Weight, Pounds Net	Weight, Pounds Boxed	Style No.	List Price	Weight, Pounds Net	Weight, Pounds Boxed	Style No.	List Price
Without Quick-Break Blades								
			Single-Pole				**Three-Pole**	
30†	¾	1¼	228322	$ 0 38	2½	3¾	228330	$ 0 90
30‡	1½	2½	254396	0 66	4	5¾	228331	1 60
60	1½	2½	228323	0 74	4¼	6¼	228332	1 84
100	2½	4	228324	1 50	8	11½	228333	3 76
200	4	6¼	228325	2 70	15½	22½	228334	6 76
			Double-Pole				**Four-Pole**	
30†	1¼	2½	228326	0 60	4	6½	228335	1 36
30‡	2¾	4¼	254397	1 06	7¼	11¾	228336	2 14
60	3	4½	228327	1 22	7½	12	228337	2 44
100	5½	8½	228328	2 50	12	19½	228338	5 00
200	10¼	15½	228329	4 50	20	32½	228339	9 00
With Quick-Break Blades								
			Single-Pole				**Three-Pole**	
30‡	1	2½	254400	1 08	4	5¾	254402	2 86
60	1½	2½	254372	1 20	4¼	6¼	254374	3 22
100	2½	4	254380	2 00	8	11½	254382	5 26
200	4	6¼	254388	3 26	15½	22½	254390	8 44
			Double-Pole				**Four-Pole**	
30‡	2¾	4¼	254401	1 90	7¼	11¾	254403	3 82
60	3	4½	254373	2 14	7½	12	254375	4 28
100	5½	8½	254381	3 50	12	19½	254383	7 00
200	10¼	15½	254389	5 62	20	23½	254391	11 24

†For 250 Volts D. C. only.
‡For 500 Volts A. C.

*Good for either 20 degrees or 30 degrees temperature rise; D.C. or 25-cycle or 60-cycle A.C.

Style number and list price include switch with plain finish; complete with base, terminals, spade handles on all four-pole switches and straight handles on all other switches.

For additional prices for switches with satin or polished finish, refer to the discount sheets, Catalog 1-B, Part 1.

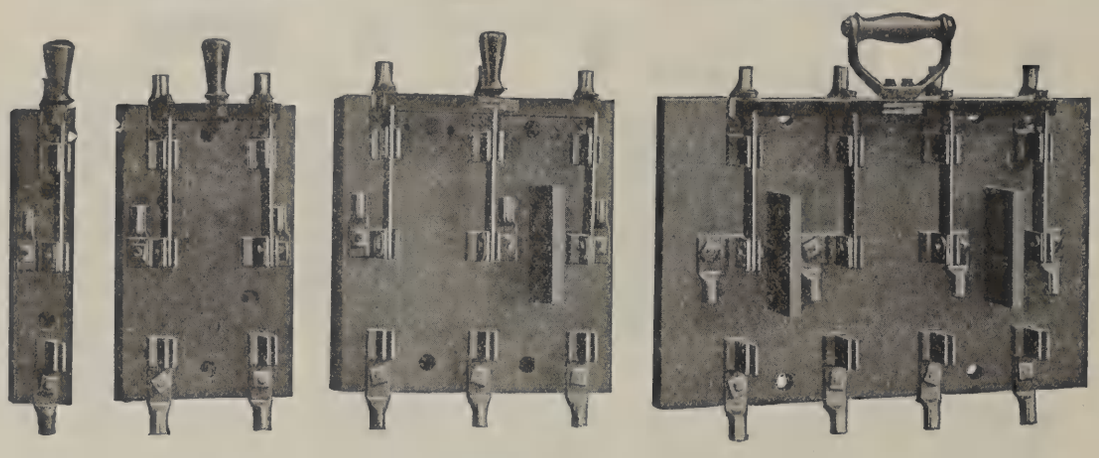
For switches without bases, deduct 10 per cent from the list price.

For special spade handles refer to the list at the end of the knife switch tables.

TYPE C FRONT-CONNECTED SWITCHES

250 Volts D. C. or 500 Volts A. C.

DOUBLE-THROW NOT FUSED



Maximum Amperes*	Weight, Pounds Net	Weight, Pounds Boxed	Style No.	List Price	Weight, Pounds Net	Weight, Pounds Boxed	Style No.	List Price
Without Quick-Break Blades								
	Single-Pole				**Three-Pole**			
30†	1¼	2¼	228340	$ 0 76	4	5¾	228348	$ 1 80
30‡	2½	4	254398	1 16	7¼	10¾	228349	2 66
60	2½	4	228341	1 30	7½	11	228350	3 10
100	4	6¼	228342	2 94	12	17½	228351	6 90
200	8	12½	228343	4 88	22	32	228352	11 60
	Double-Pole				**Four-Pole**			
30†	3	4½	228344	1 16	7	11¼	228353	2 56
30‡	5	7½	254399	1 70	12	19½	228354	3 84
60	5¼	7¾	228345	2 00	12½	20	228355	4 40
100	8½	13	228346	4 50	18	29	228356	9 80
200	16	25	228347	7 50	28	45½	228357	15 50
With Quick-Break Blades								
	Single-Pole				**Three-Pole**			
30‡	2½	4	254404	1 88	7¼	10¾	254406	4 82
60	2½	4	254376	2 06	7½	11	254378	5 38
100	4	6¼	254384	3 76	12	17½	254386	9 36
200	8	12½	254392	5 82	22	32	254394	14 42
	Double-Pole				**Four-Pole**			
30‡	5	7½	254405	3 14	12	19½	254407	6 72
60	5¼	7¾	254377	3 52	12½	20	254379	7 44
100	8½	13	254385	6 14	18	29	254387	13 08
200	16	25	254393	9 38	29	47½	254395	19 26

†For 250 Volts D. C. only.
‡For 500 Volts A. C.

*Good for either 20 degrees or 30 degrees temperature rise; D. C. or 25-cycle or 60-cycle A. C.

Style number and list price include switch with plain finish; complete with base, terminals, spade handles on all four-pole switches and straight handles on all other switches.

For additional price for switches with satin or polished finish, refer to the discount sheets, Catalog 1-B, Part 1.

For switches without bases, deduct 10 per cent from the list price.

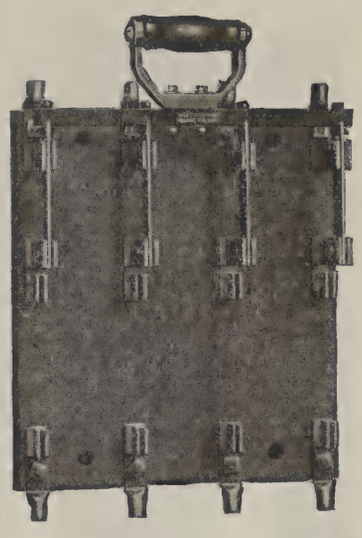
For special spade handles refer to the list at the end of the knife switch tables.

TYPE C FRONT-CONNECTED SWITCHES

250 Volts D. C. or A. C.

SINGLE-THROW

FUSED AT BOTTOM



Maximum Amperes*	Weight, Pounds Net	Weight, Pounds Boxed	Style No.	List Price	Weight, Pounds Net	Weight, Pounds Boxed	Style No.	List Price
Without Quick-Break Blades								
	Single-Pole				**Three-Pole**			
30	1	1½	228358	0 70	3½	3¼	228366	1 45
60	2½	4	228359	1 18	6	8¾	228367	2 70
100	5	7¾	228360	2 38	13½	19½	228368	5 50
200	7½	11¾	228361	4 40	24	35	228369	10 14
	Double-Pole				**Four-Pole**			
30	2¼	3½	228362	0 97	6½	9	228370	2 12
60	4	6¼	228363	1 80	10½	17	228371	4 60
100	8¾	13½	228364	3 66	20	32½	228372	7 30
200	16	25	228365	6 76	36	57	228373	13 50
With Quick-Break Blades								
	Single-Pole				**Three-Pole**			
60	2½	4	254448	1 64	6	8¾	254450	4 08
100	5	7¾	254460	2 88	13½	19½	254462	7 00
200	7½	11¾	254472	4 96	25	36	254474	11 82
	Double-Pole				**Four-Pole**			
60	4	6¼	254449	2 72	10½	17	254451	5 44
100	8¾	13½	254461	4 66	20	32½	254463	9 30
200	16	25	254473	7 88	37	60½	254475	15 74

*Good for either 20 degrees or 30 degrees temperature rise; D. C. or 25-cycle or 60-cycle A. C.

Style number and list price include switch with plain finish; complete with base, terminals, spade handles on all four-pole switches and straight handles on all other switches.

For additional price for switches with satin or polished finish, refer to the discount sheets, Catalog 1-B, Part 1.

For switches without bases, deduct 10 per cent from the list price.

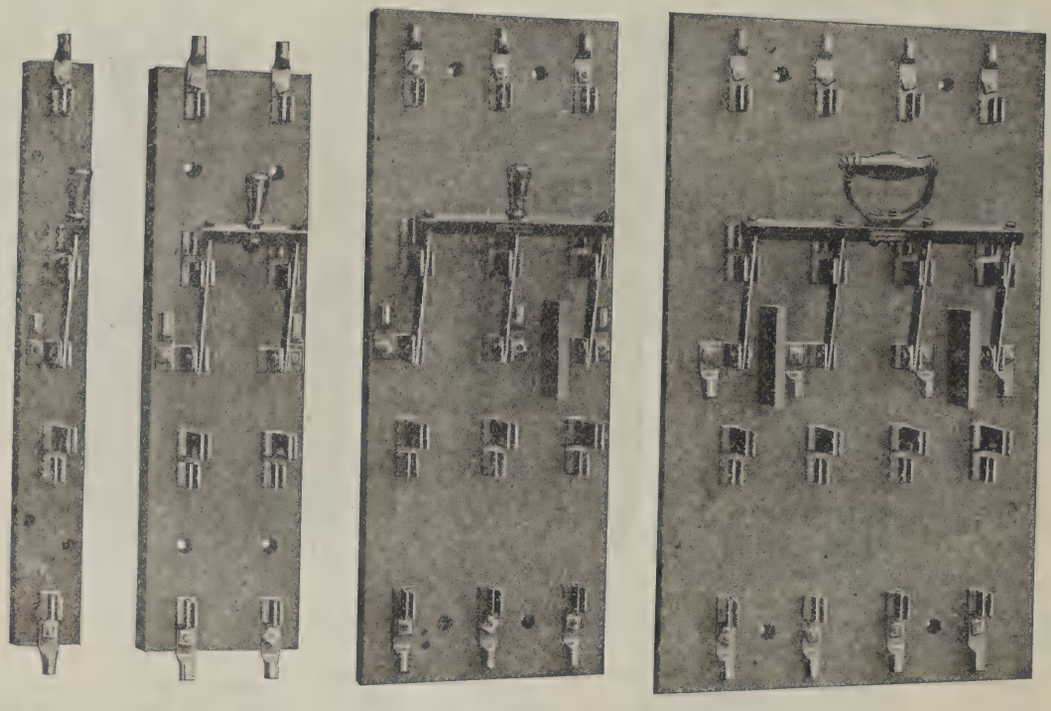
For special spade handles refer to the list at the end of the knife switch tables.

Switches fused at the top can be supplied on special request.

TYPE C FRONT-CONNECTED SWITCHES

250 Volts D. C. or A. C.

DOUBLE-THROW FUSED AT BOTH ENDS



Maximum Amperes*	Weight, Pounds Net	Weight, Pounds Boxed	Style No.	List Price	Weight, Pounds Net	Weight, Pounds Boxed	Style No.	List Price
Without Quick-Break Blades								
Single-Pole					**Three-Pole**			
30	3	4¾	228390	$ 1 54	6	8¾	228398	$ 3 52
60	5	7¾	228391	2 38	12	17½	228399	5 44
100	8	12½	228392	5 18	26	37½	228400	11 84
200	11½	18	228393	9 80	41	59½	228401	20 80
Double-Pole					**Four-Pole**			
30	5	7¾	228394	2 20	11	18	228402	4 84
60	7¾	12	228395	3 40	18½	30	228403	7 48
100	17	26½	228396	7 40	41½	67½	228404	16 28
200	24	37½	228397	13 00	59½	97	228405	26 60
With Quick-Break Blades								
Single-Pole					**Three-Pole**			
60	5	7¾	254456	3 30	12	17½	254458	7 72
100	8	12½	254468	6 00	27	39	254470	14 30
200	11½	18	254480	10 74	43	62½	254482	23 62
Double-Pole					**Four-Pole**			
60	7¾	12	254457	4 92	18½	30	254459	10 52
100	17	26½	254469	9 04	42	68½	254471	19 56
200	25	39	254481	14 88	61	99½	254483	30 36

*Good for either 20 degrees or 30 degrees temperature rise; D. C. or 25-cycle or 60-cycle A. C.

Style number and list price include switch with plain finish; complete with base, terminals, spade handles on all four-pole switches and straight handles on all other switches.

For additional price for switches with satin or polished finish, refer to the discount sheets, Catalog 1-B, Part 1.

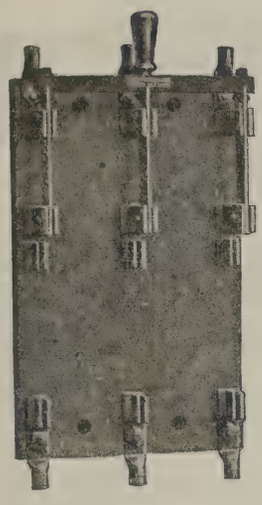
For switches without bases, deduct 10 per cent from the list price.

For special spade handles refer to the list at the end of the knife switch tables.

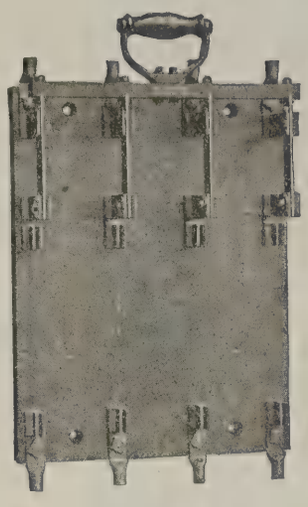
TYPE C FRONT-CONNECTED SWITCHES

500 Volts A. C.

SINGLE-THROW



FUSED AT BOTTOM



Maximum Amperes*	Weight, Pounds Net	Weight, Pounds Boxed	Style No.	List Price	Weight, Pounds Net	Weight, Pounds Boxed	Style No.	List Price
Without Quick-Break Blades								
Single-Pole					**Three-Pole**			
30	3	4¾	254484	$ 1 25	7¼	10½	228406	2 80
60	5	7¾	254490	1 55	8¼	12	228407	3 50
100	10	15½	254496	3 10	16	23	228408	7 00
200	14½	22½	254502	5 30	24½	35½	228409	12 20
Double-Pole					**Four-Pole**			
30	5	7¾	254485	1 85	11	18	228410	3 70
60	9	13¾	254491	2 35	18	29½	228411	4 80
100	13	20	254497	4 65	27	44	228412	9 30
200	23	35	254503	7 90	43	70	228413	16 20
With Quick-Break Blades								
Single-Pole					**Three-Pole**			
30	3	4¾	254508	1 67	7¼	10½	254510	4 06
60	5	7¾	254520	2 01	8¼	12	254522	4 88
100	10	15½	254532	3 60	16	23	254534	8 50
200	14½	22½	254544	5 86	26	38	254546	13 88
Double-Pole					**Four-Pole**			
30	5	7¾	254509	2 69	11	18	254511	5 38
60	9	13¾	254521	3 27	18	29½	254523	6 64
100	13	20	254533	5 65	28	45¾	254535	11 30
200	23	35	254545	9 02	45	73½	254547	18 44

*Good for either 20 degrees or 30 degrees temperature rise; D. C. or 25 cycle or 60 cycle A. C.

Style number and list price include switch with plain finish, complete with base, terminals spade handles on all four-pole switches and straight handles on all other switches.

For additional price for switches with satin or polished finish, refer to the discount sheets, Catalog 1-B, Part 1.

For switches without bases, deduct 10 per cent from the list price.

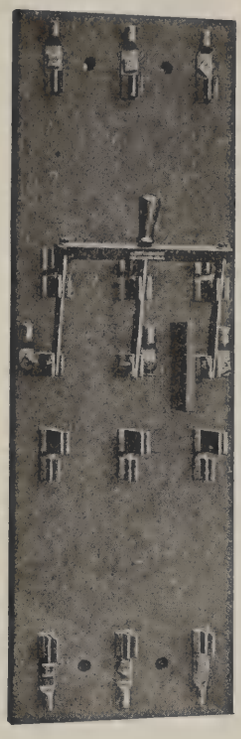
For special spade handles refer to the list at the end of the knife switch tables.

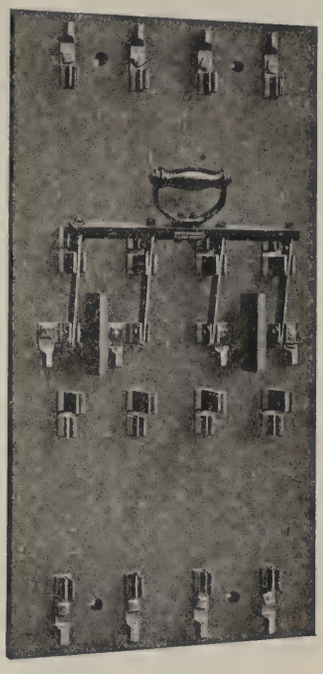
Switches fused at the top can be supplied on special request.

TYPE C FRONT-CONNECTED SWITCHES

500 Volts A. C.

DOUBLE-THROW **FUSED AT BOTH ENDS**





Maximum Amperes*	Weight, Pounds Net	Weight, Pounds Boxed	Style No.	List Price	Weight, Pounds Net	Weight, Pounds Boxed	Style No.	List Price
Without Quick-Break Blades								
		Single-Pole				**Three-Pole**		
30	6	9½	254488	$ 2 34	9	13	228422	$ 6 00
60	10	15½	254494	2 92	14	20	228423	7 40
100	20	31	254500	6 14	26	38	228424	14 00
200	28	44	254506	10 08	42	61	228425	21 50
		Double-Pole				**Four-Pole**		
30	10	15½	254489	3 28	21	34	228426	8 00
60	16	25	254495	4 26	32	52½	228427	9 80
100	26	40	254501	8 80	58	94½	228428	18 60
200	37	56½	254507	14 30	72	117	228429	28 60
With Quick-Break Blades								
		Single-Pole				**Three-Pole**		
30	6	9½	254516	3 06	9	13	254518	8 16
60	10	15½	254528	3 68	14	20	254530	9 68
100	20	31	254540	6 96	27	39	254542	16 46
200	29	46	254552	11 02	43	42½	254576	24 32
		Double-Pole				**Four-Pole**		
30	10	15½	254517	4 72	21	34	254519	10 88
60	16	25	254529	5 78	33	53¾	254531	12 84
100	27	40	254541	10 44	60	98	254543	21 88
200	38	56½	254575	16 18	75	122	254577	32 36

*Good for either 20 degrees or 30 degrees temperature rise; D. C. or 25-cycle or 60-cycle A. C.

Style number and list price include switch with plain finish; complete with base, terminals, spade handles on all four-pole switches and straight handles on all other switches.

For additional price for switches with satin or polished finish, refer to the discount sheets, Catalog 1-B, Part 1.

For switches without bases, deduct 10 per cent from the list price.

For special spade handles refer to the list at the end of the knife switch tables.

KNIFE SWITCHES—Continued

TYPE C FRONT-CONNECTED SWITCHES
600 Volts D. C. or A. C.

SINGLE-THROW NOT FUSED

Maximum Amperes*	Weight, Pounds Net	Weight, Pounds Boxed	Style No.	List Price	Weight, Pounds Net	Weight, Pounds Boxed	Style No.	List Price
Without Quick-Break Blades								
		Single-Pole				**Three-Pole**		
30	2	3¼	228430	$ 0 80	6	8¾	228438	$ 2 10
60	2¼	3½	228431	0 96	7	10	228439	2 50
100	3	4¾	228432	1 90	13	19	228440	4 90
200	5	7¾	254412	3 80	23	33½	254414	9 66
		Double-Pole				**Four-Pole**		
30	4¾	7¼	228434	1 34	9	14½	254438	2 80
60	5¼	8	228435	1 60	10	16½	254408	3 30
100	8	12¼	228436	3 16	18	29¼	254410	6 60
200	13	20	254413	6 20	29	47¼	254415	13 10
With Quick-Break Blades								
		Single-Pole				**Three-Pole**		
30	2	3¼	254440	1 08	6	8¾	254442	2 80
60	2¼	3½	254420	1 20	7	10	254422	3 10
100	3	4¾	254428	2 16	13	19	254430	5 60
200	5	7¾	228433	4 20	24	35	228441	10 86
		Double-Pole				**Four-Pole**		
30	4¾	7¼	254441	1 80	9	14½	254443	3 80
60	5¼	8	254421	2 00	10	16½	254423	4 20
100	8	12¼	254429	3 60	18	29¼	254431	7 50
200	13	20	228437	7 00	30	49	254436	14 70

DOUBLE-THROW NOT FUSED

Maximum Amperes	Weight, Pounds Net	Weight, Pounds Boxed	Style No.	List Price	Weight, Pounds Net	Weight, Pounds Boxed	Style No.	List Price
Without Quick-Break Blades								
		Single-Pole				**Three-Pole**		
30	2¼	3½	228442	$ 1 66	14	20	228450	$ 3 70
60	2¾	4¼	228443	1 90	15	22	228451	4 30
100	4	6¼	228444	3 90	22	32	228452	8 60
200	7½	11½	254416	7 70	34	49½	254418	18 15
		Double-Pole				**Four-Pole**		
30	9	13¾	228446	2 20	18	29¼	254439	5 00
60	10	15½	228447	2 60	20	32½	254409	6 00
100	13	20	228448	5 20	30	49	254411	12 00
200	20	30½	254417	11 20	45	73½	254419	25 00
With Quick-Break Blades								
		Single-Pole				**Three-Pole**		
30	2¼	3½	254444	2 38	14	20	254446	5 86
60	2¾	4¼	254424	2 66	15	22	254426	6 58
100	4	6¼	254432	4 72	23	33	254434	11 06
200	7½	11½	228445	8 64	35	51	228453	20 97
		Double-Pole				**Four-Pole**		
30	9	13¾	254445	3 64	18	29¼	254447	7 88
60	10	15½	254425	4 12	20	32½	254427	9 04
100	13	20	254433	6 84	31	50½	254435	15 28
200	20	30½	228449	13 08	47	66½	254437	28 76

*Good for either 20 degrees or 30 degrees temperature rise; D. C. or 25-cycle or 60-cycle A. C.

Style number and list price include switch with plain finish; complete with base, terminals, spade handles on all four-pole switches and straight handles on all other switches.

For additional price for switches with satin or polished finish, refer to the discount sheets, Catalog 1-B, Part 1.

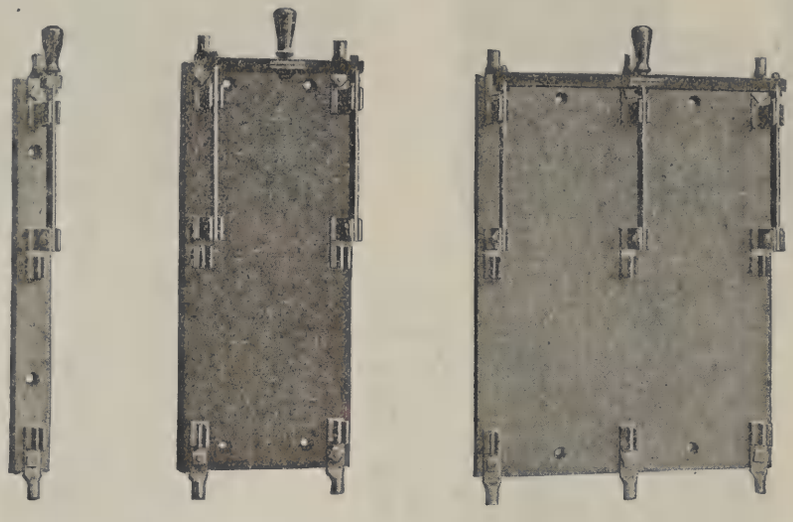
For switches without bases, deduct 10 per cent from the list price.

For special spade handles refer to the list at the end of the knife switch tables.

TYPE C FRONT-CONNECTED SWITCHES

600 Volts D. C. or A. C.

SINGLE-THROW FUSED AT BOTTOM



Maximum Amperes*	Weight, Pounds Net	Weight, Pounds Boxed	Style No.	List Price	Weight, Pounds Net	Weight, Pounds Boxed	Style No.	List Price
Without Quick-Break Blades								
	Single-Pole					**Three-Pole**		
30	2¾	4¼	228454	$ 1 40	13	19	228462	$ 3 50
60	3¼	5	228455	1 70	14	20	228463	4 16
100	7	11	228456	3 25	27	39	228464	8 00
200	15	23½	254587	5 94	42	61	254589	14 32
	Double-Pole					**Four-Pole**		
30	7	10½	228458	2 20	18	29½	254578	4 84
60	8	12¼	228459	2 60	20	32½	254581	5 70
100	17	26	228460	5 00	37	60½	254584	11 00
200	28	43	254588	8 88	59	96	254590	19 76
With Quick-Break Blades								
	Single-Pole					**Three-Pole**		
30	2¾	4¼	254599	1 70	13	19	254601	4 16
60	3¼	5	254611	1 96	14	20	254613	4 80
100	7	11	254623	3 60	28	40½	254625	8 80
200	15	23½	228457	6 50	43	62½	228465	16 00
	Double-Pole					**Four-Pole**		
30	7	10½	254600	2 60	18	29½	254602	5 70
60	8	12¼	254612	3 00	20	32½	254614	6 60
100	17	26	254624	5 50	38	62	254626	12 00
200	29	45	228461	10 00	61	99½	254635	22 00

*Good for either 20 degrees or 30 degrees temperature rise; D. C. or 25-cycle or 60-cycle A. C.

Style number and list price include switch with plain finish; complete with base, terminals, spade handles on all four-pole switches and straight handles on all other switches.

For additional price for switches with satin or polished finish, refer to the discount sheets, Catalog 1-B, Part 1.

For switches without bases, deduct 10 per cent from the list price.

For special spade handles refer to the list at the end of the knife switch tables.

Switches fused at the top can be supplied on special request.

TYPE C FRONT-CONNECTED SWITCHES

600 Volts D. C. or A. C.

DOUBLE-THROW **FUSED AT BOTH ENDS**

Maximum Amperes*	Weight, Pounds Net	Weight, Pounds Boxed	Style No.	List Price	Weight, Pounds Net	Weight, Pounds Boxed	Style No.	List Price
Without Quick-Break Blades								
Single-Pole					**Three-Pole**			
30	8	12½	228478	$ 3 30	23	33½	228486	$ 7 26
60	8½	13¼	228479	3 75	24	35	228487	8 25
100	13	20	228480	7 50	47	68	228488	16 50
200	24	37½	254595	11 60	69	100	254597	28 00
Double-Pole					**Four-Pole**			
30	13	20	228482	4 40	32	52	254580	10 00
60	14	21½	228483	5 00	34	55½	254583	11 50
100	26	40	228484	10 00	64	104	254586	23 00
200	45	69	254596	17 50	93	152	254598	36 00
With Quick-Break Blades								
Single-Pole					**Three-Pole**			
30	8	12½	254607	4 02	23	33½	254609	9 42
60	8½	13¼	254619	4 51	25	37	254621	10 53
100	13	20	254631	8 32	49	71	254633	18 96
200	24	37½	228481	12 54	71	103	228489	30 82
Double-Pole					**Four-Pole**			
30	13	20	254608	5 84	33	54	254610	12 88
60	14	21½	254620	6 52	35	57	254622	14 54
100	27	42	254632	11 64	66	108	254634	26 28
200	46	71	228485	19 38	98	160	254637	39 76

*Good for either 20 degrees or 30 degrees temperature rise; D.C. or 25-cycle or 60-cycle A. C.

Style number and list price include switch with plain finish; complete with base, terminals, spade handles on all four-pole switches and straight handles on all other switches.

For additional price for switches with satin or polished finish, refer to the discount sheets, Catalog 1-B, Part 1.

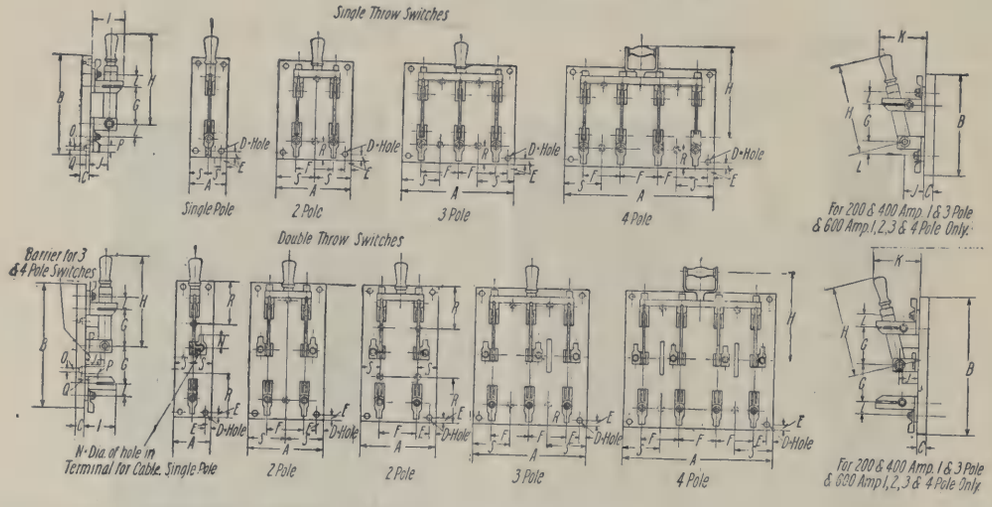
For switches without bases, deduct 10 per cent from the list price.

For special spade handles refer to the list at the end of the knife switch tables.

KNIFE SWITCHES—Continued

OUTLINE DIMENSIONS

TYPE A FRONT-CONNECTED—NOT FUSED


Single Throw Switches
Single Pole
2 Pole
3 Pole
4 Pole
D-Hole
For 200 & 400 Amp. 1 & 3 Pole & 600 Amp 1, 2, 3 & 4 Pole Only.
Double Throw Switches
Barrier for 3 & 4 Pole Switches
N-Dia. of hole in Terminal for Cable. Single Pole
2 Pole
2 Pole
3 Pole
4 Pole
For 200 & 400 Amp. 1 & 3 Pole & 600 Amp 1, 2, 3 & 4 Pole Only.

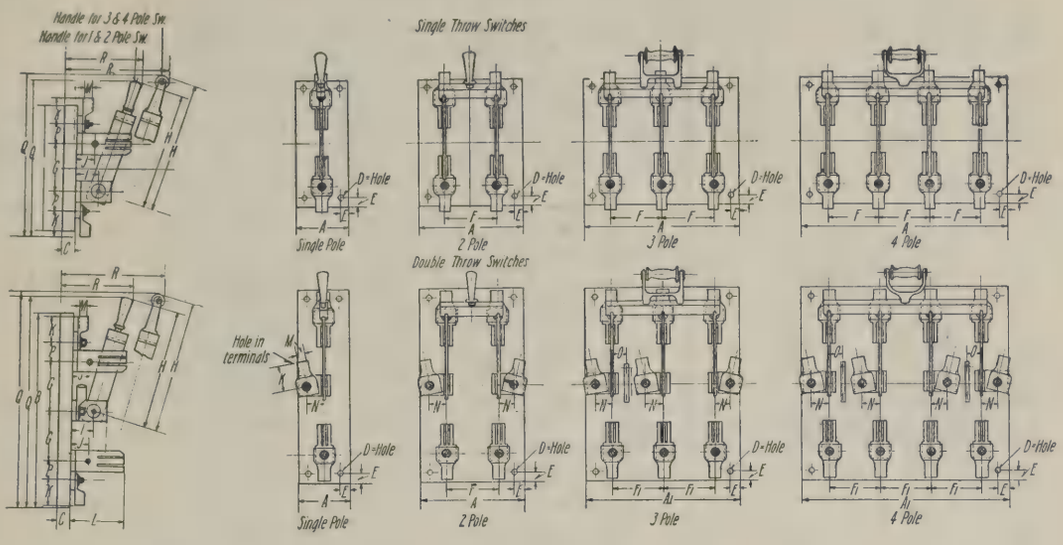
Volts	Amp.	DIMENSIONS IN INCHES															
		A				B		C	D	E	F	G	H				I
		Single Pole	2 Pole	3 Pole	4 Pole	Single Throw	Double Throw						Single Pole	2 Pole	3 Pole	4 Pole	
250VDC&AC	30	1 1/2	4	6	8 1/4	4 1/2*	6 1/2	5/8			2 1/4	2	4 9/16	4 9/16	4 9/16	4 9/16	1 13/32
250 Vol. D.C. or 500 Vol. A.C.	60	1 1/2	4 1/2	7 1/2	10 1/2	5†	8	3/4			3	2 5/8	5 11/32	5 11/32	5 11/32	5 23/32	1 11/16
	100	4	7	10	13	8	11	3/4	5/16	3/4	3 1/8	3	6 1/2	6 1/2	6 1/2	7	2 3/32
	200	4	8	12	15	10	14	1	5/16	3/4	3 3/4	3 1/4	8 5/16	7 29/32	8 5/16	8 17/32	2 23/32
	400	5	9	13	17	13	17	1	3/8	1	4 1/8	4 1/8	10 11/16	9 7/8	10 11/16	10 9/16	3 15/16
	600	6	11	15	20	14	19	1 1/2	7/16	1 1/8	4 1/2	4 7/8	11 1/2	11 1/2	11 1/2	10 9/16	
500V.AC	30	1 1/2	4 1/2	7 1/2	10 1/2	5†	8	3/4			3	2 5/8	5 11/32	5 11/32	5 11/32	5 23/32	1 11/16
600 Volts, D. C. & A. C.	30	4	8	13	18	9	13	3/4	5/16	3/4	4 3/4	4 1/8	6 27/32	6 27/32	6 27/32	7 7/32	1 11/16
	60	4	8	13	18	9	13	3/4	5/16	3/4	4 3/4	4 1/8	6 27/32	6 27/32	6 27/32	7 7/32	1 11/16
	100	4	9	15	20	10	15	3/4	5/16	3/4	5 1/2	5	8 1/2	8 1/2	8 1/2	9	2 5/32
	200	5	11	17	23	12	18	1	3/8	1	6	5 1/2	10 5/16	9 29/32	10 5/16	10 17/32	2 29/32
	400	5	11	17	23	15	21	1	3/8	1	6	6	12 5/16	11 5/8	12 5/16	12 5/16	3 13/16
	600	6	12 1/2	19	25	16	22	1 1/2	7/16	1 1/8	6 1/4	6 1/4	12 11/16	12 11/16	12 11/16	13 3/8	

Volts	Amp.	DIMENSIONS IN INCHES															
		J		K		L	M	N	N_1	O	P= C's'k	Q	R		S			
		Single Throw	Doub. Throw	1.2&3 Pole	4 Pole								Single Throw	Doub. Throw	Single Pole	2 Pole	3 Pole	4 Pole
250 V, DC&AC	30	15/16	1			9/16				7/32	7/16	1/4	11/16	11/16	3/4	2	1 7/8	1 7/8
250 Volts DC or 500 Volts A C	60	1 3/32	1 3/16			11/16	13/32	13/16	.259	7/32	7/16	3/8	1/2	‡	3/4	§	2 1/4	2 1/4
	100	1 13/32	1 1/2			11/16	13/32	1 9/32	.384									
	200	1 25/32	1 7/8	4 11/16	1 5/16	15/16	17/32	1 9/16	.558									
	400	2 3/8	2 1/2	7 5/16	7 11/16	1 7/8	1 1/8	2 11/32	.9185									
	600	2 5/16	2 3/4	8 1/16	8 9/16	2 1/2	1 1/2	3 1/8	1.28									
500V.AC.	30	1 3/32	1 3/16			11/16	13/32			7/32	7/16	3/8	1/2	‡	3/4	§	2 1/4	2 1/4
600 Volts D. C. & A. C.	30	1 3/32	1 3/16			11/16	13/32		.259									
	60	1 3/32	1 3/16			11/16	13/32	13/16	.259									
	100	1 13/32	1 1/2			15/16	17/32	1 9/32	.384									
	200	1 25/32	1 7/8	4 3/16	4 1/2	1 3/16	21/32	1 9/16	.558									
	400	2 3/8	2 1/2	6 5/8	7 1/8	1 7/8	1 1/8	2 11/32	.9185									
	600	2 5/8	2 3/4	7 3/8	7 13/16	2 1/2	1 1/2	3 1/8	1.28									

‡ 2 1/4 inches for 1 and 2 pole. 1 1/4 inches for 3 and 4 pole.
§ For S. T. Switch "S" = 2 inches. For D. T. Switch "S" = 1/2 inch.
* For S. P. Switch "B" = 6 inches.
† For S. P. Switch "B" = 6 1/2 inches.

KNIFE SWITCHES—Continued

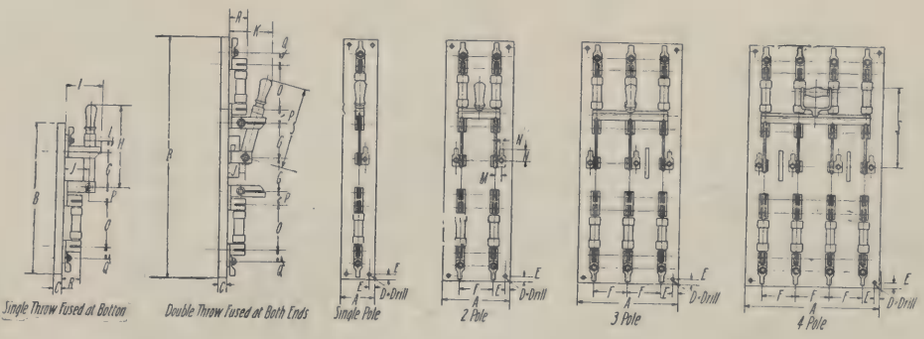
TYPE A FRONT-CONNECTED—NOT FUSED



Volts	Amp.	Dimensions in Inches																		
		A				B		C	D	E	F	G	H				I		J	K
		S. P.	2 P.	3 P.	4 P.	Single Throw	Double Throw						S. P.	2 P.	3 P.	4 P.	Single Throw	Double Throw		
250 Volts, D. C. and 500 Volts, A. C.	800	7	12	16	24	16	24	1½	9/16	1⅛	4⅞	5½	13½	13½	14⅝	14⅝	2¾	2⅞	2⅛	3⅞
	1000	7	12	17	24	16	24	2	9/16	1⅛	5	6	14⅛	14⅛	15¼	15¼	3½	3¼	2⅛	4⅛
	1200 D.C. 1100 A.C.	7	14	20	24	16	24	2	9/16	1⅛	5⅛	6	14¾	14¾	15½	15½	3½	3¼	2⅜	4⅝

Volts	Amp.	L	M	N	O	P	Q				R				A1			F1
							S. T. 1 & 2 P. Sw.	S. T. 3 & 4 P. Sw.	D. T. 1 & 2 P. Sw.	D. T. 3 & 4 P. Sw.	S. T. 1 & 2 P. Sw.	S. T. 3 & 4 P. Sw.	D. T. 1 & 2 P. Sw.	D. T. 3 & 4 P. Sw.	D. T. S. P. Sw.	D. T. 3 P. Sw.	D. T. 4 P. Sw.	D. T. 3 & 4 P. Sw.
250 Volts, D. C. and 500 Volts, A. C.	800	6¼	1.385	2	1¼	2 11/32	19 3/16	20¼	24 11/16	25 3/4	9⅛	9⅝	9 1/16	9 9/16	7	16	24	4⅞
	1000	6¾	1½	1⅞	1 5/16	2 19/32	20 13/32	21 15/32	26½	27 9/16	9 9/16	10 1/16	9⅜	9⅞	7	17	24	5
	1200D.C. 1100A.C.	7 3/16	1¾	2 7/16	1½	2 27/32	21 11/32	22 13/32	27 11/32	28 13/16	10⅛	10 21/32	10	10 15/32	10	24	27	6

TYPE A FRONT-CONNECTED—FUSED



Volts	Amp.	DIMENSIONS IN INCHES																												
		A				B		C	D	E	F	G	H		I	J			K		L	M	N	N_1	O	P	Q	R	S	
		Single Pole	2 Pole	3 Pole	4 Pole	Single Throw	Double Throw						Single Pole	4 Pole		Hinge Jaw Fused	Break Jaw Fused	Both Jaws Fused	1, 2, 3 Pole	4 Pole									Single 2, 3 Pole	4 Pole
250 Volts D C and A C	30	4	6	8	10	9	13	¾	5/16	¾	2¼	2	4 9/16	4 9/16	2 17/32	1 17/32	13/16	1	2 5/8	2 5/8	9/16	7/16	...	.....	1½	11/16	5/8	23/32	4 23/32	4 23/32
	60	4	6	9	12	11	17	¾	5/16	¾	3	2 5/8	5 11/32	5 23/32	2 9/16	1 13/16	1 3/32	1 3/16	3	3 1/8	11/16	17/32	1/2	.259	2 3/8	7/8	11/16	1 3/16	5 9/16	5 15/16
	100	*4	8	11	14	15	25	¾	3/8	1	3 1/8	3	6½	7	3 1/8	2 7/16	1 13/32	1½	3 11/16	3 7/8	15/16	25/32	1 3/32	.384	4 7/8	1 1/4	15/16	1 3/32	6 27/32	7 11/32
	200	†5	9	13	16	18	29	1	3/8	1	3 3/4	3½	7 29/32	8 17/32	4 3/32	3 1/8	1 25/32	1 7/8	4 1/16	4 1/16	1 1/16	25/32	1 5/16	.558	5 3/4	1 11/16	1 5/16	2 3/32	8 5/16	8 15/16
	400	‡5	9	13	17	22	35	1	7/16	1 1/8	4 1/8	4¼	9 7/8	10 9/16	5 13/16	4¼	2 3/8	2½	7 5/16	7 13/16	1 7/8	1 1/8	2 11/32	.9185	6 3/4	2 5/16	1 7/8	2 7/8	10 11/16	11 3/4
	600	§6½	11	15	22	26	42	1½	9/16	1¼	4½	4 7/8	10 11/16	11 3/8	6¼	4 7/8	2 5/8	2¾	8 1/16	8 5/16	2½	1½	3½	1.28	8 1/8	2 11/16	2½	3 5/16	11½	12 3/16
500 Volts A C	30	4	6	9	12	13	22	¾	5/16	¾	3	2 5/8	5 11/32	5 23/32	2 9/16	1 13/16	1 3/32	1 3/16	3	3 1/8	11/16	17/32	...	.....	4½	11/16	5/8	23/32	4 23/32	4 23/32
	60	4	6	9	12	13	22	¾	5/16	¾	3	2 5/8	5 11/32	5 23/32	2 9/16	1 13/16	1 3/32	1 3/16	3	3 1/8	11/16	17/32	13/16	.259	4 7/8	7/8	11/16	1 3/16	5 9/16	5 15/16
	100	*4	8	11	14	17	29	¾	3/8	1	3 1/8	3	6½	7	3 1/8	2 7/16	1 13/32	1½	3 11/16	3 7/8	15/16	25/32	1 3/32	.384	6 7/8	1 1/4	15/16	1 3/32	6 27/32	7 11/32
	200	†5	9	13	16	20	34	1	3/8	1	3 3/4	3½	7 29/32	8 17/32	4 3/32	3 1/8	1 25/32	1 7/8	4 1/16	4 1/16	1 1/16	25/32	1 5/16	.558	8 1/4	1 11/16	1 5/16	2 3/32	8 5/16	8 15/16
	400	‡5	9	13	17	25	41	1	7/16	1 1/8	4 1/8	4¼	9 7/8	10 9/16	5 13/16	4¼	2 3/8	2½	7 5/16	7 13/16	1 7/8	1 1/8	2 11/32	.9185	9 3/4	2 5/16	1 7/8	2 7/8	10 11/16	11 5/8
	600	§6½	11	15	21	29	48	1½	9/16	1¼	4½	4 7/8	10 11/16	11 3/8	6¼	4 7/8	2 5/8	2¾	8 1/16	8 5/16	2½	1½	3½	1.28	11 1/8	2 11/16	2½	3 5/16	11½	12 3/16
600 Volts D C and A C	30	*4	8	13	18	15	25	¾	5/16	¾	4¾	4 1/8	6 27/32	7 7/32	2 17/32	1 13/16	1 3/32	1 3/16	2 13/16	2 7/8	11/16	17/32	...	.....	4½	13/16	11/16	1 3/16	7 1/16	7 7/16
	60	*4	8	13	18	15	25	¾	5/16	¾	4¾	4 1/8	6 27/32	7 7/32	2 7/16	1 13/16	1 3/32	1 3/16	2 13/16	2 7/8	11/16	17/32	13/16	.259	4 7/8	7/8	11/16	1 3/32	7 1/16	7 7/16
	100	*4	10	15	21	19	33	¾	3/8	1	5½	5	8½	9	3 1/8	2 7/16	1 13/32	1½	3 5/8	3½	15/16	25/32	1 3/32	.384	6 7/8	1 1/4	15/16	1 3/32	8 23/32	9 7/32
	200	†5	11	17	23	22	38	1	3/8	1	6	5½	9 23/32	10 1/32	4 3/32	3 1/8	1 25/32	1 7/8	4	4 3/16	1 1/16	25/32	1 9/16	.558	8 1/4	1 11/16	1 5/16	2 3/32	10 5/16	10 15/16
	400	‡5	11	17	23	27	37	1	7/16	1 1/8	6	6	11 5/8	12 5/16	5 1/16	4¼	2 3/8	2½	6 5/8	7 1/8	1 7/8	1 1/8	2 11/32	.9185	9 3/4	2 5/16	1 7/8	2 7/8	12 3/16	12 7/8
	600	§6½	12½	19	25	31	51	1½	9/16	1¼	6¼	6¼	12	12 11/16	6¼	4 7/8	2 5/8	2¾	7 7/16	7 7/8	2 1/2	1½	3½	1.28	11 1/8	2 11/16	2½	3 5/16	12 11/16	12 3/8

*For SP-DT Switch "A"=6″.

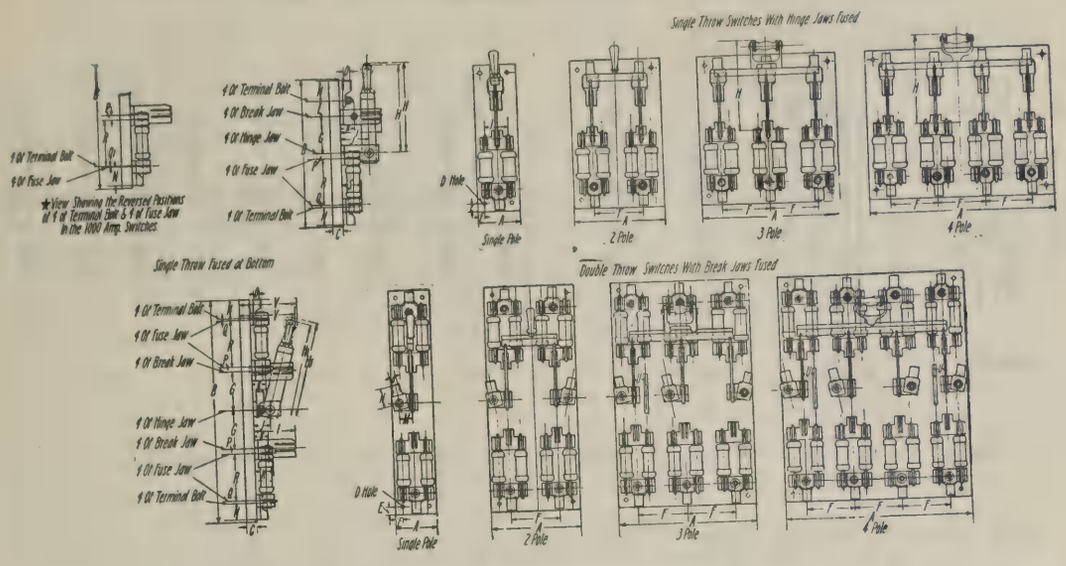
†For SP-DT Switch "A"=7″.

‡For SP-DT Switch "A"=8″.

§For SP-DT Switch "A"=10″.

KNIFE SWITCHES—Continued

TYPE A FRONT-CONNECTED—FUSED

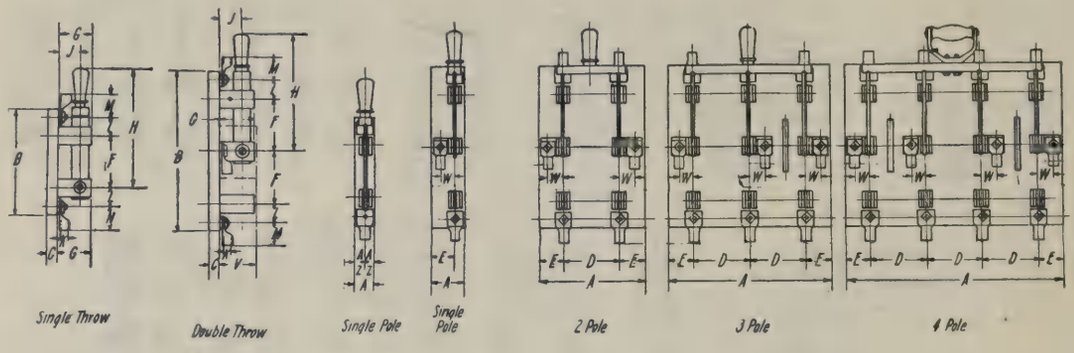

Single Throw Switches With Hinge Jaws Fused
1 Of Terminal Bolt
1 Of Fuse Jaw
★View Showing the Reversed Positions of 1 of Terminal Bolt & 1 of Fuse Jaw in the 1000 Amp. Switches.
1 Of Terminal Bolt
1 Of Break Jaw
1 Of Hinge Jaw
1 Of Fuse Jaw
1 Of Terminal Bolt
D Hole
Single Pole
2 Pole
3 Pole
4 Pole
Single Throw Fused at Bottom
1 Of Terminal Bolt
1 Of Fuse Jaw
1 Of Break Jaw
1 Of Hinge Jaw
1 Of Break Jaw
1 Of Fuse Jaw
1 Of Terminal Bolt
D Hole
Single Pole
Double Throw Switches With Break Jaws Fused
2 Pole
3 Pole
4 Pole

Volts	Amps.	Dimensions in Inches																
		A				B		C		D	E	F	G	H		H¹		I
		S. P.	2 P.	3 P.	4 P.	Single Throw	Double Throw	S. T.	D. T.					S. P. & 2 P.	3 P. & 4 P.	S. P. & 2 P.	3 P. & 4 P.	
250 D.C. & A.C.	800	8	16	24	32	24	36	1½	2	9/16	1⅛	7¼	5½	12 13/16	13 15/16	13½	14⅝	6¼
	1000	9	20	28	36	28	40	2	2	9/16	1⅜	7⅞	6	13¾	14⅞	14⅜	15¼	6¾
	1200 D.C. 1100 A.C.	9	20	28	36	28	40	2	2	9/16	1⅜	7⅞	6	13¾	14⅞	14⅜	15½	7 3/16
500 A.C.	800	9	20	28	36	28	44	1½	2	9/16	1⅛	8¼	5½	12 13/16	13 15/16	13½	14⅝	6¼
	1000	10	20	32	40	32	48	2	2	9/16	1⅜	9⅛	6	13¾	14⅞	14⅜	15¼	6¾
	1100	10	20	32	40	32	48	2	2	9/16	1⅜	9⅛	6	13¾	14⅞	14⅜	15½	7 3/16

Volts	Amps.	J			K	L	M	N	O	P	Q	R	S	T	U	V				Q
		Hinge Jaw Fused	Break Jaw Fused	D. T. Both Jaws Fused												S. T. 1 & 2P.	S. T. 3 & 4P.	D. T. 1 & 2P.	D. T. 3 Lap	1, 2, 3 & 4 P. S.T.& D. T.
250 D.C. & A.C.	800	4 1/16	2¾	2⅞	2⅛	2 11/32	2	3⅞	1.385	⅞	1/8	6¾	3⅛	3¼	2¼	9⅛	9 5/8	9 9/16	10 1/16	1/16
	1000	4 5/8	3⅛	3¼	2⅛	2 19/32	1⅞	4⅛	1½	15/16	*	8⅛	3 5/16	3¾	2⅞	9 1/16	10 1/16	9⅜	9⅞	
	1200 D.C. 1100 A.C.	4⅞	3⅛	3¼	2⅜	2 27/32	2 7/16	4⅝	1¾	15/16	3/16	8⅛	3 5/16	3¾	2⅜	10⅛	10 3/32	10	10 5/32	
500 A.C.	800	4 1/16	2¾	2⅞	2⅛	2 11/32	2	3⅞	1.385	⅞	1/8	9¾	3⅛	3¼	3	9⅛	9 5/8	9 9/16	10 1/16	1/16
	1000	4 5/8	3⅛	3¼	2⅛	2 19/32	1⅞	4⅛	1½	15/16	*	11⅛	3 5/16	3¾	3⅝	9 1/16	10 1/16	9⅜	9⅞	
	1100	4⅞	3⅛	3¼	2⅜	2 27/32	2 7/16	4⅝	1¾	15/16	3/16	11⅛	3 5/16	3¾	3⅝	10⅛	10 3/32	10	10 5/32	

KNIFE SWITCHES—Continued

TYPE C FRONT-CONNECTED—NOT FUSED



Volts	Amp.	DIMENSIONS IN INCHES																	
		A								B			C						D
		1 Pole		2 Pole		3 Pole		4 Pole		S.P. S.T.	2, 3 and 4 P. S.T.	D.T.	S. P. S.T. and D.T.	2 P. S.T. and D.T.	3 Pole		4 Pole		
		S.T.	D.T.	S.T.	D.T.	S.T.	D.T.	S.T.	D.T.						S.T.	D.T.	S.T.	D.T.	
250 V. D. C. & A. C.	30	1¼	1½	3	4	5¼	7	7½	9	3⅞	3⅞	6	½	½	½	⅝	½	⅝	2¼
250 V. D. C. or 500 V. A. C.	60	1	2	4	6	7	9	10	12	4⅞	4⅞	8	⅝	⅝	⅝	⅝	⅝	¾	3
	100	1¼	2	4⅛	6	7¼	9	10⅜	14	6	6	9	¾	¾	¾	¾	¾	¾	3⅛
	200	1¼	3	5	8	8¾	12	12½	16	8¼	7¼	12	¾	¾	¾	¾	¾	¾	3¾
500 V. A. C.	30	1	2	4	6	7	9	10	12	4⅞	4⅞	8	⅝	⅝	⅝	⅝	⅝	¾	3
600 V. A. C. or D. C.	60	1	2	5¾	8	10½	12	15¼	20	6⅜	6⅜	10½	⅝	⅝	⅝	¾	⅝	¾	4¾
	100	1¼	2	6½	9	12	14	17½	20	8	8	14	¾	¾	¾	¾	¾	1	5½
	200	1¼	3	7¼	10½	13¼	16	19¼	24	10¼	9¼	16	¾	¾	¾	¾	¾	1	6
	30	1	2	5¾	8	10½	12	15¼	20	6⅜	6⅜	10½	⅝	⅝	⅝	¾	⅝	¾	4¾

Volts	Amp.	E					F	G		H		J	K*	L	M	V	W
		S. T.	1. Pole D.T.	2 Pole D.T.	3 Pole D.T.	4 Pole D.T.		S. T.	D.T.	1. 2-3 Pole	4 Pole					3-4 Pole	
250 V. D. C. & A. C.	30	x⅜	1	⅞	1¼	1⅛	2	31/32	1 1/32	4 5/16	5 5/16	⅝	....	5/16	...	1⅛	5/16
250 V. D. C. or 500 V. A. C.	60	½	1 5/16	1½	1½	1½	2 5/8	1 7/16	1½	5 11/32	6 11/32	1	.259	11/16	27/32	1 3/8	11/16
	100	½	1 7/16	1 7/16	1 3/8	2 5/16	3	1 33/32	1 33/32	6½	7⅛	1⅛	.384	13/16	1 1/32	2⅛	⅞
	200	⅝	2	2 1/8	2¼	2⅜	3½	2 17/64	2 21/64	7 29/32	8 1/32	1½	.558	1¼	1 5/16	2⅛	1
500 V. A. C.	30	½	1 5/16	1½	1½	1½	2 5/8	1 7/16	1½	5 11/32	6 11/32	1x	....	11/16	...	1 3/8	11/16
600 V. D. C. or A. C.	60	½	1 5/16	1 5/8	1¼	2 7/8	4⅛	1 7/16	1½	6 27/32	7 27/32	1	.259	11/16	27/32	1 3/8	11/16
	100	½	1 7/16	1 3/4	1½	1¾	5	1 33/32	1 33/32	8½	9⅛	1⅛	.384	13/16	1 1/32	2⅛	⅞
	200	⅝	2	2¼	2	3	5½	2 17/64	2 21/64	9 29/32	10 1/32	1½	.558	1¼	1 5/16	2⅛	1
	30	½	1 5/16	1 5/8	1¼	2 7/8	4⅛	1 7/16	1½	6 27/32	7 27/32	1	....	11/16	...	1 3/8	11/16

*Diameter of hole in terminal for Cable.
xExcept for single pole which is ⅝-inch.

KNIFE SWITCHES—Continued

TYPE C FRONT-CONNECTED—NOT FUSED—MOUNTING-BOLT HOLES

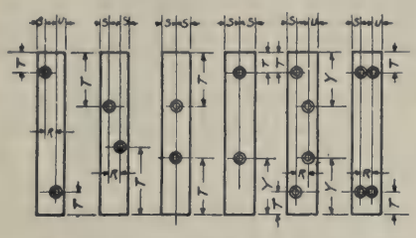


Fig 1 Fig 2 Fig 3 Fig 4 Fig 5 Fig 6

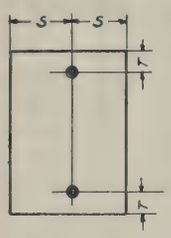


Fig 7

Fig 8

Fig 9

MOUNTING BOLT HOLES.

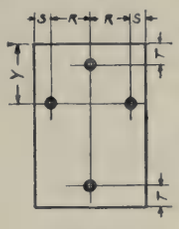


Fig 10.

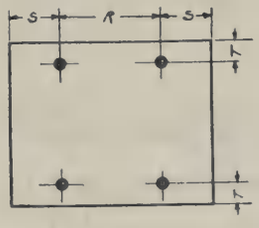


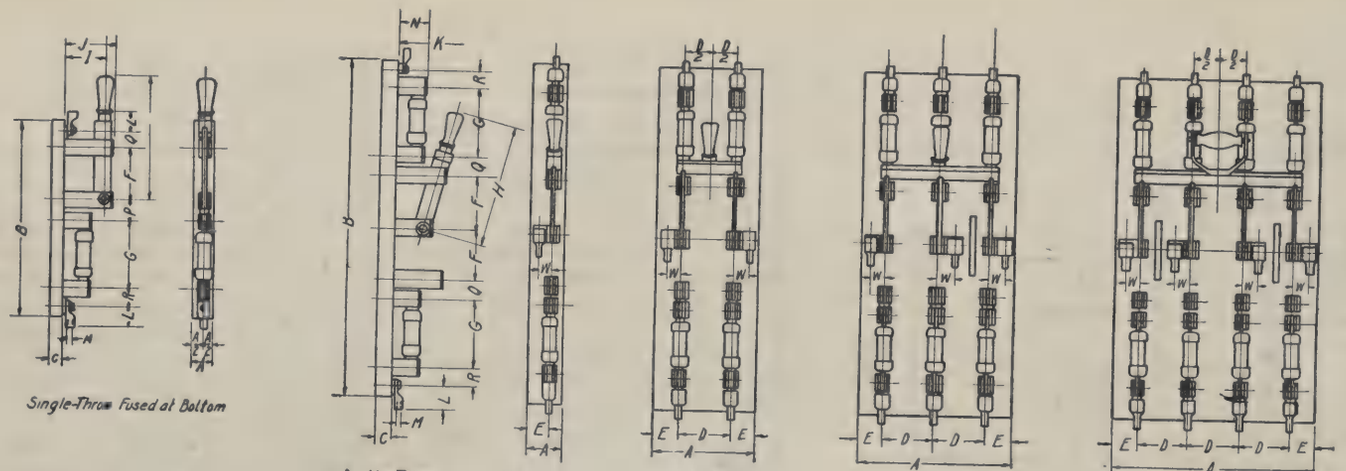
Fig 12

Volts	Amps.	DIMENSIONS IN INCHES															
		FIGURE					N=Drill P=Cbr.		Q = DEPTH OF CBR.			R					
		S. P. S. T.	S. P. D. T.	2 P. S. T.	2 P. D. T.	3&4P. S.T. & D. T.	S.T. & D. T.	S.T. & D. T.	S. T.	S.P. & 2 P. D. T.	3 P. D. T.	4 P. D. T.	S. P. S. T.	S. P. D. T.	2 P. S. T.	2 P. D. T.	3 P. S.T. & D. T.	4 P. S.T. & D. T.
250 V. D.C. & A.C.	30	2	1	7	7	12	9/32	15/32	11/32	11/32	7/16	7/16	9/16	9/16	...	...	2 1/4	4 1/2
250 V. D.C.	60	3	1	7	9	12	9/32	15/32	3/8	3/8	3/8	1/2	..	11/16	...	4 3/8	3	6
or	100	3	1	7	10	12	5/16	11/16	7/16	7/16	7/16	7/16	..	7/8	...	4 7/8	3 1/8	6 1/4
500 V. A.C.	200	4	5	9	10	12	5/16	9/16	7/16	7/16	7/16	7/16	..	1	3 3/4	2 7/8	3 3/4	7 1/2
500 V. A. C.	30	3	1	7	9	12	9/32	15/32	3/8	3/8	3/8	1/2	..	11/16	...	4 3/8	3	6
600 V.	60	3	1	8	8	12	9/32	15/32	3/8	3/8	1/2	1/2	..	11/16	2 1/2	2 1/2	4 3/4	9 1/2
D. C. or	100	3	6	8	8	12	5/16	11/16	7/16	7/16	7/16	11/16	..	7/8	3 1/4	3	5 1/2	11
A. C.	200	4	5	8	8	12	5/16	9/16	7/16	7/16	7/16	7/16	..	1	3 1/4	3 1/4	6	12
	30	3	1	8	8	12	9/32	15/32	3/8	3/8	1/2	1/2	..	11/16	2 1/2	2 1/2	4 3/4	9 1/2

Volts	Amps.	DIMENSIONS IN INCHES														
		S							T				U	Y			
		S. P. S. T.	S. P. D. T.	2 P. S. T.	2 P. D. T.	3&4P S. T.	3 P. D.T.	4 P. D. T.	S. P. S. T.	S. P. D. T.	2, 3 & 4 P. S. T.	2, 3 & 4 P. D. T.	S. P.	S. P. S. T.	S. P. D. T.	2 P. S. T.	2 P. D. T.
250 V. D.C. & A.C.	30	11/32	7/16	1 1/2	2	1 1/2	2 3/8	2 1/4	1 11/16	1 3/4	1/2	7/16	1/2	...	...	...	...
250 V. D. C.	60	1/2	5/8	2	13/16	2	3	3	2	2 1/2	3/4	11/16	11/16	...	...	...	2 1/2
or	100	9/16	9/16	2 1/16	9/16	2 1/16	2 13/16	3 7/8	2 1/2	2 3/4	7/8	9/16	9/16	...	...	...	3 1/4
500 V. A. C.	200	5/8	1	5/8	1 1/8	2 1/2	4 1/8	4 1/4	1/2	2 1/2	7/8	1 1/4	1	3 1/8	3 1/16	3 1/8	4 1/4
500 V. A. C.	30	1/2	5/8	2	13/16	2	3	3	2	2 1/2	3/4	11/16	11/16	...	...	...	2 1/2
600 V.	60	1/2	5/8	1 5/8	2 3/4	2 7/8	3 5/8	5 1/4	2	2	3/4	7/16	11/16	...	...	...	...
D. C. or	100	5/8	9/16	1 5/8	3	3 1/4	4 1/4	4 1/2	2 5/8	3 1/4	7/8	1 1/16	9/16	...	...	...	...
A. C.	200	5/8	1	2	3 5/8	3 5/8	5	6	1/2	2 1/2	1 1/4	1 1/4	1	3 1/8	3 1/16	...	...
	30	1/2	5/8	1 5/8	2 3/4	2 7/8	3 5/8	5 1/4	2	2	3/4	7/16	11/16	...	...	...	...

KNIFE SWITCHES—Continued

TYPE C FRONT-CONNECTED—FUSED



DIMENSIONS IN INCHES CORRESPONDING TO LETTERS IN OUTLINE VIEWS

Volts	Amp.	Throw	A S. P.	A 2 P.	A 3 P.	A 4 P.	B	C S. P. and 2 P.	C 3 P. and 4 P.	D	E S. P.	E 2 P.	E 3 P.	E 4 P.	F	G	H 1, 2 and 3 P.	H 4 P.	I	J	K 1, 2 and 3 P.	K 4 P.	L	M*	P	Q	R	W
250 Volts, D. C. or A. C.	30	S. T.	1¼	3⅛	5⅜	7⅝	6	½	½	2¼	…	1 7/16	1 7/16	1 7/16	2	1½	4 9/16	5 9/16	1⅜	1 23/32	…	…	…	…	11/16	9/16	9/16	…
		D. T.	1½	5	7	9	10½	5/8	5/8	2¼	…	1⅝	1¼	1⅛	2	1½	4 23/32	5 23/32	5/8	1 23/32	2 13/32	2 31/32	…	…	…	…	…	5/16
	60	S. T.	1¼	4	7	10	8⅜	5/8	5/8	3	…	1½	1½	1½	2⅝	2⅜	5 11/32	6 11/32	2	2 3/16	…	…	.259	.259	27/32	13/16	13/16	…
		D. T.	2	6	9	12	16	¾	¾	3	…	1 5/16	1½	1½	2⅝	2⅜	5 9/16	6 9/16	1	2 7/16	…	…	.259	.259	32	…	13/16	5/16
	100	S. T.	1¼	4¼	7⅜	10½	12	¾	¾	3⅛	…	1 7/16	1⅜	2 7/16	3	4⅞	6½	7⅛	2⅛	2 21/32	…	…	.384	1⅛	…	1 15/16	1 15/16	…
		D. T.	3	6	9	14	24	1	1	3⅛	…	1 7/16	1⅜	2 7/16	3	4⅞	6 37/32	7 15/32	1⅛	2 29/32	…	…	.384	…	1⅛	1 15/16	1 15/16	7/8
	200	S. T.	1½	5	8¾	12½	14½	¾	¾	3¾	…	2 5/8	2 5/8	2 5/8	3½	5¾	7 33/64	8 33/64	2½	3 11/64	…	…	.558	1 7/16	1¼	1 11/16	1¼	…
		D. T.	4	8	12	16	28	1	1	3¾	2	2⅛	2¼	2⅜	3½	5¾	8 17/64	8 17/16	1½	3 17/64	…	4 1/16	.558	4	1 7/16	…	1¼	1
500 Volts, A. C.	30	S. T.	1¼	4	7	10	10 1/16	⅝	⅝	3	…	1½	1½	1½	2⅝	4½	5 11/32	6 11/32	2	2 7/16	…	…	…	…	11/16	13/16	13/16	…
		D. T.	2	6	9	12	20	1	1	3	…	1 5/16	1½	1½	2⅝	4½	5 9/16	6 9/16	1	2 7/16	…	…	…	…	…	…	…	11/16
	60	S. T.	1¼	4	7	10	10 7/8	⅝	⅝	3	…	1½	1½	1½	2⅝	4⅞	5 11/32	6 11/32	2	2 7/16	…	…	.259	.259	27/32	13/16	13/16	…
		D. T.	2	6	9	12	20	1	1	3	…	1 5/16	1½	1½	2⅝	4⅞	5 9/16	6 9/16	1	2 7/16	…	…	…	…	…	…	…	11/16
	100	S. T.	1½	4⅜	7½	10⅝	14	¾	¾	3⅛	…	1⅝	1⅝	2⅛	3	6⅞	6½	7⅝	2⅛	2 21/32	…	…	.384	1⅛	…	1 15/16	1 15/16	…
		D. T.	3	6	9	14	28	1	1	3⅛	…	1⅝	1⅜	2⅛	3	6⅞	6 37/32	7 15/32	1⅛	2 29/32	…	…	.384	…	1⅛	1 15/16	1 15/16	7/8
	200	S. T.	2	5	8¾	12½	17	¾	¾	3¾	…	2 5/8	2 5/8	2 5/8	3½	8¼	7 33/64	8 33/64	2½	3 11/64	…	…	.558	1 7/16	1¼	1 11/16	1¼	…
		D. T.	4	8	12	16	32	1¼	1¼	3¾	2	2⅛	2¼	2⅜	3½	8¼	8 17/64	8 17/16	1½	3 17/64	…	4	.558	4	1 7/16	…	1¼	1
600 Volts, D. C. or A. C.	30	S. T.	1¼	5¾	10½	15¼	11⅞	⅝	¾	4¾	…	1½	1½	2 7/8	4⅛	4½	6 27/32	7 27/32	2	2 7/16	…	…	…	…	11/16	13/16	13/16	…
		D. T.	3	8	12	20	24	1	1	4¾	1 13/16	1⅝	1¼	2 7/8	4⅛	4½	7 1/16	8 1/16	1	2 7/16	2 15/16	3¼	…	…	…	…	…	11/16
	60	S. T.	1¼	5¾	10½	15¼	12⅜	⅝	¾	4¾	…	1½	1½	2 7/8	4⅛	4⅞	6 27/32	7 27/32	2	2 7/16	…	…	.259	.259	27/32	13/16	13/16	…
		D. T.	3	8	12	20	24	1	1	4¾	1 13/16	1⅝	1¼	2 7/8	4⅛	4⅞	7 1/16	8 1/16	1	2 7/16	2 15/16	3¼	…	…	…	…	…	11/16
	100	S. T.	1½	6¾	12¼	17¾	16	¾	¾	5½	…	1⅝	1½	2⅞	5	6⅞	8½	9 1/16	2⅛	2 29/32	…	…	.384	1⅛	…	1 15/16	1 15/16	…
		D. T.	3	9	14	20	32	1¼	1¼	5½	1 13/16	1¾	1½	2⅞	5	6⅞	8 33/32	9 33/32	1⅛	2 29/32	3 15/16	3¼	.384	…	1⅛	1 15/16	1 15/16	7/8
	200	S. T.	2	7¼	13¼	19¼	19	¾	1	6	…	2	2	3	5½	8¼	9 23/32	10 3/32	2½	3 17/64	…	…	.558	1 7/16	1¼	1 11/16	1¼	…
		D. T.	4	10½	16	24	36	1¼	1¼	6	2	2¼	2⅝	3⅝	5½	8¼	10 5/16	10 5/16	2½	3 17/64	3 15/16	3⅝	.558	…	1⅛	1 15/16	1¼	1

*Diameter of hole in terminal for cable.

KNIFE SWITCHES—Continued

TYPE C FRONT-CONNECTED—FUSED—MOUNTING-BOLT HOLES

Fig1 Fig2. Fig3. Fig4. Fig5. Fig5A. Fig6. Fig 7 Fig.8 Fig.9 Fig.9A Fig. 10
Single Pole. 2 Pole T 3 & 4 Pole

Volts	Amp.	Throw	Figures S. P.	Figures 2 P.	Figures 3 P. and 4 P.	DIMENSIONS IN INCHES CORRESPONDING TO LETTERS IN OUTLINE VIEWS: S S. P.	S 2 P.	S 3 P.	S 4 P.	T S. P.	T 2 P.	T 3 P.	T 4 P.	U S. P.	U 2 P.	U 3 P. and 4 P.	V S. P.	V 2 P.	T1 S. P.	U1 S. P.	V1 S. P.	SIZE* S. P. AND 2 P. X	S. P. AND 2 P. Y	S. P. AND 2 P. Z	3 P. AND 4 P. X	3 P. AND 4 P. Y	3 P. AND 4 P. Z
250 Volts, D. C. and A. C.	30	S. T.	3	7	10			2¼	4½	5/8	1 9/16	1 9/16	1 9/16	1 5/16	1 5/16	1½			½			9/32	15/32	11/32	9/32	15/32	11/32
		D. T.	2	9	10			2¼	4½	5/8	1 9/16	2 3/8	2 3/8	1 5/16	1 5/16	1 5/16			½			9/32	15/32	11/32	9/32	15/32	11/32
	60	S. T.	3	8	10			3	6	5/8	1½	2	2	2	2	2			1			5/16	9/16	7/16	5/16	9/16	7/16
		D. T.	1	9	10			3	6	5/8	1½	3	3	3 1/8	3 1/8	3 1/8			1 1/16			5/16	9/16	7/16	5/16	9/16	7/16
	100	S. T.	3	9	10			3⅛	6¼	5/8	1 9/16	2⅛	2⅛	2⅛	2⅛	2⅛			⅝			11/32	15/32	11/32	11/32	15/32	11/32
		D. T.	5	9	10			3⅛	6¼	5/8	1 9/16	2⅛	2⅛	2⅛	2⅛	2⅛			⅝			11/32	15/32	11/32	11/32	15/32	11/32
	200	S. T.	4	9-A	10			3¾	7½	5/8	2⅛	2½	2½	2⅞	2⅞	2⅞			1			13/32	15/32	13/32	13/32	15/32	13/32
		D. T.	5	9	10			3¾	7½	1	2⅛	4⅛	4¼	5 11/32	6¼	2 1/16			1 1/16			13/32	15/32	13/32	13/32	15/32	13/32
500 Volts A. C.	30	S. T.	3	9	10			3	6	5/8	1½	2	2	2	3	3						5/16	9/16	7/16	5/16	9/16	7/16
		D. T.	5	9	10			3	6	5/8	1½	3	3	2 1/16	3 1/16	3 1/16						5/16	9/16	7/16	5/16	9/16	7/16
	60	S. T.	3	8	10			3	6	5/8	1½	2	2	2	3	3			1			5/16	9/16	7/16	5/16	9/16	7/16
		D. T.	5	9	10			3	6	5/8	1½	3	3	2 1/16	3 1/16	3 1/16						5/16	9/16	7/16	5/16	9/16	7/16
	100	S. T.	4	9-A	10			3⅛	6¼	5/8	1 11/16	2⅛	2⅛	2⅞	2⅞	2⅞			⅞			11/32	15/32	11/32	11/32	15/32	11/32
		D. T.	5	9	10			3⅛	6¼	5/8	1 11/16	2⅛	2⅛	2 1/16	2 1/16	2 1/16			⅞			11/32	15/32	11/32	11/32	15/32	11/32
	200	S. T.	5-A	9-A	10			3¾	7½	⅝	1 11/16	2½	2½	3	4	4			1			13/32	15/32	13/32	13/32	15/32	13/32
		D. T.	5	9	10			3¾	7½	1	1 11/16	4⅛	4¼	5 11/32	6¼	4 1/16			1 1/16			13/32	15/32	13/32	13/32	15/32	13/32
600 Volts, D. C. and A. C.	30	S. T.	3	9	10			4⅜	9½	5/8	1 11/16	2⅞	2⅞	3	4	4			¾			13/32	15/32	13/32	13/32	15/32	13/32
		D. T.	1	9	10			4⅜	9½	5/8	1 11/16	3⅝	3⅝	3 5/16	4 5/16	4 5/16			1 5/16			13/32	15/32	13/32	13/32	15/32	13/32
	60	S. T.	3	9	10			4⅜	9½	5/8	1 11/16	2⅞	2⅞	3	4	4			¾			13/32	15/32	13/32	13/32	15/32	13/32
		D. T.	1	9	10			4⅜	9½	5/8	1 11/16	3⅝	3⅝	3 5/16	4 5/16	4 5/16			1 5/16			13/32	15/32	13/32	13/32	15/32	13/32
	100	S. T.	4	9	10			5½	11	⅝	2 1/16	3⅝	3⅝	3⅝	5	5			⅞			15/32	17/32	15/32	15/32	17/32	15/32
		D. T.	5	9	10			5½	11	⅝	2 1/16	4⅛	4½	4 11/32	6¼	5 1/16			1 1/16			15/32	17/32	15/32	15/32	17/32	15/32
	200	S. T.	5-A	9-A	10			6	12	1	2 1/16	4⅛	4½	4 11/32	6⅞	5 1/16			1 1/16			15/32	17/32	15/32	15/32	17/32	15/32
		D. T.	5	9	10			6	12	1	2 1/16	5⅛	6	4 11/32	6⅞	6 1/16			1 1/16			15/32	17/32	15/32	15/32	17/32	15/32

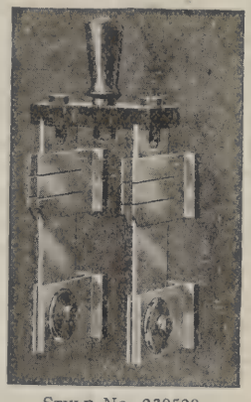
*X—Drill. Y—Counterbore. Z—Depth of Counterbore.

TYPE A REAR-CONNECTED KNIFE SWITCHES WITH ROUND STUDS

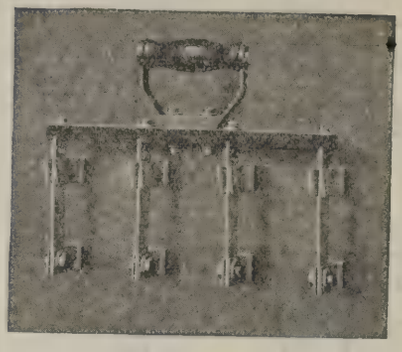
250 Volts D. C. or 500 Volts A. C.

WITHOUT QUICK-BREAK BLADES **NOT FUSED**

STYLE NO. 230526



STYLE NO. 230528



STYLE NO. 189843

MAXIMUM AMPERES						Poles	SINGLE THROW				DOUBLE THROW			
30° Rating			20° Rating				APPROXIMATE WEIGHT, LBS.		Style No.	List Price	APPROXIMATE WEIGHT, LBS.		Style No.	List Price
D. C.	A. C. 25 Cycle	A. C. 60 Cycle	D. C.	A. C. 25 Cycle	A. C. 60 Cycle		Net	Shipping			Net	Shipping		
*30	*30	*30	*30	*30	*30	1	1	1½	189800	96	1½	2	189804	$1 38
						2	1½	2	189801	1 74	2	2½	189805	2 50
						3	2¼	2¾	189802	2 60	2¾	3¼	189806	3 75
						4	2¾	3¼	189803	3 48	3½	4	189807	5 00
†30	†30	†30	†30	†30	†30	1	1	1½	280910	1 44	1½	2	280914	1 92
						2	1½	2	280911	2 58	2	2½	280915	3 46
						3	2¼	2¾	280912	3 90	2¾	3¼	280916	5 20
						4	2¾	3¼	280913	5 20	3½	4	280917	7 00
60	60	60	60	60	60	1	1	1½	189808	1 50	1½	2	189812	2 04
						2	1½	2	189809	2 70	2	2½	189813	3 70
						3	2¼	2¾	189810	4 06	2¾	3¼	189814	5 55
						4	2¾	3¼	189811	5 40	3½	4	189815	7 40
100	100	100	100	100	100	1	1½	2	189824	2 54	2	2½	189828	3 50
						2	3	3½	189825	4 60	4	4½	189829	6 40
						3	4¼	4¾	189826	6 90	5½	6½	189830	9 60
						4	6	7	189827	9 20	8	9	189831	12 80
200	200	200	200	200	200	1	2½	3	189840	3 90	4	4½	189844	5 60
						2	5	6	189841	7 10	7	8	189845	10 20
						3	8	9	189842	10 65	10	11	189846	15 30
						4	12	13	189843	14 20	15	18	189847	20 40
400	400	400	400	400	400	1	5	6	189872	8 50	7	8	189876	12 40
						2	13	14	189873	15 40	17	20	189877	22 50
						3	19	22	189874	23 10	24	27	189878	33 75
						4	26	34	189875	32 70	35	46	189879	45 00
600	600	600	600	600	600	1	8	9	189888	12 20	10	11	189892	17 35
						2	19	22	189889	22 20	27	35	189893	31 50
						3	29	38	189890	33 30	36	47	189894	47 25
						4	38	49	189891	47 20	52	68	189895	63 00
800	800	800	800	800	800	1	10	11	230526	21 45	14	17	230530	30 80
						2	25	28	230527	39 00	35	46	230531	56 00
						3	36	47	230528	58 50	50	65	230532	84 00
						4	48	62	230529	78 00	68	88	230533	112 00
1000	1000	1000	1000	1000	1000	1	15	18	230534	23 40	23	26	230538	34 10
						2	36	47	230535	42 50	63	82	230539	62 00
						3	50	65	230536	63 75	78	101	230540	93 00
						4	67	87	230537	85 00	95	124	230541	124 00
1200	1100	1100	1000	1000	1000	1	25	28	230542	29 05	35	45	230546	42 90
						2	48	62	230543	52 80	68	88	230547	78 00
						3	77	93	230544	79 20	101	131	230548	117 00
						4	92	126	230545	105 60	137	178	230549	156 00
1600	1400	1200	1300	1200	1100	1	30	39	230550	38 50	40	52	230554	57 20
						2	55	71	230551	70 00	71	92	230555	104 00
						3	80	104	230552	105 00	104	134	230556	156 00
						4	105	136	230553	140 00	137	178	230557	208 00
2000	1800	1600	1600	1400	1200	1	52	68	230558	52 80	70	91	230562	79 20
						2	98	127	220559	91 00	133	173	230563	144 00
						3	144	187	230560	144 00	199	259	230564	216 00
						4	190	247	230561	192 00	262	340	230565	288 00

†For 500 volts A. C.

See additional notes at foot of next page.

KNIFE SWITCHES—Continued

STYLE NO. 230587

TYPE A REAR-CONNECTED SWITCHES WITH ROUND STUDS

250 Volts D. C. or 500 Volts A. C.

NOT FUSED

WITH QUICK-BREAK BLADES

MAXIMUM AMPERES						Poles	SINGLE-THROW				DOUBLE-THROW			
30° RATING			20° RATING				APPROXIMATE WEIGHT, LBS.		Style No.	List Price	APPROXIMATE WEIGHT, LBS.		Style No.	List Price
D. C.	A. C. 25 Cycle	A. C. 60 Cycle	D. C.	A. C. 25 Cycle	A. C. 60 Cycle		Net	Shipping			Net	Shipping		
†30	†30	†30	†30	†30	†30	1	1	1½	280918	$ 1 92	1½	2	280922	$ 2 90
						2	1½	2	280919	3 54	2	2½	280923	5 40
						3	2¼	2¾	280920	5 34	2¾	3¼	280924	8 10
						4	2¾	3¼	280921	7 12	3½	4	280925	10 85
60	60	60	60	60	60	1	1	1½	189816	2 00	1½	2	189820	3 05
						2	1½	2	189817	3 70	2	2½	189821	5 70
						3	2¼	2¾	189818	5 55	2¾	3¼	189822	8 55
						4	2¾	3¼	189819	7 40	3½	4	189823	11 40
100	100	100	100	100	100	1	1½	2	189832	3 10	2	2½	189836	4 60
						2	3	3½	189833	5 70	4	4½	189837	8 60
						3	4¼	4¾	189834	8 60	5½	6½	189838	12 90
						4	6	7	189835	11 45	8	9	189839	17 20
200	200	200	200	200	200	1	2½	3	189848	4 60	4	4½	189852	6 95
						2	5	6	189849	8 45	7	8	189853	12 90
						3	8	9	189850	12 70	10	11	189854	19 40
						4	12	13	189851	16 90	15	18	189855	25 85
400	400	400	400	400	400	1	5	6	189880	9 60	7	8	189884	14 60
						2	13	14	189881	17 65	17	20	189885	27 00
						3	19	22	189882	26 45	25	33	189886	40 50
						4	26	34	189883	37 20	36	47	189887	53 95
600	600	600	600	600	600	1	8	9	189896	13 50	10	11	189900	19 90
						2	19	22	189897	24 75	28	36	189901	36 60
						3	30	39	189898	37 15	37	48	189902	54 95
						4	39	51	189899	52 30	54	70	189903	73 25
800	800	800	800	800	800	1	10	11	230566	22 90	14	17	230570	33 70
						2	26	34	230567	41 90	36	47	230571	61 80
						3	37	48	230568	62 85	52	68	230572	92 70
						4	50	65	230569	83 80	70	91	230573	123 60
1000	1000	1000	1000	1000	1000	1	16	17	230574	25 00	25	28	230578	37 30
						2	18	49	230575	45 70	67	87	230579	84 40
						3	53	79	230576	68 55	84	109	230580	125 60
						4	71	92	230577	91 40	103	134	230581	136 80

†For 500 volts A. C.

Style number and list price include switch with satin finish without base or stops; complete with sufficient nuts on each stud to clamp the switch and to make connections to carry the rated current; with terminals on one stud per pole on single throw switches and on 2 studs per pole on double throw switches, rated 800 amperes and below and without terminals on switches rated above 800 amperes; with spade handles on all four-pole switches and on all three-pole switches above 600 amperes and straight handles on all other switches.

If terminals are specified at time of entry of order, one stud per pole on single throw and two studs per pole on double throw 1000 amperes switches will be supplied with terminals at the regular list price.

For additional price for switches with polished finish or reduction in price for switches with plain finish refer to the discount sheets Catalog 1-B, Part 1.

For switches mounted on wood templates, slate bases or black marine marble bases, of standard sizes, add 10, 15 or 20 per cent respectively to the list price.

For special spade handles refer to the list at the end of the knife switch tables.

For stops refer to th list at the end of the knife switch table.

Order by Style Number

KNIFE SWITCHES—Continued

TYPE A REAR-CONNECTED SWITCHES WITH ROUND STUDS

250 Volts D. C. or A. C.

FUSED

		SINGLE-THROW				DOUBLE-THROW			
Max. Amps.*	Poles	Approximate Weight. Lbs. Net	Shipping	Style No. Fused at Bottom	List Price	Approximate Weight. Lbs. Net	Shipping	Style No. Fused at Both Ends	List Price
WITHOUT QUICK-BREAK BLADES									
30	1	¾	1¼	192151	$ 1 24	1¼	1¾	192159	$ 2 64
	2	1	1½	192152	2 24	1½	2	192160	4 80
	3	1½	2	192153	3 36	2½	3	192161	7 20
	4	2½	3	192154	4 48	4	4½	192162	9 60
60	1	1¼	1¾	192163	1 88	1¾	2¼	192171	3 08
	2	1¾	2¼	192164	3 42	3	3½	192172	5 60
	3	2¾	3¼	192165	5 15	5	6	192173	8 40
	4	4	4½	192166	6 85	7	8	192174	11 20
100	1	2½	3	192187	3 52	3	3½	192195	5 50
	2	3½	4	192188	6 40	5½	6½	192196	10 00
	3	5½	6½	192189	9 60	11	12	192197	15 00
	4	8	9	192190	12 80	14	17	192198	20 00
200	1	5	6	192211	5 30	5½	6½	192219	8 60
	2	6½	7½	192212	9 65	11	12	192220	15 60
	3	10	11	192213	14 50	19	22	192221	23 40
	4	15	18	192214	19 30	26	34	192222	31 20
400	1	9	10	192235	11 30	11	12	192243	18 45
	2	16	19	192236	20 50	21	24	192244	33 50
	3	24	27	192237	30 75	43	56	192245	50 25
	4	33	43	192238	43 55	60	78	192246	67 00
600	1	13	14	192259	16 35	16	19	192267	25 10
	2	25	33	192260	29 75	34	44	192268	45 60
	3	41	53	192261	44 60	73	95	192269	68 40
	4	55	72	192262	63 20	99	129	192270	91 20
800	1	18	21	289223	27 05	25	28	289231	42 90
	2	40	52	289224	49 20	62	81	289232	78 00
	3	65	84	289225	73 80	95	124	289233	117 00
	4	88	114	289226	98 40	130	169	289234	156 00
1000	1	23	26	289235	30 60	34	44	289243	48 70
	2	52	68	289236	55 60	85	110	289244	88 50
	3	80	104	289237	83 40	117	153	289245	132 75
	4	111	144	289238	111 20	167	217	289246	177 00
†1200	1	38	49	289247	36 85	52	67	289255	57 20
	2	72	94	289248	67 00	111	144	289256	104 00
	3	122	159	289249	100 50	163	212	289257	156 00
	4	160	208	289250	134 00	232	301	289258	208 00
WITH QUICK-BREAK BLADES									
60	1	1¼	1¾	192175	$ 2 38	1¾	2¼	192183	$ 4 08
	2	1¾	2¼	192176	4 42	3	3½	192184	7 60
	3	2¾	3¼	192177	6 65	5	6	192185	11 40
	4	4	5	192178	8 85	7	8	192186	15 20
100	1	2½	3½	192199	4 10	3	3½	192207	6 60
	2	3½	4½	192200	7 50	5½	6½	192208	12 20
	3	5½	6½	192201	11 30	11	12	192209	18 30
	4	8	9	192202	15 05	14	17	192210	24 40
200	1	5	6	192223	6 00	5½	6½	192231	9 95
	2	6½	7½	192224	11 00	11	12	192232	18 30
	3	10	11	192225	16 55	19	22	192233	27 50
	4	15	18	192226	22 05	27	35	192234	36 65
400	1	9	10	192247	12 40	11	12	192255	20 70
	2	16	19	192248	22 75	21	24	192256	38 00
	3	24	27	192249	34 10	44	57	192257	56 95
	4	34	45	192250	48 05	62	81	192258	75 95
600	1	13	16	192271	17 65	16	17	192279	27 65
	2	25	33	192272	32 30	35	46	192280	50 70
	3	42	55	192273	48 45	76	99	192281	76 10
	4	57	74	192274	68 30	103	134	192282	101 45
800	1	19	22	289259	28 50	27	30	289267	45 80
	2	42	55	289260	52 10	66	86	289268	83 80
	3	68	88	289261	78 15	101	131	289269	125 70
	4	92	120	289262	104 20	138	179	289270	167 60
1000	1	24	27	289271	32 25	36	47	289279	52 00
	2	54	70	289272	58 90	89	116	289280	95 10
	3	83	108	289273	88 35	123	160	289281	142 65
	4	115	150	289274	117 80	175	228	289282	190 20

*For 1000 amperes and below, the ratings are the same on both the 20° and 30° rise basis. Above that the ratings given are on the basis of 30° rise.

†1100 amperes for 25 and 60 cycles A. C.

Style number and list price include switch with satin finish without base or stops; complete with sufficient nuts on each stud to clamp the switch and to make connections to carry the rated current; with terminals on one stud per pole on single throw witches and on 2 studs per pole on double throw switches, rated 800 amperes and below and without terminals on switches rated above 800 amperes; with spade handles on all four-pole switches and on all three-pole switches above 600 amperes and straight handles on all other switches.

If terminals are specified at time of entry of order, one stud per pole on single throw and two studs per pole on double throw 1000 and 1200 ampere switches will be supplied with terminals at the regular list price.

For additional price for switches with polished finish or reduction in price for switches with plain finish refer to the discount sheets, Catalog 1-B Part 1.

For switches mounted on wood templates, slate bases or black marine marble bases, of standard sizes, add 10, 15 or 20 per cent respectively to the list price.

For special spade handles refer to the list at the end of the knife switch tables.

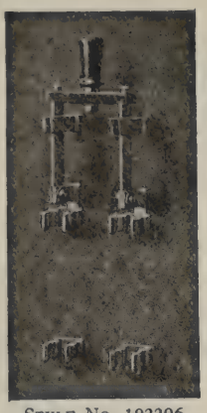
For stops refer to the list at the end of the knife switch table.

KNIFE SWITCHES—Continued

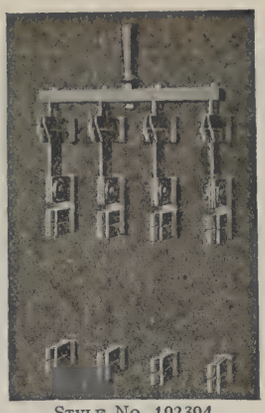
TYPE A REAR-CONNECTED SWITCHES WITH ROUND STUDS

500 Volts A. C.

FUSED



STYLE NO. 192296



STYLE NO. 192394

Max. Amps.‡	Poles	SINGLE-THROW						DOUBLE-THROW					
		Approximate Weight, Lbs.		Without Quick-Break		With Quick-Break		Approximate Weight, Lbs.		Without Quick-Break		With Quick-Break	
		Net	Shipping	Style No. Fused at Bottom	List Price	Style No. Fused at Bottom	List Price	Net	Shipping	Style No. Fused at Both Ends	List Price	Style No. Fused at Bottom	List Price
30	1	¾	1¼	192283	$ 2 54	195313	$ 3 02	1¼	1¾	192291	$ 3 81	195321	$ 4 77
	2	1	1½	192284	4 37	195314	5 35	1½	2	192292	5 70	195322	7 60
	3	1¼	1¾	192285	5 40	195315	6 85	2¼	2¾	192293	8 40	195323	11 30
	4		2½	192286	7 20	195316	9 10	3¾	4¼	192294	11 20	195324	15 04
60	1	1¼	1¼	192295	2 64	192307	3 14	1¾	2¼	192303	13 96	192315	4 96
	2	1¾	2¼	192296	4 70	192308	5 70	3	3½	192304	7 05	192316	9 05
	3	2½	3	192297	6 20	192309	7 70	4¾	5¼	192305	9 80	192317	12 80
	4	3¼	3¼	192298	8 30	192310	10 30	6¾	7¾	192306	13 10	192318	17 10
100	1	2½	3	192319	5 10	192331	5 65	3	3½	192327	7 60	192339	8 70
	2	3½	4	192320	7 45	192332	8 55	5½	6½	192328	11 15	192340	13 35
	3	5	6	192321	10 40	192333	12 08	10¾	11¾	192329	18 50	192341	21 80
	4	6½	7½	192322	13 90	192334	16 15	13½	14½	192330	24 70	192342	29 10
200	1	5	6	192343	6 30	192355	7 00	5½	6½	192351	9 45	192363	10 80
	2	6½	7½	192344	10 65	192356	12 00	11	12	192352	16 50	192364	15 20
	3	9¼	9¾	192345	15 50	192357	17 55	18¼	21¼	192353	26 00	192365	30 10
	4	12	13	192346	20 70	192358	23 40	26	34	192354	34 70	192366	40 10
400	1	9	10	192367	11 95	192379	12 10	11	12	192375	19 40	192387	18 65
	2	16	19	192368	21 25	192380	23 50	21	24	192376	37 90	192388	36 40
	3	22½	25½	192369	34 00	192381	37 35	43	56	192377	54 50	192389	61 20
	4	30½	40	192370	45 35	192382	49 85	59	77	192378	72 70	192390	81 65
600	1	13	14	192391	16 75	192403	17 00	16	17	192399	27 95	192411	24 50
	2	25	33	192392	30 65	192404	32 25	34	45	192400	48 95	192412	49 05
	3	38¾	50	192393	46 00	192405	49 85	72½	94	192401	75 00	192413	82 70
	4	52¼	68	192394	61 35	192406	66 45	96½	125	192402	100 00	192414	110 25
800	1	18	21	289295	30 00	289331	31 45	25	28	289303	45 00	289339	47 90
	2	40	52	289296	52 00	289332	54 90	62	81	289304	92 00	289340	97 80
	3	65	84	289297	75 00	289333	79 35	95	124	289305	130 00	289341	138 70
	4	88	114	289298	100 00	289334	105 80	130	169	289306	173 00	289342	184 60
1000	1	23	26	289307	33 00	289343	34 65	34	44	289315	50 00	289351	53 30
	2	52	68	289308	60 00	289344	63 30	85	110	289316	90 00	289352	96 60
	3	80	104	289309	86 00	289345	90 95	117	153	289317	105 00	289353	114 90
	4	111	144	289310	114 70	289346	121 30	167	217	289318	192 00	289354	205 20
1100	1	38	49	289319	40 00	289355	41 90	52	67	289327	70 00	289363	73 80
	2	72	94	289320	75 00	289356	78 80	111	144	289328	120 00	289364	127 65
	3	122	159	289321	105 00	289357	110 75	163	212	289329	168 00	289365	179 45
	4	160	208	289322	140 00	289358	147 65	232	301	289330	224 00	289366	239 30

‡For 1000 ampere and below, the ratings are the same on both the 20-degree and 30-degree rise basis. Above that the ratings given are on the basis of 30 degrees rise.

Style number and list price include switch with satin finish without base or stops; complete with sufficient nuts on each stud to clamp the switch and to make connections to carry the rated current; with terminals on one stud per pole on single throw switches and on 2 studs per pole on double throw switches, rated 800 amperes and below and without terminals on switches rated above 800 amperes; with spade handles on all four pole switches and on all three pole switches above 600 amperes and straight handles on all other switches.

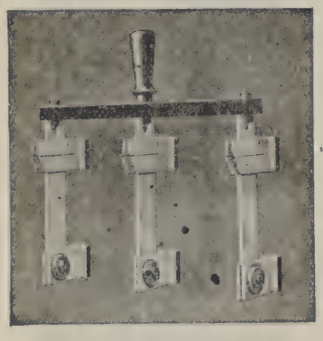
If terminals are specified at time of entry of order, one stud per pole on single throw and two studs per pole on double throw 1000 and 1100 ampere switches, will be supplied with terminals at the regular list price.

For additional price for switches with polished finish or reduction in price for switches with plain finish refer to the discount sheets Catalog 1-B Part 1.

For switches mounted on wood templates, slate bases or black marine marble bases, of standard sizes, add 10, 15 or 20 per cent respectively to the list price.

For special spade handles refer to the list at the end of the knife switch tables.

For stops refer to the list at the end of the knife switch table.



STYLE No. 192749

TYPE A REAR-CONNECTED SWITCHES WITH ROUND STUDS

600 Volts D. C. or A. C.

WITHOUT QUICK-BREAK BLADES **NOT FUSED**

MAXIMUM AMPERES						Poles	SINGLE-THROW				DOUBLE-THROW			
30° RATING			20° RATING				Approx. Weight, Lbs.		Style No.	List Price	Approx. Weight, Lbs.		Style No.	List Price
D. C.	A. C. 25 Cycle	A. C. 60 Cycle	D. C.	A. C. 25 Cycle	A. C. 60 Cycle		Net	Ship.			Net	Ship.		
30	30	30	30	30	30	1	1½	2	280926	$1 84	2	2½	280930	$2 70
						2	2½	3	280927	3 32	3½	4	280931	4 86
						3	4	4½	280928	5 34	5½	6½	280932	7 80
						4	5	6	280929	7 34	7	8	280933	10 74
60	60	60	60	60	60	1	1½	2	192683	1 94	2	2½	192687	2 80
						2	2½	3	192684	3 50	3½	4	192688	5 10
						3	4	4½	192685	5 60	5½	6½	192689	8 15
						4	5	6	192686	7 70	7	8	192690	11 20
100	100	100	100	100	100	1	1¾	2¼	192699	3 04	2½	3½	192703	4 10
						2	3¾	4¼	192700	5 50	5	6	192704	7 40
						3	6	7	192701	8 80	10	11	192705	11 75
						4	8	9	192702	12 10	12	13	192706	16 30
200	200	200	200	200	200	1	3	3½	192715	4 60	4½	5½	192719	6 02
						2	6	7	192716	8 25	9	10	192720	10 70
						3	10	11	192717	13 30	16	19	192721	17 35
						4	15	18	192718	18 40	22	25	192722	24 05
400	400	400	400	400	400	1	6	7	192747	9 90	8	9	192751	13 15
						2	16	19	192748	17 75	21	24	192752	23 50
						3	25	33	192749	28 65	37	48	192753	38 10
						4	31	40	192750	39 50	48	62	192754	52 65
600	600	600	500	600	600	1	9	10	192763	14 10	12	13	192767	18 35
						2	23	26	192764	25 45	31	40	192768	32 90
						3	34	44	192765	40 95	48	62	192769	53 10
						4	48	62	192766	56 50	63	82	192770	73 35
800	800	800	800	800	800	1	11	12	230715	23 30	15	16	230719	42 30
						2	28	36	230716	49 95	38	49	230720	64 60
						3	39	51	230717	66 05	55	72	230721	86 25
						4	54	70	230718	89 15	74	96	230722	119 50
1000	1000	1000	1000	1000	1000	1	16	19	230723	39 80	25	28	230727	58 00
						2	39	49	230724	72 20	69	90	230728	105 30
						3	54	70	230725	108 40	86	112	230729	158 00
						4	73	95	230726	144 40	107	139	230730	211 00
1200	1100	1100	1000	1000	1000	1	27	30	230731	49 00	25	33	230735	72 70
						2	52	67	230732	91 20	69	90	230736	123 55
						3	77	99	230733	125 50	85	111	230737	158 55
						4	103	134	230734	183 50	104	135	230738	246 35
1600	1400	1200	1300	1200	1100	1	32	41	230739	64 90	42	55	230743	98 05
						2	59	77	230740	122 50	75	98	230744	163 60
						3	86	112	230741	165 60	110	143	230745	212 10
						4	113	147	230742	239 70	145	189	230746	311 40
2000	1800	1600	1600	1400	1200	1	55	72	230747	87 75	73	95	230751	126 70
						2	104	135	230748	162 90	139	181	230752	215 30
						3	153	199	230749	237 55	208	270	230753	296 35
						4	212	276	230750	304 80	274	336	230754	436 90

Style number and list price include switch with satin finish without base or stops; complete with sufficient nuts on each stud to clamp the switch and to make connections to carry the rated current: with terminals on one stud per pole on single throw switches and on 2 studs per pole on double throw switches, rated 800 amperes and below and without terminals on switches rated above 800 amperes; with spade handles on all four pole switches and on all three pole switches above 600 amperes and straight handles on all other switches.

If terminals are specified at time of entry of order, one stud per pole on single throw and two studs per pole on double throw 1000 and 1200 ampere switches will be supplied with terminals at the regular list price.

For additional price for switches with polished finish or reduction in price for switches with plain finish refer to the discount sheets, Catalog 1-B Part 1.

For switches mounted on wood templates, slate bases or black marine marble bases, of standard sizes, add 10, 15 or 20 per cent respectively to the list price.

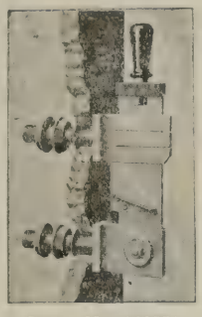
For special spade handles refer to the list at the end of the knife switch tables.

For stops refer to the list at the end of the knife switch table.

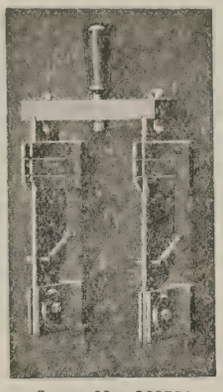
KNIFE SWITCHES—Continued

TYPE A REAR-CONNECTED SWITCHES WITH ROUND STUDS
600 Volts D. C. or A. C.

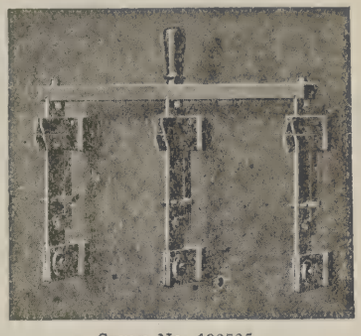
WITH QUICK-BREAK BLADES **NOT FUSED**



STYLE No. 230771



STYLE No. 230756



STYLE No. 192725

MAXIMUM AMPERES						Poles	SINGLE-THROW				DOUBLE-THROW			
30° Rating			20° Rating				Approx. Weight, Lbs.		Style No.	List Price	Approx. Weight, Lbs.		Style No.	List Price
D. C.	A. C. 25 Cycle	A. C. 60 Cycle	D. C.	A. C. 25 Cycle	A. C. 60 Cycle		Net	Ship.			Net	Ship.		
30	30	30	30	30	30	1	1½	2	280934	$ 2 10	2	2½	280938	$ 3 22
						2	2½	3	280935	3 82	3½	4	280939	5 74
						3	4	4½	280936	6 12	5½	6½	280940	9 24
						4	5	6	280937	8 44	7	8	280941	12 72
60	60	60	60	60	60	1	1½	2	192691	2 20	2	2½	192695	3 30
						2	2½	3	192692	4 00	3½	4	192696	6 00
						3	4	4½	192693	6 40	5½	6½	192697	9 60
						4	5	6	192694	8 80	7	8	192698	13 20
100	100	100	100	100	100	1	1¾	2¼	192707	3 58	2½	3	192711	4 96
						2	3¾	4¼	192708	6 50	5	6	192712	9 00
						3	6	7	192709	10 40	10	11	192713	14 40
						4	8	9	192710	14 30	12	14	192714	19 80
200	200	200	200	200	200	1	3	3½	192723	5 30	4½	5	192727	7 40
						2	6	7	192724	9 60	9	10	192728	13 40
						3	10	11	192725	15 35	16	19	192729	21 45
						4	15	18	192726	21 10	22	25	192730	29 50
400	400	400	400	400	400	1	6	7	192755	11 00	8	9	192759	15 40
						2	16	19	192756	20 00	21	24	192760	28 00
						3	25	33	192757	32 00	38	49	192761	44 80
						4	32	42	192758	44 00	50	65	192762	61 60
600	600	600	600	600	600	1	9	10	192771	15 40	12	13	192775	20 90
						2	23	26	192772	28 00	32	42	192776	38 00
						3	35	46	192773	44 80	50	65	192777	60 80
						4	50	65	192774	61 60	65	85	192778	83 60
800	800	800	800	800	800	1	11	12	230755	24 75	15	18	230759	45 25
						2	29	38	230756	52 85	39	50	230760	70 45
						3	40	52	230757	70 45	57	74	230761	95 00
						4	56	73	230758	95 00	77	100	230762	131 20
1000	1000	1000	1000	1000	1000	1	17	20	230763	41 40	27	30	230767	61 20
						2	41	53	230764	75 40	73	95	230768	117 70
						3	57	74	230765	113 20	92	120	230769	167 60
						4	77	100	230766	150 80	115	150	230770	223 80

Style number and list price include switch with satin finish without base or stops; complete with sufficient nuts on each stud to clamp the switch and to make connections to carry the rated current; with terminals on one stud per pole on single throw switches and on 2 studs per pole on double throw switches, rated 800 amperes and below and without terminals on switches rated above 800 amperes; with spade handles on all four pole switches and on all three pole switches above 600 amperes and straight handles on all other switches.

If terminals are specified at time of entry of order, one stud per pole on single throw and two studs per pole on double throw 1000 amperes switches will be supplied with terminals at the regular list price.

For additional price for switches with polished finish or reduction in price for switches with plain finish refer to the discount sheets, Catalog 1-B, Part 1.

For switches mounted on wood templates, slate bases or black marine marble bases, of standard sizes, add 10, 15 or 20 per cent respectively to the list price.

For special spade handles refer to the list at the end of the knife switch tables.

For stops refer to the list at the end of the knife switch table.

TYPE A REAR-CONNECTED SWITCHES WITH ROUND STUDS

600 Volts D. C. or A. C.

FUSED

Max. Amps.‡	Poles	SINGLE-THROW Approximate Weight Lbs. Net	Shipping	Style Nos. Fused at Bottom	List Price	DOUBLE-THROW Approximate Weight Lbs. Net	Shipping	Style Nos. Fused at Both Ends	List Price
WITHOUT QUICK-BREAK BLADES									
30	1	1¼	1¾	192779	$ 2 34	1½	2	192787	$ 3 18
	2	2	2½	192780	4 22	3	3½	192788	5 75
	3	2½	3	192781	6 80	5½	6½	192789	9 25
	4	3	3½	192782	9 30	6	7	192790	12 70
60	1	1½	2	192791	2 60	2	2½	192799	3 58
	2	2½	3	192792	4 70	4	4½	192800	6 50
	3	3½	4	192793	7 55	7	8	192801	10 40
	4	4½	5	192794	10 35	8	9	192802	14 30
100	1	3	3½	192815	4 10	4	4½	192823	6 05
	2	4	4½	192816	7 40	7	8	192824	11 00
	3	7	8	192817	11 85	14	17	192825	17 60
	4	9	10	192818	16 30	15	18	192826	24 20
200	1	5	6	192839	6 25	6½	7½	192847	8 80
	2	7½	8½	192840	11 25	13	14	192848	15 80
	3	12	13	192841	18 10	22	25	192849	25 50
	4	16	19	192842	25 00	30	39	192850	35 25
400	1	9	10	192863	13 45	13	14	192871	18 10
	2	18	21	192864	24 25	25	33	192872	32 50
	3	28	36	192865	39 05	50	65	192873	52 50
	4	36	46	192866	53 80	65	85	192874	72 45
600	1	14	15	192887	18 80	20	23	192895	26 05
	2	28	36	192888	33 95	40	52	192896	46 90
	3	45	59	192889	54 55	80	104	192897	75 50
	4	60	78	192890	75 70	110	143	192898	104 15
WITH QUICK-BREAK BLADES									
30	1	1¼	1¾	195893	$ 2 66	1½	2	195901	$ 3 74
	2	2	2½	195894	4 82	3	3½	195902	6 90
	3	2½	3	195895	7 75	5½	6½	195903	10 85
	4	3	3½	195896	10 65	6	7	195904	14 90
60	1	1½	2	192803	2 95	2	2½	192811	4 14
	2	2½	3	192804	5 40	4	4½	192812	7 50
	3	3½	4	192805	8 65	7	8	192813	12 00
	4	4½	5	192806	11 90	8	9	192814	16 50
100	1	3	3½	192827	4 70	4	4½	192835	6 90
	2	4	4½	192828	8 50	7	8	192836	12 50
	3	7	8	192829	13 60	14	15	192837	20 00
	4	9	10	192830	18 70	15	18	192838	27 50
200	1	5	6	192851	6 95	6½	7½	192859	10 20
	2	7½	8½	192852	12 60	13	14	192860	18 50
	3	12	13	192853	20 15	22	25	192861	29 60
	4	16	19	192854	27 70	30	39	192862	40 70
400	1	9	10	192875	14 60	13	14	192883	20 40
	2	18	21	192876	26 50	25	33	192884	37 00
	3	28	36	192877	42 40	50	65	192885	59 20
	4	36	47	192878	58 30	65	85	192886	81 40
600	1	14	15	192899	20 10	20	23	192907	28 60
	2	28	36	192900	36 50	40	52	192908	52 00
	3	45	59	192901	58 40	80	104	192909	83 20
	4	60	78	192902	80 30	110	133	192910	114 40

‡Good for either 20° or 30° temperature rise; D. C. or 25-cycle, or 60-cycle A. C.

Style number and list price include switch with satin finish, without base, stops or fuses; complete with sufficient nuts on each stud to clamp the switch and to make connections to carry the rated current; with terminals on one stud per pole on single throw and on two studs per pole on double throw switches; with spade handles on all four pole switches, amperes and straight handles on all other switches.

For additional price for switches with polished finish or reduction in price for switches with plain finish, refer to the discount sheets, Catalog 1-B Part 1.

For switches mounted on wood templates, slate bases, or black marine marble bases of standard sizes, add 10, 15 or 20 per cent respectively to the list price.

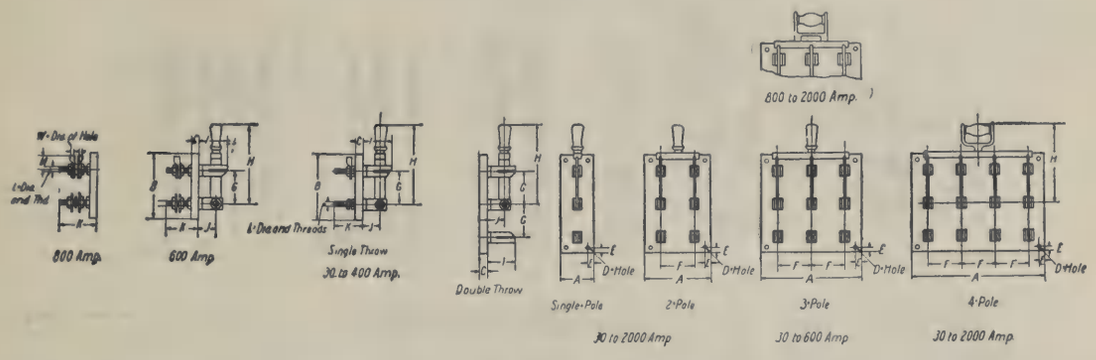
For special spade handles refer to the list at the end of knife switch tables.

For stops refer to the list at the end of the knife switch tables.

Switches fused at the top will be supplied on special request.

KNIFE SWITCHES—Continued

TYPE A REAR-CONNECTED—NOT FUSED

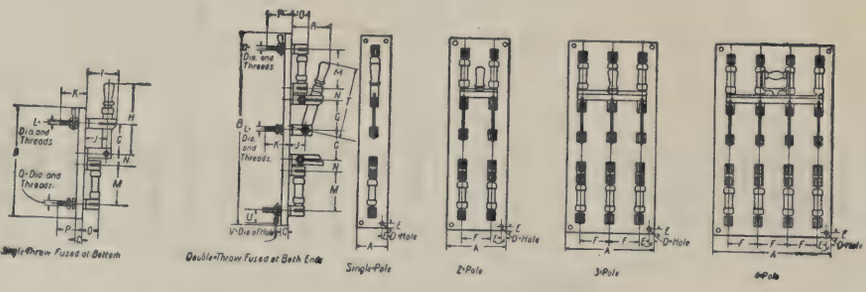


Volts	Amps.	DIMENSIONS IN INCHES																				
		A				B		C	D	E	F	G	H				I	J	K	L†	M	W
		Single Pole	2 Pole	3 Pole	4 Pole	Single Throw	D'ble. Throw						Single Pole	2 Pole	3 Pole	4 Pole						
250 V. D.C.&A.C	30	4	6	9	11	6	8	¾	¼	⅝	2¼	2	4 9/16	4 9/16	4 9/16	5 9/16	1 19/32	1	2¾	.242–24	..	..
250 Volts D. C. or 500 V. A. C.	60	4	7	10	13	7	10	¾	¼	⅝	3	2⅝	5 11/32	5 11/32	5 11/32	6 11/32	1⅞	1 3/16	3	5/16–18	13/16	.259
	100	5	8	11	14	8	11	¾	5/16	¾	3⅛	3	6½	6½	6½	7½	2 1/16	1½	3	⅜–16	1 3/32	.384
	200	6	9	13	17	9	13	1	⅝	¾	3¾	3½	7 29/32	7 29/32	7 29/32	8 1/32	3	1⅞	3¼	½–13	1 9/16	.558
	400	6	10	14	19	10	15	1	3/8	1	4⅛	4¼	9 7/16	9 7/16	9 7/16	10 9/16	4 1/16	2½	3¾	5/8–11	2 11/32	.9185
	600	7	11	16	20	12	16	1¼	7/16	1⅛	4½	4⅞	10 11/16	10 11/16	10 11/16	11 3/16	4 5/8	2¾	4	¾–16	3 1/32	1.28
	800	....	....	....	....	....	....	....	....	....	4⅞	5½	12 13/16	12 13/16	13 13/16	13 15/16	4¾	2⅞	5¼	1 –14	2 5/16	1.385
	1000	....	....	....	....	....	....	....	....	....	5	6	13¾	13¾	14⅞	14⅞	5⅜	3¼	5¼	1 –14		
	1200	....	....	....	....	....	....	....	....	....	5⅛	6	13¾	13¾	14⅞	14⅞	5⅜	3¼	5½	1¼–14		
	*1100	....	....	....	....	....	....	....	....	....												
	1600	....	....	....	....	....	....	....	....	....	5¼	6¾	15 15/16	15 15/16	17 1/16	17 1/16	6¼	3¾	6¼	1½–14		
	*1200	....	....	....	....	....	....	....	....	....												
	2000	....	....	....	....	....	....	....	....	....	5⅝	6¾	15 15/16	15 15/16	17 1/16	17 1/16	6⅜	3⅞	6½	1¾–12		
	*1600	....	....	....	....	....	....	....	....	....												
500 V A. C.	30	4	7	10	13	7	10	¾	¼	⅝	3	2⅝	5 11/32	5 11/32	5 11/32	6 11/32	1⅞	1 3/16	3	5/16–18		
600 Volts D.C.&A.C.	30	5	9	14	19	9	13	¾	5/16	¾	4¾	4⅛	6 27/32	6 27/32	6 27/32	7 27/32	1⅞	1 3/16	3	5/16–18	13/16	.259
	60	5	9	14	19	9	13	¾	5/16	¾	4¾	4⅛	6 27/32	6 27/32	6 27/32	7 27/32	1⅞	1 3/16	3	5/16–18	13/16	.259
	100	5	10	16	21	10	15	¾	5/16	¾	5½	5	8½	8½	8½	9⅛	2 1/16	1½	3	⅜–16	1 3/32	.384
	200	6	12	18	24	12	17	1	3/8	1	6	5½	9 25/32	9 25/32	9 25/32	10 1/32	3	1⅞	3¼	½–13	1 9/16	.558
	400	6	12	18	24	12	18	1	3/8	1	6	6	11 5/8	11 5/8	11 5/8	12 5/16	4 1/16	2½	3¾	5/8–11	2 11/32	.9185
	600	7	13	20	26	13	20	1¼	7/16	1⅛	6¼	6¼	12	12	12	12 11/16	4 5/8	2¾	4	¾–16	3 1/32	1.28
	800	....	....	....	....	....	....	....	....	....	6⅜	7½	14 13/16	14 13/16	15 15/16	15 15/16	4¾	2⅞	5¼	1 –14	2 5/16	1.385
	1000	....	....	....	....	....	....	....	....	....	6½	8	15¾	15¾	16⅞	16⅞	5⅜	3¼	5¼	1 –14		
	1200	....	....	....	....	....	....	....	....	....	6⅝	8	15¾	15¾	16⅞	16⅞	5⅜	3¼	5½	1¼–14		
	*1100	....	....	....	....	....	....	....	....	....												
	1600	....	....	....	....	....	....	....	....	....	7	8¾	17 15/16	17 15/16	19 1/16	19 1/16	6¼	3¾	6¼	1½–14		
	*1200	....	....	....	....	....	....	....	....	....												
	2000	....	....	....	....	....	....	....	....	....	7⅜	8¾	17 15/16	17 15/16	19 1/16	19 1/16	6⅜	3⅞	6½	1¾–12		
	*1600	....	....	....	....	....	....	....	....	....												

Catalogue Style Number does not include base.
*For 60 cycle alternating current only.
†Diameter in inches and number of threads to the inch.

KNIFE SWITCHES—Continued

TYPE A REAR-CONNECTED—FUSED



DIMENSIONS IN INCHES

Amp.	A: Single Pole	A: 2 Pole	A: 3 Pole	A: 4 Pole	B: Single Throw	B: Double Throw	C	D	E	F	G	H: 1, 2 & 3 Pole	H: 4 Pole	I
250 Volts D. C. or A. C.														
30	4	7	9	11	9	13	3/4	5/16	3/4	2 1/4	2	4 9/16	4 9/16	2 1/8
60	5	8	11	14	11	16	3/4	5/16	3/4	3	2 5/8	5 3/32	5 3/32	2 17/32
100	5	8	12	15	14	24	3/4	3/8	1	3 1/8	3	6 1/2	7	3 7/32
200	6	10	14	17	17	28	1	3/8	1	3 3/4	3 1/2	7 29/32	8 13/32	4 5/32
400	6	11	15	19	20	33	1	7/16	1 1/8	4 1/8	4 1/4	9 7/8	10 9/16	5 11/16
600	7	11	16	20	23	38	1 1/4	9/16	1 1/4	4 1/2	4 7/8	10 11/16	11 3/8	6 3/8
500 Volts A. C.														
30	5	8	11	14	13	21	3/4	5/16	3/4	3	2 5/8	5 11/32	5 23/32	2 17/32
60	5	8	11	14	13	21	3/4	5/16	3/4	3	2 5/8	5 11/32	5 23/32	2 17/32
100	5	8	12	15	16	28	3/4	3/8	1	3 1/8	3	6 1/2	7	3 7/32
200	6	10	14	17	20	33	1	3/8	1	3 3/4	3 1/2	7 29/32	8 13/32	4 5/32
400	*6	11	15	19	23	39	1	7/16	1 1/8	4 1/8	4 1/4	9 7/8	10 9/16	5 11/16
600	‡7	11	16	20	26	44	1 1/4	9/16	1 1/4	4 1/2	4 7/8	10 11/16	11 3/8	6 3/8
600 Volts D. C. or A. C.														
30	5	9	14	19	15	24	3/4	5/16	3/4	4 3/4	4 1/8	6 27/32	7 7/32	2 17/32
60	5	9	14	19	15	24	3/4	5/16	3/4	4 3/4	4 1/8	6 27/32	7 7/32	2 17/32
100	†5	11	16	22	18	32	3/4	3/8	1	5 1/2	5	8 1/2	9	3 7/32
200	*6	12	18	24	22	37	1	3/8	1	6	5 1/2	9 23/32	10 17/32	4 5/32
400	*6	12	18	24	25	43	1	7/16	1 1/8	6	6	11 5/8	12 3/4	5 11/16
600	‡7	13	20	26	27	47	1 1/4	9/16	1 1/4	6 1/4	6 1/4	12	12 11/16	6 3/8

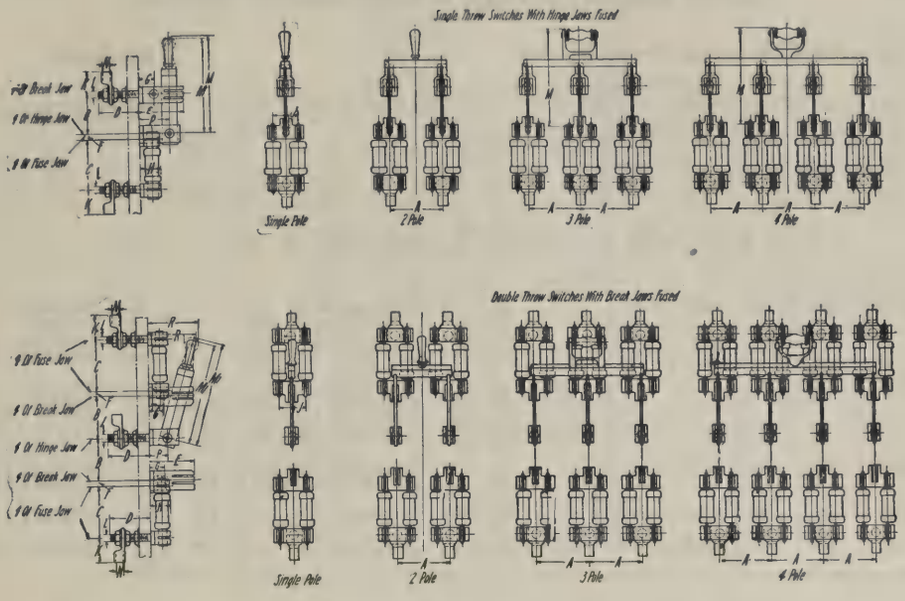
DIMENSIONS IN INCHES

Amp.	J: Hinge Jaw Fused	J: Break Jaw Fused	K	L§	M	N	O	P	Q§	R: 1, 2 & 3 Pole	R: 4 Pole	T: 1, 2 & 3 Pole	T: 4 Pole	U	V
250 Volts D. C. or A. C.															
30	1 17/32	1	2 3/4	.242–24	1 1/2	11/16	29/32	2 13/16	.242–24	2 5/8	2 5/8	4 23/32	4 23/32	...	.....
60	1 15/16	1 3/16	3	5/16–18	2 3/8	7/8	1 3/16	3 1/16	5/16–18	3	3 1/8	5 9/16	5 9/16	13/16	.259
100	2 7/16	1 1/2	3	3/8–16	4 7/8	1 1/4	1 13/16	3	3/8–16	3 11/16	3 7/8	6 27/32	7 11/32	1 9/32	.384
200	3 1/8	1 7/8	3 1/4	1/2–13	5 3/8	1 11/16	2 3/16	3 1/4	1/2–13	4 1/16	4 11/16	8 5/16	8 15/16	1 7/32	.558
400	4 1/4	2 1/2	3 3/4	5/8–11	6 3/4	2 5/16	3	3 3/4	5/8–11	7 5/16	7 11/16	10 11/16	11 3/8	2 11/32	.9185
600	4 7/8	2 3/4	4	3/4–16	8 1/8	2 11/16	3 7/16	4	3/4–16	7 13/16	8 7/16	11 1/2	12 3/16	3 1/2	1.28
500 Volts A. C.															
30	1 17/32	1 3/16	3	5/16–18	4 1/2	13/16	1 3/16	2 13/16	.242–24	3	3 1/8	5 9/16	5 15/16	...	.....
60	1 15/16	1 7/16	3	5/16–18	4 7/8	7/8	1 15/32	3 1/16	5/16–18	3	3 1/8	5 9/16	5 15/16	13/16	.259
100	2 7/16	1 1/2	3	3/8–16	6 7/8	1 1/4	1 13/16	3	3/8–16	3 11/16	3 7/8	6 27/32	7 11/32	1 9/32	.384
200	3 1/8	1 7/8	3 1/4	1/2–13	8 1/4	1 11/16	2 3/16	3 1/4	1/2–13	4 1/16	4 11/16	8 5/16	8 15/16	1 7/32	.558
400	4 1/4	2 1/2	3 3/4	5/8–11	9 3/4	2 5/16	3	3 3/4	5/8–11	7 5/16	7 11/16	10 11/16	11 3/8	2 11/32	.9185
600	4 7/8	2 3/4	4	3/4–16	11 1/8	2 11/16	3 7/16	4	3/4–16	7 13/16	8 7/16	11 1/2	12 3/16	3 1/2	1.28
600 Volts D. C. or A. C.															
30	1 15/16	1 3/16	3	5/16–18	4 1/2	13/16	1 3/16	2 13/16	.242–24	2 13/16	2 7/8	7 1/16	7 1/16	13/16	.259
60	1 15/16	1 3/16	3	5/16–18	4 7/8	7/8	1 15/32	3 1/16	5/16–18	2 13/16	2 7/8	7 1/16	7 1/16	13/16	.259
100	2 7/16	1 1/2	3	3/8–16	6 7/8	1 1/4	1 13/16	3	3/8–16	3 3/4	3 1/2	8 23/32	9 7/32	1 9/32	.384
200	3 1/8	1 7/8	3 1/4	1/2–13	8 1/4	1 11/16	2 3/16	3 1/4	1/2–13	4	4 5/16	10 5/16	10 13/16	1 9/32	.558
400	4 1/4	2 1/2	3 3/4	5/8–11	9 3/4	2 5/16	3	3 3/4	5/8–11	6 5/8	7	12 5/16	12 7/8	2 11/32	.9185
600	4 7/8	2 3/4	4	3/4–16	11 1/8	2 11/16	3 7/16	4	3/4–16	7 5/16	7 3/4	12 11/16	13 3/8	3 1/2	1.28

†For single-pole double-throw switches, A = 7 inches.
*For single-pole double-throw switches, A = 9 inches.
‡For single-pole double-throw switches, A = 11 inches.
§Diameter in inches and number of threads to the inch.

KNIFE SWITCHES—Continued

TYPE A REAR-CONNECTED—FUSED



DIMENSIONS IN INCHES

Volts	Amp.	A	B	C	D	E		F	G		H	J	K	L	M		M¹		N	P		R	
						Break Jaw	Break Jaw Fused		Break Jaw	Break Jaw Fused					S.P. & 2 P.	3 P. & 4 P.	S.P. & 2 P.	3 P. & 4 P.		Hinge Jaw Fused	Break Jaw Fused	1&2 P. Sw.	3 & 4 P. Sw.
250 Volts D.C.&A.C.	800*	7¼	5½	6¾	5¼	6 7/16	6¼	7/8	2 5/16	2⅛	3 5/16	3¼	3 7/8	1	12 13/16	13 15/16	13½	14 5/8	1.385	4 7/16	2⅞	7 9/16	8 1/16
	1000*	7⅞	6	8⅛	5¼	6⅞	6¾	15/16	2¼	2⅛	3 1/16	3¾	4⅛	1	13¾	14⅞	14⅛	15¼	1½	4⅝	3¼	7⅞	7⅞
	1200 D.C.* 1100 A.C.*	7⅞	6	8⅛	5½	7 5/16	7 3/16	15/16	2½	2⅜	3 1/16	3⅝	4 5/8	1¼	13¾	14⅞	14⅜	15½	1¾	4⅞	3¼	8	8 15/32
500 Volts A. C.	800*	8¼	5½	9¾	5¼	6 7/16	6¼	7/8	2 5/16	2⅛	3 5/16	3¼	3 7/8	1	12 13/16	13 15/16	13½	14 5/8	1.385	4 7/16	2⅞	7 9/16	8 1/16
	1000*	9⅛	6	11⅛	5¼	6⅞	6¾	15/16	2¼	2⅛	3 1/16	3¾	4⅛	1	13¾	14⅞	14⅛	15¼	1½	4⅝	3¼	7⅞	7⅞
	1100*	9⅛	6	11⅛	5½	7 5/16	7 3/16	15/16	2½	2⅜	3 1/16	3⅝	4 5/8	1¼	13¾	14⅞	14⅜	15½	1¾	4⅞	3¼	8	8 15/32

*NOTE—Terminals are not included in style number and price of the 1000 and 1200–1100-ampere switches. On the 800 ampere switches, terminals are included on the break jaws only.

KNIFE SWITCHES—Continued

TYPE A REAR-CONNECTED KNIFE SWITCHES WITH HORIZONTALLY LAMINATED STUDS

Without Quick-Break Blades **Not Fused**

MAXIMUM AMPERES						Poles	SINGLE THROW				DOUBLE THROW			
30° Rating			20° Rating				Approx. Wt., Lb.		Style No.	List Price	Approx. Wt., Lb.		Style No.	List Price
D. C.	A. C. 25 Cycle	A. C. 60 Cycle	D. C.	A. C. 25 Cycle	A. C. 60 Cycle		Net	Ship.			Net	Ship.		
250 Volts D. C. or 500 Volts A. C.														
1600	1400	1200	1300	1200	1100	1	38	59½	260410	$ 38 50	54	84½	260490	57 20
						2	76	116	260411	70 00	114	174	260491	104 00
						3	114	171	260412	105 00	168	252	260492	156 00
						4	156	257	260413	146 00	222	366	260493	208 00
2000	1800	1600	1600	1400	1200	1	42	65½	260218	52 80	59	92	260298	79 20
						2	84	129	260219	96 00	118	181	260299	144 00
						3	124	186	260220	144 00	178	268	260300	216 00
						4	165	282	260221	192 00	236	390	260301	288 00
3000	2600	2200	2400	2000	1800	1	52	81	259622	128 00	82	128	259682	188 00
						3	146	219	259624	350 00	245	369	259684	521 00
4000	3400	2800	3200	2700	2200	1	102	159	259954	188 00	139	217	259994	264 00
6000	4200	3800	4500	3200	2800	1	159	248	260110	250 00	235	367	260130	368 00
600 Volts D. C. or A. C.														
1600	1400	1200	1300	1200	1100	1	40	62½	260394	$ 64 90	56	87½	260458	98 05
						2	80	123	260395	122 50	118	181	260459	163 60
						3	121	182	260396	165 60	173	260	260460	212 10
						4	165	272	260397	239 70	228	376	260461	311 40
2000	1800	1600	1600	1400	1200	1	43	67	260202	87 75	61	95	260266	126 70
						2	86	132	260203	162 90	122	187	260267	215 30
						3	129	194	260204	237 55	183	275	260268	296 35
						4	172	284	260205	304 80	243	400	260269	436 90
3000	2500	2200	2400	2000	1800	1	54	84	259610	218 00	84	131	259658	282 00
						3	162	252	259612	595 00	251	376	259660	781 00
4000	3400	2800	3200	2700	2200	1	105	164	259946	320 00	142	222	259978	396 00
6000	4200	3800	4500	3200	2800	1	165	257	260106	425 00	238	372	260122	552 00

Style number and list price include switch with satin finish, without base, stops or terminals; complete with spade handles on all 3 and 4 pole switches and straight handles on all single and double pole switches; and with standard mounting screws for mounting the switches on bases 2 inches thick.

For additional price for switches with polished finish or reduction in price for switches with plain finish refer to the discount sheets, Catalog 1-B Part 1.

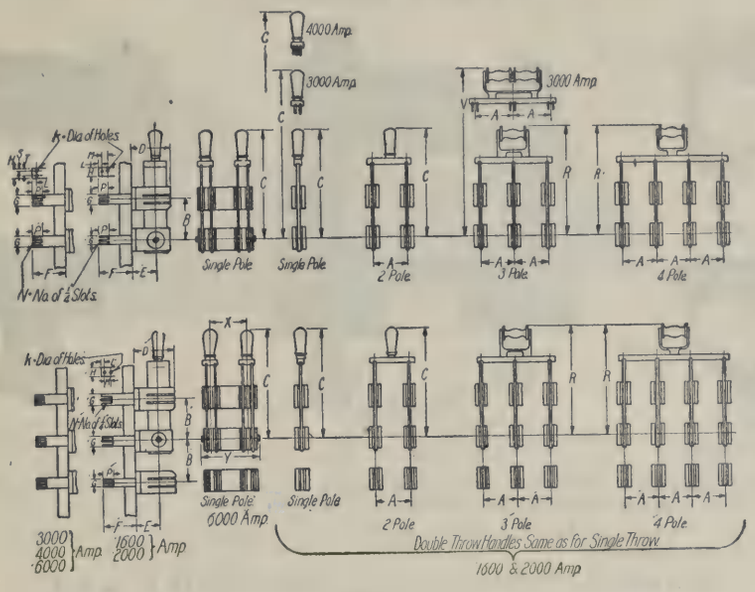
For switches mounted on wood templates, slate bases or black marine bases of standard sizes, add 10, 15 or 20 per cent respectively to the list price.

For special spade handles refer to the list at the end of the knife switch tables.

For stops refer to the list at the end of the knife switch tables.

KNIFE SWITCHES—Continued

TYPE A REAR-CONNECTED WITH LAMINATED STUDS



	Amps.		Dimensions—Inches																		
	D. C.	A. C.	A	B	C	D	E	F	G	H	K	L	M	N	P	R	S	T	V	No. of Bl. per P.	X	Y
250 V. D. C. 500 V. A. C.	1600	1200	5¼	6¾	15 13/16	6¼	3¾	5½	1¼	1¼	7/16	13/32	15/16	2	1⅞	16 5/16	...	...	.....	.....	...	...
	2000	1600	5⅝	6¾	15 13/16	6⅜	3⅞	5½	1¼	1¾	7/16	13/32	15/16	2	1⅞	16 5/16	...	...	.....	.....	...	...
	3000	2200	6¼	6¾	15 13/16	6¼	3¾	6½	2¼	2½	9/16	3/4	..	4	1⅝	.....	½	1½	16 5/16	.....	...	...
	4000	2800	...	6¾	15 13/16	6⅜	3⅞	6½	2¾	3	9/16	3/4	..	5	1⅝	.....	⅝	1¾	.....	3	...	...
	6000	4000	...	7¼	16 7/16	6⅝	4⅛	7	3¾	4	9/16	3/4	..	7	1⅝	.....	1	2	.....	4	4½	8¼
600 V. D. C. 600 V. A. C.	1600	1200	7	8¾	17 13/16	6¼	3¾	5½	1¼	1¼	7/16	13/32	15/16	2	1⅞	18 5/16	...	...	.....	.....	...	...
	2000	1600	7⅜	8¾	17 13/16	6⅜	3⅞	5½	1¼	1¾	7/16	13/32	15/16	2	1⅞	18 5/16	...	...	.....	.....	...	...
	3000	2400	7¾	8¾	17 13/16	6¼	3¾	6½	2¼	2½	9/16	3/4	..	4	1⅝	.....	½	1½	18 5/16	.....	...	...
	4000	2800	...	8¾	17 13/16	6⅜	3⅞	6½	2¾	3	9/16	3/4	..	5	1⅝	.....	⅝	1¾	.....	3	...	...
	6000	4000	...	8¾	17 13/16	6⅝	4⅛	7	3¾	4	9/16	3/4	..	7	1⅝	.....	1	2	.....	4	4½	8¼

SPADE HANDLES FOR TYPES A AND C FRONT AND REAR-CONNECTED KNIFE SWITCHES

STYLE No. 272989

STYLE No. 272987

STYLE No. 272994

STYLE No. 272993

Style number and list price include mounting screws. List prices are in addition to the regular list prices of complete switches, except on switches regularly equipped with spade handles.

Type of Switch	Amperes	Poles	Style No.	List Price
		250 Volts D. C. or 500 Volts A. C. and 600 Volts D. C. or A. C.		
A and C	30 and 60	2 or 4	272987	$0 48
A and C	30 and 60	3	272989	48
A and C	100 and 200	2 or 4	272988	75
A and C	100 and 200	3	272990	75
A	400 to 600	2 or 4	272991	1 20
A	400 to 600	3	272992	1 20
		250 and 600 Volts D. C.*		
A	800 to 2000	2 or 4	272993	2 25
A	800 to 2000	3	272994	2 25
A	2400 to 4000	2 or 4	272995	3 00
A	2400 to 3000	3	272996	3 00

*For A. C. capacities see list of A. C. capacities corresponding to each D. C. capacity given above, for each Style No. of complete switch.

STOPS FOR TYPE A KNIFE SWITCHES

Front or rear-connected 250 or 600 volts. This attachment will stop the switch when open at an angle of 90 degrees, and will prevent the blade from swinging all the way back.

Stops are often required on switchboard and other work where the space is limited and switches or other live parts are brought close together as would be caused by throwing the switch all the way back, allowing it to come in contact with live parts of other apparatus underneath the switch. On double-throw switches, the stop is many times required to prevent the blade from engaging the lower contacts of the switch when it is desired to have both throws "dead."

The stops listed below can be added to the standard switches by removing the hinge screw and nut and placing the stop next to the jaw blade under the cup washer and replacing the hinge screw and nut. Stops cannot be furnished for addition to 30 and 60-ampere switches which have been built, due to the difference in construction from the higher capacity switches; namely, that a rivet is used instead of a screw. Stops for 30 and 60-ampere switches can be supplied on order with the switch; price on request.

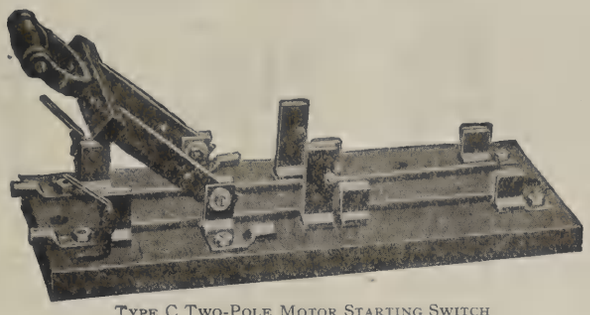
90 DEGREE STOPS

Amp.	Single Throw Without or With Quick Break Style No.	Double Throw Without Quick Break Style No.	Double Throw With Quick Break Style No.	Amp.	Single Throw Without or With Quick Break Style No.	Double Throw Without Quick Break Style No.	Double Throw With Quick Break Style No.
100	286886	286899	286911	1200	286892	286905	286917
200	286887	286900	286912	1600	286893	286906	286918
400	286889	286902	286914	2000	286993	286906	286918
600	286890	286903	286915	3000	286985	286908	286920
800	286891	286904	286916	4000	286895	286908	286920
1000	286892	286905	286917	6000	286896	286909	286921

Prices on stops will be supplied on request

Order by Style Number

TYPES A AND C MOTOR STARTING SWITCHES



TYPE C TWO-POLE MOTOR STARTING SWITCH

APPLICATION

The starting current of induction motors is several times the normal running current and, when the controlling switch is fused to carry the running load only, the fuses are apt to blow on starting. The fuses must be of a capacity to prevent overloads under running conditions. These switches are designed to meet this difficulty and are used without auto-starters to control motors up to 5-horse-power rating.

CONSTRUCTION

These switches are arranged for National Electric Code Fuses on one end only and have springs on the other end to open the switch automatically if left closed at this end. The corresponding terminals at both ends of the switch are connected so that the wiring need be connected to one set of these terminals only, thus decreasing the number of connections necessary. See accompanying diagram.

In starting an induction motor by this switch, the switch is thrown to the end that is not fused and held there until the motor is up to running speed; then it is quickly thrown to the fused position, thus protecting the circuit under running conditions.

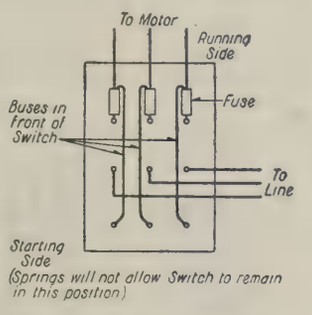


DIAGRAM OF CONNECTIONS FOR THREE-POLE SWITCH

PRICES

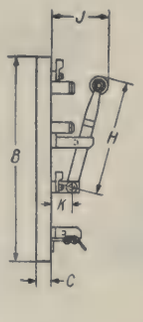
Switches Fused at One End Only, With Spring Throw-Out at Other End

Style number and price include switch without fuses

		Two Pole			Three Pole			Four Pole		
Amp.	Volts	Wt. Lb. Boxed	Style No.	List Price	Wt. Lb. Boxed	Style No.	List Price	Wt. Lb. Boxed	Style No.	List Price
					Type A Switches					
30	250	8	228490	$ 4 15	12	228492	$ 5 50	16	228494	$ 7 30
60	250	12½	228491	5 50	18	228493	7 30	25	228495	9 75
30	500	19	228496	5 25	28	228498	7 00	38	228500	9 30
60	500	25	228497	6 50	37	228499	8 60	50	228501	11 50
30	600	....	.....	.....	35	182945	9 00	....	.....	.....
					Type C Switches					
30	250	8	228502	3 75	12	228504	5 00	15½	228506	6 70
60	250	12	228503	4 75	17	228505	6 30	22½	228507	8 40
100	250	15½	254648	9 90	24	254649	13 20	....	.....	.....
30	500	13	228508	4 50	18	228510	6 00	27	228512	8 00
60	500	13¼	228509	5 60	18½	228511	7 50	27½	228513	10 00

TYPES A AND C MOTOR STARTING SWITCHES—Continued

TYPE A SWITCHES



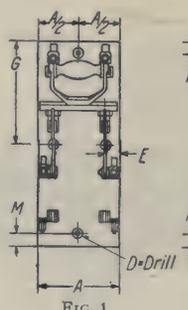


FIG. 1

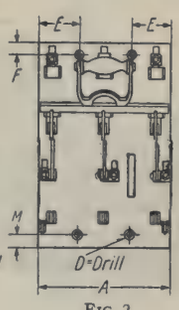


FIG. 2

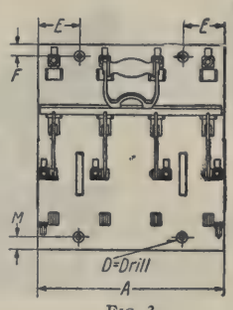
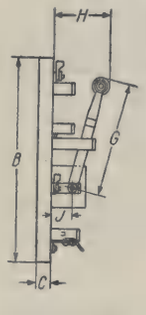


FIG. 3

Fig.	Amp.	Volts	Poles	Dimensions in Inches A	B	C	D	E	F	G	H	J	K	M
1	30	250	2	6	10 1/2	3/4	9/32	1 1/2	5/8	4 3/4	6 9/16	3 3/8	1 3/16	1 1/8
2	30	250	3	9	10 1/2	3/4	9/32	3	5/8	...	6 9/16	3 3/8	1 3/16	1 1/8
3	30	250	4	12	10 1/2	3/4	9/32	3	5/8	...	6 13/16	3 13/32	1 3/16	1 1/8
1	30	500	2	6	14	3/4	9/32	1 1/2	1 1/16	4	6 9/16	3 3/8	1 3/16	1 1/16
2	30	500	3	9	14	3/4	9/32	3	1 1/16	...	6 9/16	3 3/8	1 3/16	1 1/16
3	30	500	4	12	14	3/4	9/32	3	1 1/16	...	6 13/16	3 13/32	1 3/16	1 1/16
2	30	600	3	12	17	1	9/32	3 5/8	1 1/16	...	8 5/16	3 1/16	1 3/16	1 1/16
1	60	250	2	6	12	3/4	9/32	1 1/2	1 1/16	3 1/16	6 9/16	3 3/8	1 3/16	1 1/16
2	60	250	3	9	12	3/4	9/32	3	1 1/16	...	6 9/16	3 3/8	1 3/16	1 1/16
3	60	250	4	12	12	3/4	9/32	3	1 1/16	...	6 13/16	3 13/32	1 3/16	1 1/16
1	60	500	2	6	14	3/4	9/32	1 1/2	1 1/4	4 3/4	6 9/16	3 3/8	1 3/16	1 1/16
2	60	500	3	9	14	3/4	9/32	3	1 1/4	...	6 9/16	3 3/8	1 3/16	1 1/16
3	60	500	4	12	14	3/4	9/32	3	1 1/4	...	6 13/16	3 13/32	1 3/16	1 1/16

TYPE C SWITCHES



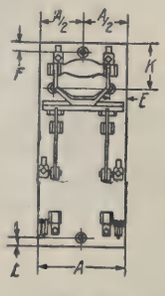


FIG. 1

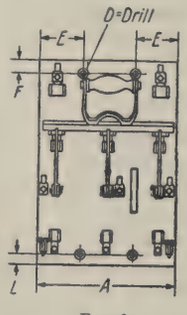


FIG. 2

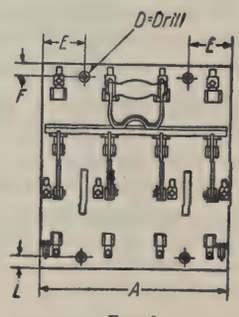


FIG. 3

Fig.	Amp.	Volts	Poles	Dimensions in Inches A	B	C	D	E	F	G	H	J	K	L
1	*30	250	2	6	10 1/2	3/4	9/32	1 1/2	9/16	6 9/16	3 11/16	1	4 7/8	1
2	*30	250	3	9	10 1/2	3/4	9/32	3	9/16	6 9/16	3 11/16	1	...	1
3	*30	250	4	12	10 1/2	3/4	9/32	3	9/16	6 13/16	3 25/32	1	...	1
1	*30	500	2	6	14	3/4	9/32	1 1/2	1 1/32	6 9/16	3 11/16	1	4	1 1/32
2	*30	500	3	9	14	3/4	9/32	3	1 1/32	6 9/16	3 11/16	1	...	1 1/32
3	*30	500	4	12	14	3/4	9/32	3	1 1/32	6 13/16	3 25/32	1	...	1 1/32
1	60	250	2	6	12	3/4	9/32	1 1/2	1 1/32	6 9/16	3 11/16	1	3	1 1/32
2	60	250	3	9	12	3/4	9/32	3	1 1/32	6 9/16	3 11/16	1	...	1 1/32
3	60	250	4	12	12	3/4	9/32	3	1 1/32	6 13/16	3 25/32	1	...	1 1/32
1	60	500	2	6	14	3/4	9/32	1 1/2	1 3/8	6 9/16	3 11/16	1	4 3/4	1
2	60	500	3	9	14	3/4	9/32	3	1 3/8	6 9/16	3 11/16	1	...	1
3	60	500	4	12	14	3/4	9/32	3	1 3/8	6 13/16	3 25/32	1	...	1
1	100	250	2	6	16	1	5/16	1 7/16	1 1/16	7 15/32	3 3/4	1 1/8	4 3/8	1 1/16
2	100	250	3	10 1/2	16	1	5/16	3 11/16	1 1/16	7 15/32	3 3/4	1 1/8	...	1 1/16

*Supplied with terminal washers instead of tube terminals as shown.

APPLICATION DATA FOR FUSES AND KNIFE SWITCHES

Fuses for Use With Direct-Current Motors, Based on 25% Overload

H. P. Rating	115 Volts, Motor Voltage		230 Volts, Motor Voltage		550 Volts Motor Voltage	
	Style No.	Amp.	Style No.	Amp.	Style No.	Amp.
1	37160	10	37157	5	37187	3
1½	37162	15	37159	8	37187	3
2	37163	20	37160	10	37189	5
2½	37164	25	37161	12	37190	6
3	37165	30	37162	15	37190	6
3½	37166	35	37163	20	37190	6
5	37169	50	37164	25	37192	10
6½	184111	65	37165	35	37194	15
7½	184112	70	37165	35	37194	15
8½	37172	85	37168	45	37195	20
10	184114	90	37168	45	37195	20
11	37173	100	184110	55	37196	25
12½	184116	110	37160	60	37196	25
15	37174	125	184112	70	37197	30
20	37176	175	184114	90	37198	35
25	37178	225	184116	110	37200	45
30	184118	275	37174	125	184125	55
35	.....	325	37175	150	184126	65
40	.....	350	37176	175	37203	75
50	.....	450	37178	225	184130	95
60	.....	550	.....	...	184131	110
75	.....	...	.....	...	37207	150
100	.....	...	.....	...	37209	200

For other horse-power and voltage ratings, use size of fuses in proportion, i. e., for higher voltages use smaller ampere rating on fuses, etc.

Fuses and Knife Switches for Use With Wound Rotor Induction Motors

H. P. Rating	Switch		Fuse		Switch		Fuse	
	Style No.	Amp.	Style No.	Amp.	Style No.	Amp.	Style No.	Amp.
	Two-Phase Alternating Current							
	220 Volts, Motor Voltage				**440 Volts, Motor Voltage**			
5	228370	30	37163	20	228410	30	37191	8
7½	228370	30	37164	25	228410	30	37194	15
10	228371	60	37166	35	228410	30	37195	20
15	228371	60	37168	45	228410	30	37196	25
20	228371	60	37170	60	228410	30	37197	30
25	228372	100	184112	70	228411	60	37198	35
30	228372	100	184114	90	228411	60	37200	45
35	228373	200	184116	110	228411	60	184125	55
40	228373	200	184117	120	228411	60	37202	60
50	228373	200	37175	150	228412	100	184127	70
	Three-Phase Alternating Current							
	220 Volts, Motor Voltage				**440 Volts, Motor Voltage**			
5	228366	30	37163	20	228406	30	37192	10
7½	228366	30	37165	30	228406	30	37194	15
10	228367	60	37167	40	228406	30	37195	20
15	228367	60	37169	50	228406	30	37196	25
20	228368	100	184112	70	228407	60	37198	35
25	228368	100	37172	85	228407	60	37199	40
30	228368	100	37173	100	228407	60	37201	50
35	228369	200	37174	125	228407	60	37202	60
40	228369	200	37175	150	228408	100	184127	70
50	228369	200	37176	175	228408	100	184128	80

550 Volts, Motor Voltage

H. P. Rating	Switch		Fuse		H. P. Rating	Switch		Fuse	
	Style No.	Amp.	Style No.	Amp.		Style No.	Amp.	Style No.	Amp.
5	228462	30	37191	8	25	228463	60	37198	35
7½	228462	30	37193	12	30	228463	60	37199	40
10	228462	30	37194	15	35	228463	60	37201	50
15	228462	30	37195	20	40	228463	60	27202	60
20	228462	30	37197	30	50	228464	100	184126	65

APPLICATION DATA FOR FUSES AND KNIFE SWITCHES—Continued

Fuses and Knife Switches for Use With Squirrel Cage Induction Motors

H. P. Rating	Switch		Fuse		Switch		Fuse	
	Style No.	Amp.	Style No.	Amp.	Style No.	Amp.	Style No.	Amp.
Two-Phase Alternating Current								
	110 Volts, Motor Voltage				**220 Volts, Motor Voltage**			
½	228370	30	37160	10	228370	30	37158	6
1	228370	30	37163	20	228370	30	37160	10
2	228371	60	37166	35	228370	30	37162	15
3	228371	60	37168	45	228370	30	37164	25
5	228372	100	184113	80	228371	60	37167	40
	440 Volts, Motor Voltage							
½	228410	30	37187	3	.....	...	.....	...
1	228410	30	37189	5	.....	...	.....	...
2	228410	30	37192	10	.....	...	.....	...
3	228410	30	37194	15	.....	...	.....	...
5	228410	30	37195	20	.....	...	.....	...
Three-Phase Alternating Current								
	110 Volts, Motor Voltage				**220 Volts, Motor Voltage**			
½	228366	30	37161	12	228366	30	37158	6
1	228366	30	37163	20	228366	30	37160	10
2	228367	60	37166	35	228366	30	37163	20
3	228367	60	37169	50	228366	30	37165	30
5	228368	100	184114	90	228367	60	37168	45
	440 Volts, Motor Voltage				**550 Volts, Motor Voltage**			
½	228406	30	37187	3	228462	30	37186	2
1	228406	30	37189	5	228462	30	37188	4
2	228406	30	37192	10	228462	30	37191	8
3	228406	30	37194	15	228462	30	37193	12
5	228406	30	37196	25	228462	30	37195	20

Fuses and Knife Switches for Use With Type AR Induction Motors

Single-Phase Alternating Current

H. P. Rating	Switch		Fuse		Switch		Fuse	
	Style No.	Amp.	Style No.	Amp.	Style No.	Amp.	Style No.	Amp.
WITHOUT RHEOSTAT								
	110 Volts, Motor Voltage				**220 Volts, Motor Voltage**			
2	228364	100	184113	80	228363	60	37167	40
3	228365	200	184117	120	228363	60	37170	60
5	228365	200	37177	200	228364	100	37173	100
7½	227985	400	184119	325	228365	200	37176	175
10	227985	400	37182	400	228365	200	37177	200
Fuses for Four Times Full-Load Current								
½	228362	30	37163	20	228362	30	37160	10
¾	228362	30	37165	30	228362	30	37162	15
1	228363	60	37167	40	228362	30	37163	20
WITH RHEOSTAT								
2	228363	60	37167	40	228362	30	37163	20
3	228363	60	37170	60	228362	30	37165	30
5	228364	100	37173	100	228363	60	184110	55
7½	228365	200	37176	175	228364	100	184113	80
10	228365	200	37170	200	228364	100	37173	100
Fuses for Twice Full-Load Current								
½	228362	30	37160	10	228362	30	37158	6
¾	228362	30	37162	15	228362	30	37159	8
1	228362	30	37163	20	228362	30	37160	10

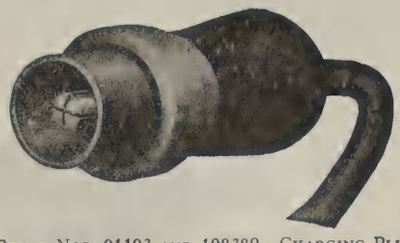
TWO-WIRE CHARGING RECEPTACLES AND PLUGS

These receptacles and plugs are used in automobile garages, roundhouses, factories, and wherever it is desirable to have a detachable connection, as on a battery-charging circuit. Two styles are listed; one especially adaptable to heavy automobile service, such as auto-trucks; the other for roundhouse and factory service. For additional single circuit fittings see Section 6-B under "Bus Line Receptacles and Jumpers."

AUTO-TRUCK TYPE

100 Amperes—250 Volts

STYLE NO. 136468—CHARGING RECEPTACLE



STYLE NOS. 91193 AND 108380—CHARGING PLUG

This receptacle and plug are made for heavy service. Although particularly adapted for use with electric auto-trucks, their durable construction makes them desirable for use in all battery charging service on vehicles or otherwise. The insulation of both receptacle and plug is such that it is practically impossible to short-circuit either. Both are simply and strongly made and will stand hard service.

The receptacle consists of a cast-iron shell surrounding a moulded insulating material in which two phosphor-bronze tube-shaped contacts are imbedded concentrically. A hinged lid which is held closed by a spring when the plug is not in place makes the receptacle dust-proof. Cables are readily attached at the rear by soldering into the removable part of the screw connectors furnished.

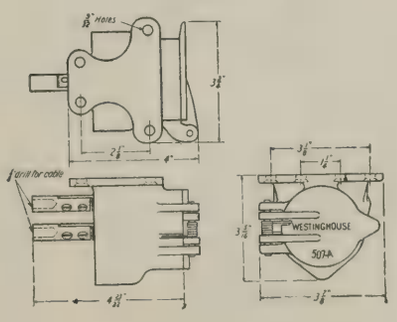
The body of the **plug** is of moulded insulating material and the handle is of wood; the two contact parts are of the best hard-drawn copper; the other metallic parts are of brass. The center contact is a pin with two saw cuts at right angles. This pin is held firmly in place by the insulating body in which it is mounted. The outer contact is tubular in shape and is supported on the same insulating body as the center contact. A sleeve of spun brass covers this insulating material and clamps it to the body of the plug.

PRICES

Style number and list price include the receptacle or plug as described.

Style No	Description	Approx. Wt., Lb. Net	Approx. Wt., Lb. Shipping	List Price
136468	Type 507 charging receptacle, without cable	4	8	$5 85
91193	Type 508-A charging plug, with two 11-foot cables	7	14	10 35
108380	Type 508-A charging plug with two 1-foot cables	3	6	5 85

OUTLINE DIMENSIONS



Order by Style Number

CHARGING RECEPTACLES AND PLUGS—Continued

ROUNDHOUSE AND FACTORY TYPE

25 Amperes—250 Volts

This receptacle and plug are especially adapted for hard service and rough usuage. It is used in engine houses and in other places where particularly strong and durable apparatus is desired.

In construction the **receptacle** consists of a cast-iron shell containing two copper contacts mounted in a fireproof insulating block. The terminals of these contacts are thoroughly insulated from each other by an insulating compound which is poured into the shell when liquid, and fills, when cold, every part of the interior. Short-circuiting between terminals of the receptacle is therefore impossible. The back of the receptacle furnished without cables is threaded for ¾-inch pipe to enable its use on a conduit system.

The **plug** consists of a cast-iron shell containing two split copper pins, imbedded in insulating material. A short-circuit is impossible between the pins. When the plug is inserted in the receptacle it is held in place by a spring clip.

STYLE NO. 112537 CHARGING PLUG

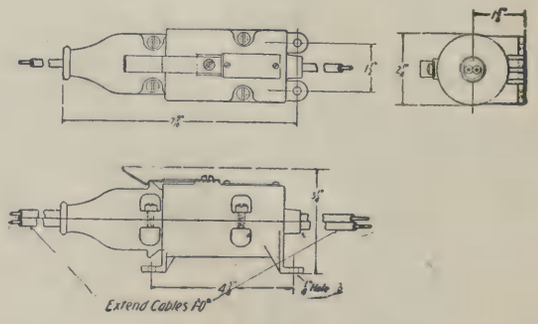
STYLE NO. 112538 CHARGING RECEPTACLE

PRICES

Style number and list price include the receptacle or plug complete as described, except that where furnished without cables, the insulating compound around the terminals must be put in by the purchaser after inserting the cables.

Style No.	Description	Approx. Wt., Lb. Net	Approx. Wt., Lb. Shipping	List Price
104391	Charging plug, without cable	3	6	$2 50
112537	Charging plug, with two 1-foot cables	4	∎	3 25
104392-C	Charging receptacle, without cable	4	6	3 50
112538	Charging receptacle, with two 1-foot cables	5	∎	4 25

OUTLINE DIMENSIONS



Order by Style Number

KNUCKLE-JOINT CONNECTORS

DETACHABLE

PIVOT-TYPE

SEGMENT-PIN-TYPE

Knuckle-joint connectors are used extensively as separable connectors between railway-motor leads and the car body wiring in order to facilitate removal of the trucks. They are also often used for connecting wiring between halves of railway motors and in other places where quickly detachable connectors are desirable.

These connectors consist of brass, and are made in two parts, each part being soldered to the respective wire to be connected. After the wires are soldered into the connectors, no tools are required for connecting or disconnecting, since simply straightening out the two halves by hand clamps the parts tightly together and the opposite operation unclamps them. To insulate the joint, it is only necessary to draw a piece of rubber tubing over connector or tape it in usual manner.

Two types are listed; the pivot-type and the segment-pin-type. One half of the **pivot-type** has a central pin engaging with a hole in the other half. Connectors of this type, therefore, require mating. The **segment-pin-type** has an ingenious arrangement which permits coupling any two halves together, besides which there is an additional interchangeability between connectors of the same diameter. Connectors of this latter type have counterbored holes to receive some of the cable insulation.

Besides the connectors listed in the following tables, connectors can be supplied drilled for different size cables at either end. Special connectors not listed, can be supplied; give full information as to size of cable, drilling of connector and type of connector.

Style number and list price include connector, consisting of the two halves, complete with drilling as specified.

Style No.	Nominal Capacity in Amperes	Takes Wire or Cable up to B & S Gauge	List Price
		Pivot-Type	
47941	25	No. 10	$0 30
43105	40	7	30
47889	55	3	35
43107	80	2	50
123692	90	1	50
198699	110	00	50
157649	125	000	1 20
11557	125	(Starting Drill)	1 55
11559	150	00	2 40
26666	175	000	2 55
164673	200	0000	2 30
112127	215	250,000	2 30
122659	250	400,000	3 50
159520	300	650,000	4 00
		Segment-Pin-Type	
7655	75	No. 2	1 30
35373	100	00	1 30
91383	125	0000	2 70
41595	150	200,000	2 70
99038	200	350,000	3 85

Approximate weight knuckle-joint connector net ¾ pounds, shipping weight 1 pound.

Order by Style Number

OUTLINE DIMENSIONS

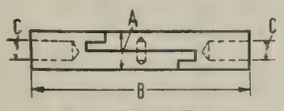


FIG. 1—PIVOT-TYPE

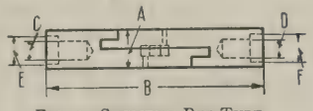


FIG. 2—SEGMENT-PIN-TYPE

Style No.	Fig.	A	B	C
47941-A	1	5/16	2 1/2	1/8
43105	1	5/16	2 1/2	5/16
47889	1	7/16	2 3/4	9/32
43107	1	9/16	3 1/4	5/16
123692	1	9/16	3 1/4	3/8
198699	1	9/16	3 1/4	7/16
157649	1	3/4	3 1/4	13/32
*11557	1	3/4	5	9/32
*11559	1	1	5	7/16
*26666	1	1	5	1/2
164673	1	1	*4 15/16	5/8
122659	1	1 1/4	5 1/4	3/4
159520	1	1 1/4	6	13/16

Style No.	Fig.	A	B	C	D	E	F
7655-A	2	3/4	5 3/4	5/16	5/16	17/32	17/32
35373-A	2	3/4	5 3/4	13/32	13/32	9/16	9/16
91383	2	15/16	6 3/8	1/2	1/2	5/8	5/8
41728	2	15/16	6 3/8	1/2	5/8	3/4	3/4
41595	2	15/16	6 3/8	5/8	5/8	3/4	3/4
99038	2	1	7	3/4	3/4	25/32	25/32

*Has ends counter bored to receive cable insulation also.

These dimensions are for reference only. For official dimensions apply to the nearest district office.

CUTTER STEEL SERVICE AND CUT-OUT BOXES

Schedule O—Standard Package, 5 of One Size

SPECIFICATIONS

The following specifications apply to all Cutter Cut-out Boxes:

Cutter Steel Service and Cut-out Boxes are formed up from a single piece of sheet steel and electrically welded. There are no rivets to work loose.

Finished with high grade black enamel paint.

Underwriters' label on every box—approved by the National Board of Fire Underwriters.

Four $\frac{5}{16}$-inch holes, one inch from each corner, for fastening cabinet in place.

STOCK CUT-OUT BOXES

The following specifications apply only to stock cut-out boxes listed below and cannot be changed:

Doors overlap boxes on all four sides and are hinged on right-hand side.

Made for surface mounting.

Large quantities in stock for prompt shipment.

PRICE LIST OF STOCK CUT-OUT BOXES

No. 16 U. S. Gauge Steel Cut-out Boxes

With $\frac{7}{8}$-inch Knock-outs for $\frac{1}{2}$-inch Conduit Pipes

Width Inches	Length Inches	Trade No.	List Price, Each — 3 Inches Deep	Trade No.	4 Inches Deep	Trade No.	5 Inches Deep	Trade No.	6 Inches Deep
4	6	W30857	$0 55	.....	*	.....	*	.....	*
4	8	W30859	60	W30860	$0 80	.....	*	.....	*
4	10	.....	*	W30862	80	.....	*	.....	*
6	6	W30863	65	W30864	75	.....	*	.....	*
6	8	W30865	70	W30866	80	.....	*	.....	*
6	10	W30867	80	W30868	90	W30869	$1 65	.....	*
6	12	.....	*	W30871	1 00	.....	*	.....	*
6	16	.....	*	W30873	1 55	.....	*	.....	*
8	8	W30874	80	W30875	90	.....	*	.....	*
8	10	W30876	85	W30877	1 00	.....	*	.....	*
8	12	W30878	95	W30879	1 10	.....	*	.....	*
8	14	W30880	1 45	W30881	1 60	.....	*	.....	*
8	16	.....	*	W30883	1 30	.....	*	.....	*
9	9	W30884	1 30	W30885	1 50	.....	*	.....	*
10	10	W30886	1 00	W30887	1 10	.....	*	.....	*
10	12	W30888	1 10	W30889	1 25	.....	*	.....	*
10	16	.....	*	W30891	1 45	.....	*	W30892	$2 20
10	18	.....	*	W30893	1 55	.....	*	.....	*
12	12	.....	*	W30894	1 35	.....	*	.....	*
12	16	.....	*	W30895	1 60	.....	*	.....	*
12	18	.....	*	W30896	1 70	.....	*	.....	*
12	20	.....	*	W30897	2 25	.....	*	.....	*
12	24	.....	*	W30898	2 35	.....	*	.....	*

*Not carried in stock. See price list on following page.

Special Prices:

No. 30899, 4½ x 9 x 3½ box hinged at top instead of right hand side (with ⅞-inch knock-outs)..... $0 60
When ordered in lots of 50, or with 10 or more standard packages of stock boxes, use list price of..... 55

No. 16 U. S. Gauge Steel Cut-out Boxes

With Combination Knock-outs

One row of ⅞-inch knock-outs for ½-inch conduit pipe and one row of $\frac{11}{16}$-inch knock-outs for ¼-inch circular loom are furnished in the following boxes which are carried in stock.

Trade No.	Dimensions	Price Each
W30900	6 inches wide, 8 inches long, 4 inches deep	$1 05
W30901	8 inches wide, 10 inches long, 4 inches deep	1 25
W30902	10 inches wide, 12 inches long, 4 inches deep	1 50
W30903	10 inches wide, 16 inches long, 4 inches deep	1 70

No. 14 U. S. Gauge Steel Cut-out Boxes

With Standard ⅞-inch Knock-outs for ½-inch Conduit Pipe

Doors overlap boxes on all four sides and are hinged on right hand (long) side.

Four $\frac{5}{16}$-inch holes (1 inch from each corner) are provided for fastening box in place.

Trade No.	Dimensions	Price Each
W30904	12 inches wide, 30 inches long, 4 inches deep	$4 15
W30905	18 inches wide, 24 inches long, 4 inches deep	4 60
W30906	18 inches wide, 36 inches long, 4 inches deep	6 30
W30907	18 inches wide, 42 inches long, 4 inches deep	7 10
W30908	18 inches wide, 48 inches long, 4 inches deep	7 75

If any deviation is made in the aforementioned specifications or if other sizes are required, the prices should be taken from the pages following listing made-to-order boxes.

CUTTER STEEL SERVICE AND CUT-OUT BOXES

MADE TO ORDER CUT-OUT BOXES—Schedule O

Boxes listed on the following pages are not regularly carried in stock but are made to order.

The following specifications apply:

KNOCKOUTS: Unless otherwise ordered, boxes will be furnished with standard ⅞-inch knockouts for ½-inch conduit pipes. For knockouts other than standard, add 10 cents list per box for each change in size of knockout. Knockouts for loom will be furnished when ordered, without additional charge, provided all knockouts in the same box are of the same size.

Sketch with order, showing size and location of knockouts, will avoid errors and delays.

MOUNTING: Made for surface mounting unless otherwise specified. For flush mounted boxes add 50 percent to list price and specify "Flush Boxes" on the order.

DOORS: Unless otherwise ordered, all boxes will be furnished with hinged doors. Boxes ordered with covers fastened on with screws take same list prices as surface type boxes. Unless otherwise ordered, box doors will be made with all four sides overlapping and hinged on right-hand side. Doors will be hinged at top when so ordered, without additional charge.

For hasp and staple on door, add 60 cents each list. For boxes with doors omitted, deduct 20 percent from the list. For boxes with sloping bottom, add 50 percent to list. For commode catch, add 40 cents list to prices of boxes less than 6 inches deep; boxes over 6 inches deep are regularly furnished with commode catch. Prices of galvanized boxes will be quoted on application. For nickel-plated vault handle, add $1.00 list. For Yale cylinder lever lock, add 70 cents list. For master keyed cylinder lever lock, add $1.00 list. For master keys, add 75 cents list for each key. For spring hinges on doors, add 30 cents list per hinge. (All boxes less than 32 inches long require 2 hinges; No. 14 U. S. Gauge Steel boxes over 32 inches long require 3 hinges; No. 12 and 10 U. S. Gauge steel boxes over 36 inches long require 3 hinges; all boxes over 54 inches long require 4 hinges.)

WEATHER BOXES: For weatherproof boxes, galvanized according to Underwriters' code, add 200 percent to list price if made of 12 or 14 U. S. gauge steel; add 150 percent if made of No. 10 U. S. gauge steel, each box to bear Underwriters' label. For plain steel boxes with overhanging and sloping roof, painted black, add 50 percent. (Plain weatherproof boxes do not bear Underwriters' label. All other Cutter cut-out boxes are labeled).

PRICE LIST OF NO. 16 U. S. GAUGE STEEL BOXES

UNDERWRITERS' REQUIREMENTS { No one dimension to exceed 24 inches. No one surface to exceed 360 square inches.

Width Inches	Length Inches	Depth, Inches 3	4	5	6	8	9	10	12	14	15
4	4	$1 05	$1 20	$1 35	$1 55	.....	.....	.....	.....	.....	.....
4	6	1 15	1 30	1 45	1 65	.....	.....	.....	.....	.....	.....
4	8	1 25	1 40	1 60	1 80	.....	.....	.....	.....	.....	.....
4	10	1 35	1 50	1 75	1 90	.....	.....	.....	.....	.....	.....
6	6	1 25	1 45	1 60	1 80	.....	.....	.....	.....	.....	.....
6	8	1 40	1 55	1 75	2 00	.....	.....	.....	.....	.....	.....
6	9	1 45	1 60	1 85	2 10	.....	.....	.....	.....	.....	.....
6	10	1 50	1 70	1 90	2 15	.....	.....	.....	.....	.....	.....
6	12	1 60	1 80	2 05	2 30	.....	.....	.....	.....	.....	.....
6	14	1 75	1 95	2 20	2 45	.....	.....	.....	.....	.....	.....
6	15	1 80	2 05	2 25	2 50	.....	.....	.....	.....	.....	.....
6	16	1 85	2 10	2 30	2 60	.....	.....	.....	.....	.....	.....
8	8	1 50	1 70	1 90	2 15	$2 70	$2 80	.....	.....	.....	.....
8	9	1 60	1 80	2 00	2 25	2 80	2 90	.....	.....	.....	.....
8	10	1 70	1 90	2 10	2 35	3 10	3 19	.....	.....	.....	.....
8	12	1 80	2 05	2 25	2 50	3 25	3 35	.....	.....	.....	.....
8	14	1 95	2 15	2 40	2 70	3 55	3 64	.....	.....	.....	.....
8	15	2 00	2 25	2 50	2 75	3 65	3 77	.....	.....	.....	.....
8	16	2 10	2 35	2 60	2 85	3 80	3 95	.....	.....	.....	.....
8	18	2 25	2 50	2 75	3 05	4 10	4 21	.....	.....	.....	.....
8	20	2 45	2 70	3 00	3 35	4 35	4 50	.....	.....	.....	.....
8	22	2 60	2 90	3 20	3 55	4 65	4 80	.....	.....	.....	.....
10	10	1 85	2 05	2 25	2 55	3 25	3 35	$3 50	.....	.....	.....
10	12	2 00	2 25	2 45	2 75	3 66	3 75	3 95	.....	.....	.....
10	14	2 15	2 40	2 55	2 95	3 85	4 00	4 20	.....	.....	.....
10	15	2 25	2 50	2 75	3 05	4 05	4 15	4 35	.....	.....	.....
10	16	2 35	2 60	2 85	3 15	4 20	4 35	4 60	.....	.....	.....
10	18	2 50	2 75	3 05	3 35	4 50	4 65	5 00	.....	.....	.....
10	20	3 05	3 35	3 70	4 05	4 80	4 95	5 30	.....	.....	.....
10	22	3 25	3 55	3 90	4 30	5 00	5 25	5 65	.....	.....	.....
10	24	3 40	3 75	4 15	4 50	5 40	5 55	6 00	.....	.....	.....
12	12	2 20	2 40	2 80	3 10	3 90	4 00	4 30	$4 70	.....	.....
12	14	2 40	2 60	3 00	3 30	4 25	4 35	4 65	5 10	.....	.....
12	15	2 45	2 75	3 10	3 45	4 40	4 55	4 85	5 30	.....	.....
12	16	2 55	2 85	3 25	3 55	4 60	4 70	5 05	5 50	.....	.....
12	18	2 76	3 05	3 45	3 80	4 89	5 05	5 43	5 90	.....	.....
12	20	3 40	3 70	4 05	4 30	5 26	5 50	5 80	6 30	.....	.....
12	22	3 60	3 90	4 30	4 70	5 60	5 75	6 15	6 70	.....	.....
12	24	3 80	4 15	4 50	4 95	5 95	6 10	6 50	7 10	.....	.....
15	16	2 95	3 20	3 65	4 00	5 15	5 30	5 70	6 20	$6 70	$6 95
15	18	3 15	3 45	3 90	4 30	5 55	5 70	6 10	6 50	7 15	7 40
15	20	3 85	4 20	4 55	4 95	5 95	6 10	6 50	7 05	7 60	7 90
15	22	4 10	4 45	4 85	5 25	6 30	6 50	6 90	7 50	8 10	8 40
15	24	4 35	4 75	5 15	5 55	6 70	6 85	7 35	7 95	8 60	8 90
18	18	3 55	3 85	4 40	4 75	6 20	6 35	6 75	7 85	7 90	8 20
18	20	4 30	4 35	4 70	5 10	6 60	6 75	7 20	7 80	8 40	8 75

CUTTER STEEL SERVICE AND CUT-OUT BOXES—Continued

MADE TO ORDER CUT-OUT BOXES—Schedule O

The specifications and prices of special features given at the top of page 119 apply to the boxes listed below

PRICE LIST OF NO. 14 U. S. GAUGE STEEL BOXES

UNDERWRITERS' REQUIREMENTS { No dimension to exceed 48 inches. No one surface to exceed 1200 square inches.

Width Inches	Length Inches	Depth, Inches 3	4	5	6	8	9	12	15	18	22
6	10	$1 90	$2 10	$2 40	$2 70	.....	.....	.....	.....	.....	.....
6	12	2 05	2 30	2 55	2 90	.....	.....	.....	.....	.....	.....
6	14	2 20	2 45	2 75	3 10	.....	.....	.....	.....	.....	.....
6	15	2 25	2 55	2 85	3 20	.....	.....	.....	.....	.....	.....
6	16	2 35	2 65	2 95	3 30	.....	.....	.....	.....	.....	.....
8	10	2 10	2 35	2 65	2 95	.....	.....	.....	.....	.....	.....
8	12	2 30	2 55	2 85	3 20	.....	.....	.....	.....	.....	.....
8	14	2 45	2 75	3 05	3 95	.....	.....	.....	.....	.....	.....
8	15	2 55	2 85	3 20	3 55	.....	.....	.....	.....	.....	.....
8	16	2 65	2 95	3 30	3 65	.....	.....	.....	.....	.....	.....
8	18	2 85	3 15	3 50	3 90	.....	.....	.....	.....	.....	.....
8	20	3 00	3 35	3 70	4 10	.....	.....	.....	.....	.....	.....
8	22	3 20	3 55	3 90	4 30	.....	.....	.....	.....	.....	.....
10	10	2 30	2 60	2 90	3 25	$3 50	$3 70	.....	.....	.....	.....
10	12	2 50	2 80	3 15	3 50	3 95	4 20	.....	.....	.....	.....
10	14	2 75	3 05	3 40	3 75	4 25	4 45	.....	.....	.....	.....
10	15	2 85	3 15	3 50	3 90	4 45	4 65	.....	.....	.....	.....
10	16	2 95	3 30	3 65	4 05	4 60	4 85	.....	.....	.....	.....
10	18	3 30	3 50	3 90	4 30	4 95	5 20	.....	.....	.....	.....
10	20	3 70	4 10	4 50	4 95	5 30	5 60	.....	.....	.....	.....
10	22	3 95	4 35	4 75	5 20	5 65	5 95	.....	.....	.....	.....
10	24	4 20	4 60	5 00	5 50	6 00	6 35	.....	.....	.....	.....
12	12	2 80	3 10	3 40	3 50	4 25	4 45	$5 15	.....	.....	.....
12	15	3 15	3 45	3 85	4 15	4 85	5 10	5 85	.....	.....	.....
12	18	3 55	3 85	4 25	4 65	5 40	5 70	6 55	.....	.....	.....
12	22	4 35	4 75	5 20	5 65	6 25	6 55	7 50	.....	.....	.....
12	24	4 60	5 05	5 50	6 00	6 60	6 95	7 95	.....	.....	.....
12	27	5 15	5 60	6 05	6 55	7 20	7 60	8 65	.....	.....	.....
12	30	5 55	6 00	6 50	7 00	7 80	8 20	9 35	.....	.....	.....
15	15	3 60	3 95	4 35	4 75	5 50	5 80	6 60	$7 45	.....	.....
15	18	4 05	4 40	4 80	5 25	6 15	6 45	7 40	8 30	.....	.....
15	22	5 00	5 40	5 85	6 35	7 05	7 40	8 40	9 55	.....	.....
15	24	5 30	5 75	6 20	6 70	7 50	7 85	8 95	10 05	.....	.....
15	27	5 90	6 35	6 80	7 50	8 15	8 55	9 75	10 90	.....	.....
15	30	6 35	6 80	7 30	7 85	8 85	9 25	10 50	11 80	.....	.....
15	33	6 75	7 30	7 85	8 40	9 55	10 00	11 75	12 60	.....	.....
15	36	7 25	7 75	8 80	8 90	10 20	10 70	12 05	13 45	.....	.....
15	42	8 10	8 70	9 35	10 00	11 55	12 05	13 60	15 15	.....	.....
15	48	9 00	9 70	10 40	11 15	12 90	13 45	15 20	16 90	.....	.....
18	18	4 55	4 95	5 40	5 85	6 90	7 20	8 25	9 25	$10 90	$12 20
18	21	5 55	5 85	6 35	6 85	7 65	8 00	9 10	10 15	11 90	13 45
18	24	6 10	6 40	6 95	7 45	8 35	8 80	9 95	11 10	12 90	14 45
18	27	6 45	7 10	7 60	8 15	9 15	10 00	10 80	12 05	13 90	15 50
18	30	7 10	7 65	8 15	8 75	9 90	10 30	11 60	12 95	14 90	16 65
18	33	7 65	8 40	8 60	9 35	10 65	11 10	12 55	13 90	15 90	17 75
18	36	8 15	9 70	9 35	9 95	11 40	11 90	13 35	14 85	16 90	18 85
18	42	9 20	9 90	10 55	11 10	12 90	13 45	15 10	16 70	18 90	21 00
18	48	10 25	10 90	11 55	12 35	14 45	15 00	16 80	18 60	20 90	23 20
21	21	6 05	6 50	7 05	7 55	8 45	8 80	10 00	11 15	12 95	14 45
21	24	6 60	7 15	7 65	8 20	9 25	9 70	10 95	12 15	14 05	15 75
21	27	7 20	7 85	8 65	8 95	10 10	10 55	11 85	13 15	15 10	16 85
21	30	7 90	8 45	9 05	9 60	10 95	11 40	12 80	14 20	16 20	18 00
21	33	8 50	9 05	9 15	10 25	11 30	12 25	13 75	15 20	17 25	19 20
21	36	9 10	9 70	10 30	12 00	12 60	13 15	14 65	16 40	18 30	20 35
21	42	10 25	10 90	11 55	13 10	14 25	14 90	15 55	18 30	20 45	22 15
21	48	11 45	12 10	12 80	13 55	15 90	16 60	18 40	20 30	22 65	25 05
24	24	7 25	7 90	8 45	9 05	10 15	10 60	11 95	13 25	15 15	17 20
24	27	7 85	8 60	9 15	9 75	11 05	11 55	12 95	14 30	16 30	18 15
24	30	8 70	9 25	9 85	10 50	12 00	12 45	14 00	14 45	17 50	19 40
24	33	9 40	10 00	10 55	11 55	12 90	13 40	15 00	16 50	18 60	20 60
24	36	10 05	10 65	11 25	11 90	13 80	14 35	15 55	17 20	19 35	21 45
24	42	11 65	12 05	12 75	13 70	15 65	16 25	18 05	19 85	22 05	24 30
24	48	12 70	13 35	14 05	14 85	17 40	18 10	20 05	21 95	24 30	26 85

CUTTER STEEL SERVICE AND CUT-OUT BOXES—Continued

MADE TO ORDER CUT-OUT BOXES—Schedule O

The specifications and prices of special features given at the top of page 119 apply to the boxes listed below.

PRICE LIST OF NO. 12 U. S. GAUGE STEEL BOXES

UNDERWRITERS' REQUIREMENTS { No dimension to exceed 48 inches. No one surface to exceed 1200 square inches.

Width Inches	Length Inches	Depth, Inches 4	5	6	8	9	12	15	18	22	24
10	10	$3 25	$3 60	$4 00	$4 55	$4 80	.....	.....	.....	.....	.....
10	12	3 50	3 90	4 30	5 10	5 35	.....	.....	.....	.....	.....
10	15	4 00	4 30	4 75	5 65	5 90	.....	.....	.....	.....	.....
10	18	4 30	4 75	5 25	6 25	6 55	.....	.....	.....	.....	.....
10	20	5 05	5 55	6 10	6 65	7 00	.....	.....	.....	.....	.....
10	24	5 65	6 20	6 45	7 55	7 90	.....	.....	.....	.....	.....
10	27	5 75	6 30	6 85	8 15	8 55	.....	.....	.....	.....	.....
10	30	6 20	6 75	7 35	8 80	9 25	.....	.....	.....	.....	.....
10	33	6 60	7 10	7 85	9 45	9 90	.....	.....	.....	.....	.....
10	36	7 05	7 65	8 30	10 10	10 55	.....	.....	.....	.....	.....
12	12	3 80	4 20	4 65	5 45	5 70	$6 50	.....	.....	.....	.....
12	15	4 20	4 70	5 20	6 15	6 45	7 15	.....	.....	.....	.....
12	18	4 75	5 20	5 70	6 85	7 15	8 15	.....	.....	.....	.....
12	20	5 65	6 05	6 60	7 30	7 65	8 70	.....	.....	.....	.....
12	24	5 90	6 75	7 35	8 35	8 60	9 80	.....	.....	.....	.....
12	27	6 35	6 90	7 45	8 90	9 35	10 60	.....	.....	.....	.....
12	30	6 85	7 40	8 05	9 65	10 10	11 40	.....	.....	.....	.....
12	33	7 05	7 95	8 60	10 30	10 80	12 25	.....	.....	.....	.....
12	36	7 80	8 45	9 15	11 00	11 50	13 10	.....	.....	.....	.....
12	42	8 80	9 50	10 30	12 30	13 00	14 80	.....	.....	.....	.....
12	48	9 75	10 50	11 35	13 90	14 65	16 35	.....	.....	.....	.....
15	15	4 85	5 30	5 80	6 90	7 25	8 20	$9 20	.....	.....	.....
15	18	5 40	5 90	6 40	7 70	8 05	9 05	10 20	.....	.....	.....
15	20	6 25	6 80	7 40	8 20	8 60	9 75	10 85	.....	.....	.....
15	24	6 95	7 60	8 25	9 25	9 70	10 95	12 20	.....	.....	.....
15	27	7 25	7 85	8 65	10 05	10 50	11 80	13 30	.....	.....	.....
15	30	7 80	8 45	9 10	10 85	11 30	12 70	14 30	.....	.....	.....
15	33	8 40	9 05	9 75	11 85	12 15	13 70	15 25	.....	.....	.....
15	36	8 95	9 65	10 35	12 40	13 00	14 60	16 25	.....	.....	.....
15	42	10 10	10 85	11 65	14 00	14 60	16 40	18 25	.....	.....	.....
15	48	11 25	12 05	12 85	15 50	16 20	18 25	20 25	.....	.....	.....
18	18	6 00	6 55	7 10	8 55	8 90	10 09	11 25	$12 00	.....	.....
18	20	6 45	7 00	7 55	9 10	9 55	10 75	11 95	12 80	.....	.....
18	24	7 90	8 50	9 15	10 30	10 75	11 67	13 50	14 30	.....	.....
18	27	8 15	8 80	9 40	11 15	11 70	13 10	14 50	15 40	.....	.....
18	30	8 80	9 45	10 15	12 05	12 60	14 15	15 65	16 60	.....	.....
18	33	9 85	9 95	10 85	12 90	13 50	15 15	16 75	17 65	.....	.....
18	36	10 15	10 85	11 70	13 80	14 40	16 10	17 90	18 80	.....	.....
18	42	11 40	12 15	13 05	15 55	16 20	18 20	20 00	21 05	.....	.....
18	48	12 75	13 55	14 45	17 40	18 00	20 10	22 10	23 30	.....	.....
21	21	8 00	8 60	9 25	10 35	10 80	12 20	13 50	14 15	$16 10	.....
21	24	8 75	9 35	10 05	11 30	11 80	13 30	14 70	15 55	17 45	.....
21	27	9 10	10 00	10 40	12 45	12 80	14 35	15 85	16 75	18 75	.....
21	30	9 80	10 50	11 45	13 30	13 80	15 45	17 10	18 00	20 20	.....
21	33	10 55	11 50	11 95	14 30	14 80	16 55	18 25	19 20	21 30	.....
21	36	11 65	11 95	12 80	15 30	15 80	17 60	19 45	19 45	22 80	.....
21	42	12 75	13 65	13 05	17 20	17 80	18 53	21 75	22 90	25 55	.....
21	48	14 20	15 00	14 50	19 10	19 80	21 60	24 15	25 30	28 15	.....
24	24	9 15	9 80	10 55	11 40	12 90	14 45	16 00	16 80	18 90	$19 90
24	27	10 00	10 85	11 36	13 40	13 90	15 60	16 80	18 20	20 30	21 30
24	30	10 80	11 50	12 25	14 50	15 05	16 85	18 45	19 50	21 70	22 90
24	33	11 80	12 35	13 10	15 55	16 20	18 00	19 80	20 80	23 10	24 30
24	36	12 45	13 50	14 10	16 55	17 30	18 65	20 60	21 40	24 10	25 30
24	42	14 10	14 95	15 80	18 70	19 50	21 40	23 45	24 50	27 50	28 70
24	48	15 75	16 65	17 50	20 90	21 80	23 90	26 15	27 30	30 30	31 70

CUTTER STEEL SERVICE AND CUT-OUT BOXES—Continued

MADE TO ORDER CUT-OUT BOXES—Schedule O

PRICE LIST OF NO. 10 U. S. GAUGE STEEL BOXES

The specifications and prices for special features given at the top of page 119 apply to the boxes listed on this page

NOTE.—Doors over 48 inches long will be provided with a substantial vault handle and three way catch. Doors less than 48 inches long will be provided with galvanized commode catch unless otherwise specified.

The National Board of Fire Underwriters' code specifies No. 10 U. S. gauge steel for all boxes having any dimensions over [illegible] inches and any surface over 1200 square inches.

Width Inches	Length Inches	Depth, Inches 4	6	9	12	15	18	22	24
10	11	$ 4 50	[illegible] 5 55	$ 6 05	.....	.....	.....	.....	.....
10	12	4 70	6 00	6 80	.....	.....	.....	.....	.....
10	15	5 55	6 40	7 45	.....	.....	.....	.....	.....
10	18	6 00	7 30	8 30	.....	.....	.....	.....	.....
10	21	6 60	8 70	9 50	.....	.....	.....	.....	.....
10	24	7 85	9 35	10 00	.....	.....	.....	.....	.....
10	27	8 45	10 05	10 90	.....	.....	.....	.....	.....
10	30	9 10	10 75	11 75	.....	.....	.....	.....	.....
10	33	9 70	11 50	12 55	.....	.....	.....	.....	.....
10	36	10 30	12 15	13 40	.....	.....	.....	.....	.....
12	12	5 30	6 45	7 20	$8 30	.....	.....	.....	.....
12	15	5 95	7 30	8 15	9 40	.....	.....	.....	.....
12	18	6 60	7 90	9 05	10 50	.....	.....	.....	.....
12	21	7 95	9 55	10 15	11 60	.....	.....	.....	.....
12	24	8 60	10 20	10 95	12 75	.....	.....	.....	.....
12	27	9 30	11 00	12 10	13 75	.....	.....	.....	.....
12	30	10 00	11 75	12 80	14 85	.....	.....	.....	.....
12	36	11 40	13 30	15 00	17 05	.....	.....	.....	.....
12	42	12 85	14 95	16 95	19 30	.....	.....	.....	.....
12	48	14 15	16 40	18 90	21 50	.....	.....	.....	.....
15	15	6 70	8 05	[illegible] 05	10 55	$11 80	.....	.....	.....
15	18	7 55	8 90	10 35	11 75	13 20	.....	.....	.....
15	21	7 65	10 60	11 45	13 00	14 60	.....	.....	.....
15	24	8 25	11 50	12 55	14 20	15 95	.....	.....	.....
15	27	10 65	12 30	13 60	15 45	17 30	.....	.....	.....
15	30	11 40	13 20	14 70	16 65	18 65	.....	.....	.....
15	36	13 05	15 00	16 90	19 10	21 30	.....	.....	.....
15	42	14 65	16 75	20 10	21 40	24 00	.....	.....	.....
15	[illegible]	16 30	18 55	21 30	24 00	26 70	.....	.....	.....
18	18	8 40	9 85	11 50	12 95	14 60	$16 95	.....	.....
18	21	10 05	11 70	12 70	14 45	15 65	18 10	.....	.....
18	24	10 95	12 75	13 95	15 75	17 60	19 70	.....	.....
18	27	11 85	13 75	15 50	17 10	19 05	21 25	.....	.....
18	30	12 80	14 75	16 40	18 50	20 55	22 85	.....	.....
18	36	14 80	16 80	19 15	21 10	23 50	26 05	.....	.....
18	42	16 55	18 85	21 25	23 80	26 45	39 25	.....	.....
18	48	18 40	20 80	23 50	26 50	29 35	32 45	.....	.....
18	54	21 80	24 40	31 35	34 75	39 15	42 50	.....	.....
21	21	11 10	12 85	14 00	15 85	17 65	19 75	$22 20	.....
21	24	12 15	13 95	15 40	17 35	19 30	21 45	24 10	.....
21	27	13 20	15 10	16 70	18 80	20 85	23 20	26 95	.....
21	30	14 25	16 20	18 05	20 30	22 45	24 95	27 80	.....
21	36	16 35	18 50	20 80	23 20	25 60	28 35	31 60	.....
21	42	18 40	20 75	23 45	26 20	28 90	31 80	35 40	.....
21	48	20 35	23 90	26 20	29 05	32 05	35 25	39 15	.....
21	54	24 20	26 90	33 15	37 50	41 45	45 50	45 98	.....
21	60	26 40	29 20	35 90	40 50	44 65	48 90	54 90	.....
21	66	27 55	31 55	38 70	43 50	47 80	52 40	58 68	.....
21	72	29 70	33 90	41 50	46 50	51 00	55 90	62 40	.....
24	24	13 30	15 20	16 85	18 90	21 00	23 30	26 00	$27 40
24	27	14 45	16 45	18 30	20 50	22 50	25 10	28 05	29 55
24	30	15 65	17 80	19 75	22 10	24 50	26 95	30 05	31 65
24	36	17 95	20 20	22 70	24 60	27 20	29 95	33 35	25 15
24	42	20 30	22 75	25 50	28 40	31 30	33 70	38 05	39 95
24	48	22 55	24 20	28 55	31 45	35 75	36 40	42 05	44 15
24	54	26 15	29 30	35 30	39 00	42 30	46 00	50 80	53 15
24	60	29 50	31 90	38 30	42 25	45 90	49 70	54 85	57 40
24	66	31 90	34 55	41 30	45 50	49 30	53 40	58 85	61 55
24	72	34 20	37 10	44 30	48 75	52 80	56 90	62 90	65 80

TYPE L CUT-OUT BOXES

A first class installation calls for a high grade cut-out box with a door secured to a matt or trim which is fastened to the front flanges of the box. This construction insures perfect fitting doors on large cut-out boxes.

Prices below apply to cut-out boxes having trims and doors. The following prices apply only to boxes with single doors. Made of No. 10 U. S. gauge steel.

Width Inches	Length Inches	Depth, Inches 4	6	9	12	15	18	22	24
18	54	$27 45	$30 45	$40 45	$39 65	$45 85	$48 85	$54 95	$57 95
21	54	30 30	33 45	38 10	43 05	47 65	52 35	58 55	61 75
21	60	32 85	36 15	41 10	46 15	51 45	56 15	62 85	66 15
21	66	44 40	38 65	44 05	49 45	54 95	60 10	67 10	70 85
21	72	37 95	41 70	47 25	52 75	58 55	64 05	71 45	75 05
24	54	33 60	36 40	40 45	44 55	48 65	53 90	58 15	60 95
24	60	36 55	39 30	43 70	48 05	52 60	57 00	62 85	65 70
24	66	39 30	42 45	46 95	51 65	56 55	61 15	67 35	70 45
24	72	42 15	45 45	50 45	55 35	60 45	65 25	71 95	75 25

Surface type boxes will be furnished unless otherwise specified. Flush type boxes will be furnished when so ordered at the same prices.

MADE TO ORDER CUT-OUT BOXES—Schedule O

Flush Type Cut-out Boxes will be furnished when so ordered at an addition of 50 per cent to the list prices given on pages 119, 120, 121 and 122, not including type L boxes listed on page 122. This price applies only to boxes having the door opening the same size as the box. For flush cut-out boxes with door opening smaller than the box, add 75 percent to list price.

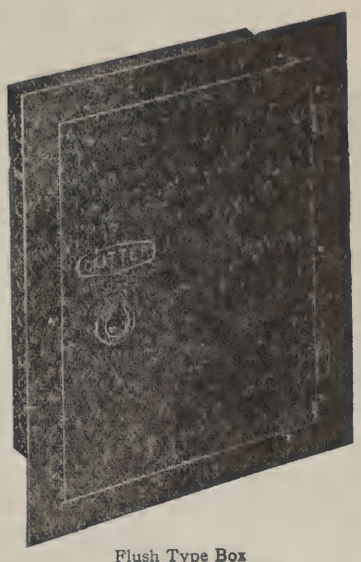
The standard finish of flush cut-out boxes is a high grade black enamel.

For white enamel finish, add $1.00 list per square foot area of trim and door.

Steel Barriers forming gutters around an open space in the center of the cut-out box will be provided with surface type or flush type boxes listed on pages 119, 120, 121 and 122 for 100 percent additional to list prices.

Steel Barriers will be furnished securely riveted to the back of the box, and arranged to allow a wide vein pocket or raceway around the center section of the box. Knock-outs for the accommodation of ½-inch steel or porcelain bushings will be provided in all barriers. All boxes are provided with standard ⅞-inch knock-outs for ½-inch conduit pipe.

NOTE A.—When ordering cut-out boxes with steel barriers specify size of cabinet and width of gutter desired—rather than the dimensions of the space required for wiring devices. Prices are based on size of cabinet and not on size of space for wiring devices.



Flush Type Box

Underwriters' requirements for cut-out boxes containing devices controlling more than four circuits:

Wire Compartments

NOTE B.—Cabinets and cut-out boxes, when used to enclose devices or apparatus connected within the cabinet or cut-out box to the wires of more than four circuits, not including the supply circuit or a continuation thereof must have back wiring spaces or one or more side wiring spaces, side gutters or wiring compartments unless the wires leave the cabinet or cut-out box directly opposite their terminal connections.

Barriers

Cabinets or cut-out boxes having one or more side wiring spaces, side gutters or side wiring compartments must be furnished with covers, barriers or partitions extending around, or from the side or sides of all bases or groups of bases of the switches, cut-outs, circuit breakers or feeder and circuit branch panelboards within the cabinet or cut-out box and providing a close fit with the door, frame or side walls so as to enclose these spaces, gutters or compartments and the wires stowed within them. At sides where wires or cables are led from the cabinet or cut-out box at points directly opposite their terminal connections to devices or appartus within the cabinet or cut-out box and other wires or cables are not placed, these covers, barriers or partitions may be omitted.

Porcelain bushings will be furnished for cut-out boxes at the following list prices per bushing:

No. 1 Internal diameter $\frac{7}{16}$ inches for No. 12 DBRC Solid Wire	$0 07
No. 2 Internal diameter $\frac{17}{32}$ inches for No. 8 DBRC Solid Wire	08
No. 3 Internal diameter $\frac{5}{16}$ inches for No. 3 DBRC Stranded Wire	09
No. 4 Internal diameter ¾ inches for No. 00 DBRC Stranded Wire	12
No. 5 Internal diameter 1⅛ inches 450000 CM cable	14
No. 6 Internal diameter 1⅝ inches 1000000 CM cable	24

Extended Cover Pull Boxes

Extended cover pull boxes with cover fastened on with machine screws are easy to install and afford all the space required to make splices, taps, or bends, without the inconvenience of working in a deep box. The box proper is made of sufficient depth to accommodate only the conduit connected to the box. This provides an open space for pulling in heavy cables without drawing them over the edge of a deeper box. This feature saves time and labor and eliminates abrasion of the insulation. When all connections have been made, the extended cover is put on and completely incloses all cables.

Extended Cover Pull Box

List prices include any number of one size of knock-outs up to 3-inch conduit pipe. Add 10 cents list in each box for each change of knock-outs not larger than for 3-inch conduit. For larger holes add 25 cents list per hole.

Cover—3 to 6 inches deep No. 14 U. S. guage steel.
Box —3 to 6 inches deep No. 14 U. S. gauge steel.

For No. 12 U. S. gauge steel add 20 %.
For No. 10 U. S. gauge steel add 45 %.
Prices for sizes not listed will be quoted upon receipt of full details.

Length Inches	Width Inches	List Price	Length Inches	Width Inches	List Price
12	12	$6 70	18	24	$13 10
12	15	7 80	21	21	13 10
12	18	8 75	21	24	14 30
15	15	8 75	21	27	17 20
15	18	9 90	24	24	16 00
18	18	10 75	24	27	18 85
18	21	11 95	24	30	20 00

CUTTER SERVICE SWITCHES AND BOXES

SERVICE BOX
WITH THREE-POLE FUSED
KNIFE SWITCH

SERVICE BOX
WITH THREE-POLE PORCELAIN
PLUG FUSE SWITCH
No. 37571

SERVICE BOX
WITH TWO-POLE PORCELAIN

These boxes contain Cutter Paragon Knife Switches with New Code fuse terminals at hinge end of switch. Each box has three knock-outs in each end. Boxes are made so that door may be closed with switch open or closed.

Prices do not include fuses.

For 250-Volt Switches

Two-Pole

Capacity Amperes	Dimensions, Inches — Depth	Length	Width	Supplier's Trade No.	Price Each
30	3½	12	5	W37541	$ 3 95
60	3½	15	7	W37542	5 30
100	5	20	8	W37543	8 35
200	6	26	9	W37544	13 65
400	7	32	11	W37545	24 70

Three-Pole

30	3½	12	7	W37546	5 00
60	3½	15	9	W37547	6 85
100	5	20	10	W37548	11 55
200	6	26	11	W37549	18 15
400	7	32	15	W37550	36 00

Four-Pole

30	3½	12	10	W37551	6 10
60	3½	15	12	W37552	8 50
100	5	20	13	W37553	14 90
200	6	26	15	W37554	23 15
400	7	32	21	W37555	50 00

For 600-Volt Switches

Two-Pole

30	4	20	9	W37556	7 55
60	6	20	10	W37557	8 65
100	6	24	11	W37558	12 35
200	7	32	13	W37559	20 15
400	8	38	15	W37560	38 00

Three-Pole

30	4	20	14	W37561	10 80
60	6	20	15	W37562	12 10
100	6	24	16	W37563	18 80
200	6	32	20	W37564	30 00
400	7	38	22	W37565	60 00

Four-Pole

30	4	20	18	W37566	14 55
60	6	20	20	W37567	16 90
100	6	24	22	W37568	25 00
200	7	32	26	W37569	40 00
400	8	38	29	W37570	80 00

Add 10 per cent to list price for switches fused at handle end.

Boxes longer than 24 inches are No. 14 U. S. gauge.

Add for cylinder lock and key, 50 cents each, net.

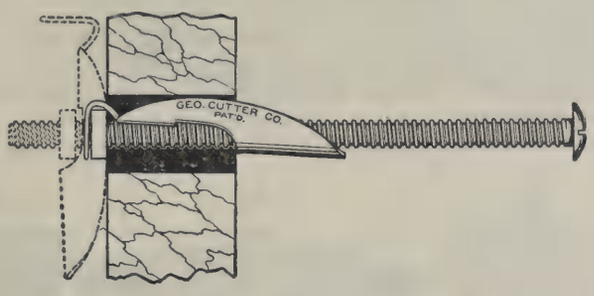
The following service boxes are furnished complete, with 30-ampere porcelain plug fused switch mounted therein.

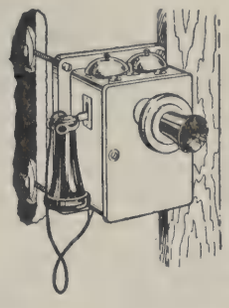
Description	Supplier's Trade No.	Price Each
Three-wire box, 3½x8x12 inches	W37571	$3 00
Two-wire box, 3½x6x12 inches	W37572	2 20

Standard package, 25 switches and boxes same size and kind.

CUTTER TOGGLE BOLTS

SCHEDULE O—STANDARD PACKAGE QUANTITY, 1000 ASSORTED





Unequalled for securing molding, brackets, telephones or any fixtures to walls or ceilings on which screws will not hold, such as tile, metal or marble.

Can be used with the nut or thread outside; or with the nut inside, exposing only the slotted head of the bolt. Easy to put up. Simply bore or chip a hole (½ inch is large enough for the $\frac{3}{16}$-inch size, but the Cutter Toggle holds firmly even in a ¾ or 1-inch hole). Insert the toggle as per illustration till the loose bar drops; then pull back and turn the bolt (or nut) till it binds the work.

Has no tiny rivet to limit its strength, hence the regular size (with $\frac{3}{16}$-inch shank) is as strong as the ⅜-inch old style toggle bolt. Adapts itself to fastening objects of varying thicknesses, the 4-inch size meeting most needs.

Made in four sizes: Regular ($\frac{3}{16}$-inch shank); slender (⅛-inch); quarter-inch and Jumbo ($\frac{5}{16}$-inch).

Size Inches	Double Offset Iron Head		Nickel-Plated* Brass Cone Head		Nickel-Plated* Brass Hex. Head		Nickel-Plated* Brass Round Head	
	Trade No.	Price per 100	Trade No.	Price per 100	Trade No.	Price per 100	Trade No.	Price per 100
⅛ x 3	W23911	$3 40	.....	.....	.....	.....	.....	.....
⅛ x 4	W23912	3 80	.....	.....	.....	.....	.....	.....
⅛ x 6	W23913	4 40	.....	.....	.....	.....	.....	.....
$\frac{3}{16}$ x 3	W23914	3 60	W23904	$7 70	W23796	$7 70	W23802	$7 70
$\frac{3}{16}$ x 4	W23915	4 00	W23905	8 00	W23797	8 00	W23803	8 00
$\frac{3}{16}$ x 6	W23916	5 00	W23906	8 50	W23798	8 50	W23804	8 50
¼ x 3	W23910	5 60	W23907	9 00	W23799	9 00	W23805	9 00
¼ x 4	W23917	6 00	W23908	9 50	W23800	9 50	W23806	9 50
¼ x 5	W23918	7 00	W23909	10 00	W23801	10 00	W23807	10 00
$\frac{5}{16}$ x 4	W23919	8 00	.....	.....	.....	.....	.....	.....
$\frac{5}{16}$ x 6	W23920	10 00	.....	.....	.....	.....	.....	.....

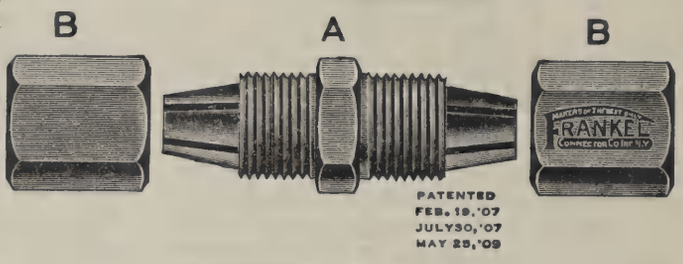
*For plain brass heads, deduct $1.00 list.

FRANKEL SOLDERLESS CONNECTORS

GENERAL

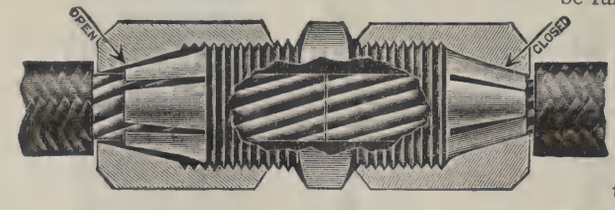
Frankel solderless connectors constitute a complete line of connectors for splicing either stranded or solid wire, without the use of solder. Their application makes possible a perfect mechanical and electrical joint, and at the same time provides a saving in labor and time. Frankel connectors will not heat as much on overload as the cables which they connect.

Construction—In the construction of Frankel connectors a minimum number of parts has been used. For example, the two-way connector illustrated is composed of only three parts, consisting of a center fitting A with slotted jaws and two compression nuts B.



DETAILS OF TWO-WAY CONNECTOR

Instructions for Making a Splice—To make a splice with a two-way Frankel connector, remove the insulation from the ends of the cable or wire for a distance equal to half the length of the connector and insert the bared ends in the fitting A so that they meet at the center, after which screw up the compression nuts B. The nuts are so constructed that they force the jaws or slotted part of the fitting inwards causing it to grip the conductor firmly and thus form a perfect joint.



CROSS SECTION OF TWO-WAY CONNECTOR

Splices with the other connectors are made in the same manner as with the two-way.

Finish—Frankel connectors have a plain or polished finish only. For finish in any of the following colors, namely, nickel, copper bronze, copper oxidized, or satin bronze, add 25% to the list price of the polished connectors. When finish is not specified on an order plain finish will always be furnished.

Approval—Frankel connectors have been approved by the National Board of Fire Underwriters. In a burnout test with No. 1 stranded cable, in which the current was gradually increased until failure occurred, the circuit was opened by the melting of the solder from a soldered lug at 550 amperes. The test was completed without serious injury to the solderless connector.

Insulating Covers—Approved insulating covers can be furnished for all Frankel two-way solderless connectors and cable taps for 250,000 cm cable and sizes below on special order; prices on request.

INSTRUCTIONS FOR ORDERING

Frankel connectors when ordered for standard sizes of wire or cable are furnished for wire or cable of the diameter indicated opposite the standard B. and S. gauge numbers or circular mil sizes in table following the lists of connectors.

Where concentric stranded cables are used, it is preferable to measure their diameter and pick a standard connector from this table accordingly. Where there is any doubt as to the proper connector to use for a special diameter of cable the order should be entered giving the diameter of the cable with a full description of the connector wanted, or a sample of the cable should be sent with the order.

Where flexible conductors are used the diameter must be given or a sample of the conductor sent with the order.

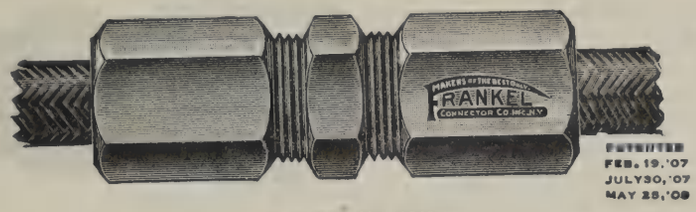
Where rope laid cable is used, this must be specified in addition to giving the diameter and other information if the proper connector is to be obtained.

In sizes from 0000 wire down, connectors are furnished for either stranded cable or solid wire. It is, therefore, necessary to specify whether stranded or solid in giving the gauge number when ordering connectors of these sizes.

For two-way connectors and cable taps use Westinghouse style numbers where possible, as these cover connectors ordinarily carried in stock.

FRANKEL SOLDERLESS CONNECTORS—Continued

TWO-WAY CONNECTORS



FRANKEL No. 2560

Two-way connectors are used to splice two conductors of the same size end to end. For splicing conductors of different sizes see "Reducers."

Style number includes complete terminal drilled for wire or cable, as stated in the table. Style number and list price cover connector with plain finish only. When ordering connectors with polished finish at list price specified, follow instructions for special connectors.

Connectors differing from the standard listed style numbers should be specified "Two-way connectors, FRANKEL STYLE No. 2560..... finish, for.....(giving number or size of solid wire or stranded cable.)"

Size of Wire or Cable*	—PLAIN FINISH— Style No.	List Price	Polished Finish List Price
No. 14 Stranded	276015	$0 35	$0 45
No. 12 Stranded	276016	35	45
No. 10 Stranded	276017	35	45
No. 9 Stranded	276018	35	45
No. 8 Stranded	276019	35	45
No. 7 Stranded	276020	35	45
No. 6 Stranded	276021	35	45
No. 5 Stranded	276022	40	50
No. 4 Stranded	276023	40	50
No. 3 Stranded	276024	40	50
No. 2 Stranded	276025	45	55
No. 1 Stranded	276026	50	75
No. 0 Stranded	276027	60	85
No. 00 Stranded	276028	75	1 00
No. 000 Stranded	276029	90	1 20
No. 0000 Stranded	276030	1 10	1 50
80,000 C. M. Stranded	276031	50	75
100,000 C. M. Stranded	276032	60	85
150,000 C. M. Stranded	276033	87	1 15
200,000 C. M. Stranded	276034	1 05	1 45
250,000 C. M. Stranded	276035	1 30	2 00
300,000 C. M. Stranded	276036	1 50	2 20
350,000 C. M. Stranded	276037	1 75	2 50
400,000 C. M. Stranded	276038	2 00	2 75
450,000 C. M. Stranded	276039	2 25	3 00
500,000 C. M. Stranded	276040	2 60	3 25
550,000 C. M. Stranded	276041	2 90	3 50
600,000 C. M. Stranded	276042	3 25	3 75
650,000 C. M. Stranded	276043	3 50	4 00
700,000 C. M. Stranded	276044	3 75	4 25
750,000 C. M. Stranded	276045	4 00	4 50
800,000 C. M. Stranded	276046	4 25	4 75
850,000 C. M. Stranded	276047	4 50	5 00
900,000 C. M. Stranded	276048	4 75	5 50
950,000 C. M. Stranded	276049	5 00	6 00
1,000,000 C. M. Stranded	276050	5 25	6 25
1,050,000 C. M. Stranded	276051	5 40	6 40

Size of Wire or Cable*	—PLAIN FINISH— Style No.	List Price	Polished Finish List Price
1,100,000 C. M. Stranded	276052	$5 50	$6 50
1,150,000 C. M. Stranded	276053	5 65	6 65
1,200,000 C. M. Stranded	276054	5 75	6 75
1,250,000 C. M. Stranded	276055	6 00	7 00
1,300,000 C. M. Stranded	276056	6 25	7 25
1,350,000 C. M. Stranded	276057	6 65	7 65
1,400,000 C. M. Stranded	276058	7 00	8 00
1,450,000 C. M. Stranded	276059	7 40	8 40
1,500,000 C. M. Stranded	276060	7 75	8 75
1,550,000 C. M. Stranded	276061	8 15	9 15
1,600,000 C. M. Stranded	276062	8 50	9 50
1,650,000 C. M. Stranded	276063	8 90	9 90
1,700,000 C. M. Stranded	276064	9 25	10 25
1,750,000 C. M. Stranded	276065	9 65	10 65
1,800,000 C. M. Stranded	276066	10 00	11 00
1,850,000 C. M. Stranded	276067	10 40	11 40
1,900,000 C. M. Stranded	276068	10 75	12 00
1,950,000 C. M. Stranded	276069	11 15	12 25
2,000,000 C. M. Stranded	276070	11 50	12 50
2,500,000 C. M. Stranded	276071	12 25	13 50
No. 18 Solid	276072	35	45
No. 16 Solid	276073	35	45
No. 14 Solid	276074	35	45
No. 12 Solid	276075	35	45
No. 10 Solid	276076	35	45
No. 9 Solid	276077	35	45
No. 8 Solid	276078	35	45
No. 7 Solid	276079	35	45
No. 6 Solid	276080	35	45
No. 5 Solid	276081	40	50
No. 4 Solid	276082	40	50
No. 3 Solid	276083	40	50
No. 2 Solid	276084	45	55
No. 1 Solid	276085	50	75
No. 0 Solid	276086	60	85
No. 00 Solid	276087	75	1 00
No. 000 Solid	276088	90	1 20
No. 0000 Solid	276089	1 10	1 50

*Wire and cable numbers are B. and S. standard gauge.

See table following lists of connectors for diameter of solid wire or stranded cable for which the standard terminals above listed are provided.

REDUCERS

Reducers are used for connecting two conductors of different sizes of cable or solid wire. They are especially useful in connecting solid round buses on switchboards to feeder cables.

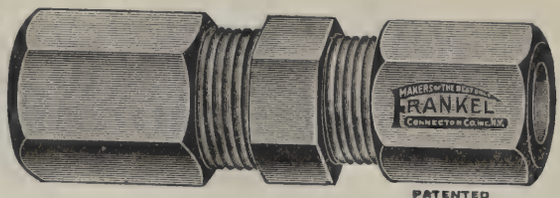
All reducers are special owing to the possible combinations of sizes. Order should specify "Reducers, FRANKEL STYLE No. 2586, for..... (giving number or size of solid wire or cable for each end)."

List price covers connector with both ends of the same size. To ascertain the list price of reducers take ½ of the list price of each of the two required sizes and the sum of these results will be the total list price.

For example, the list price of a reducer connecting a 400,000 c. m. cable with a No. 000 cable is obtained as follows:

½ list price of two-way for 400,000 c.m. (list price $2.00) = $1.00
½ list price of two-way for No. 000 (list price $ .90) = .45

Total list price $1.45



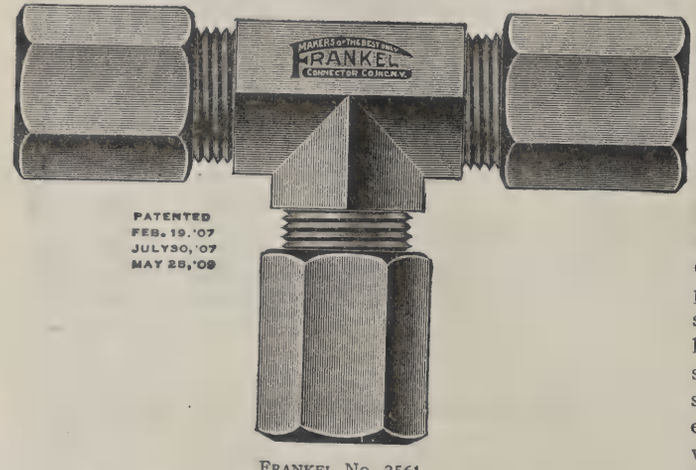
PATENTED
FEB. 19, '07
JULY 30, '07
MAY 25, '09

FRANKEL No. 2586

Size of Wire or Cable*	Plain Finish List Price	Polished Finish List Price
14 to 6	[illegible] 35	$45
5 to 3	40	50
2	45	55
1	50	75
0	60	85
00	75	1 00
000	90	1 20
0000	1 10	1 50
250,000	1 30	2 00
300,000	1 50	2 20
350,000	1 75	2 50
400,000	2 00	2 75
450,000	2 25	3 00
500,000	2 60	3 25
550,000	2 90	3 50
600,000	3 25	3 75
650,000	3 50	[illegible] 00
700,000	$3 75	$4 25
750,000	4 00	4 50
800,000	4 25	4 75
850,000	4 50	5 00
900,000	4 75	5 50
950,000	5 00	6 00
1,000,000	5 25	[illegible] 25
1,100,000	5 50	6 50
1,200,000	5 75	6 75
1,300,000	6 25	7 25
1,400,000	7 00	8 00
1,500,000	7 75	8 75
1,600,000	[illegible] 50	9 50
1,700,000	9 25	10 25
1,800,000	10 00	11 00
1,900,000	10 75	12 00
2,000,000	11 50	12 50
2,500,000	12 25	13 50

*Wire and cable numbers are B. and S. standard gauge.
See table following lists of connectors for diameter of solid wire or stranded cable for which the standard terminals above listed are provided.

THREE-WAY CONNECTORS



PATENTED
FEB. 19, '07
JULY 30, '07
MAY 25, '09

FRANKEL No. 2561

Three-way connectors are used to make a main-line splice that is on a straight line, and a branch splice off of the main. They can be furnished to connect any three sizes of solid wire or stranded cable.

All three-way connectors are special owing to the large number of possible combinations of sizes in main or branch. Orders should specify "Three-way connectors, FRANKEL STYLE No. 2561, mains for..... (giving number or size of solid wire or cable for both ends of main); branch for..... (giving number or size of wire or cable.)"

State whether plain or polished finish is wanted. List price covers connection with mains and branch of same size. To ascertain the list price of connectors having different size mains and branch, take ⅓ the list price of each of the three required sizes and the sum of these three results will be the total list price. For example, the list price for a three-way connector for 400,000 c. m. to 300,000 c. m. cables in main to branch for 0000 cable is found as follows:

⅓ list price of three-way for 400,000 c.m. (list price $3.00) = $1.00
⅓ list price of three-way for 300,000 c.m. (list price $2.25) = .75
⅓ list price of three-way for 0000 (list price $1.65) = .55

Total list price $2.30

Or, if both mains are 400,000 c.m., and branch 0000 cable:
⅔ list price of three-way for 400,000 c.m. (list price $3.00) = $2.00
⅓ list price of three-way for 0000 (list price $1.65) = .55

Total list price $2.55

(Continued on next page)

FRANKEL SOLDERLESS CONNECTORS—Continued

THREE-WAY CONNECTORS—Continued

Size of Wire or Cable*	Plain Finish List Price	Polished Finish List Price	Size of Wire or Cable*	Plain Finish List Price	Polished Finish List Price
14 to 6	$ 55	$ 75	750,000	$ 6 00	$ 7 20
5 to 3	60	80	800,000	6 40	7 50
2	70	1 00	850,000	6 75	8 00
1	75	1 10	900,000	7 00	8 50
0	90	1 25	950,000	7 50	9 00
00	1 10	1 50	1,000,000	7 80	9 40
000	1 35	1 75	1,100,000	8 25	10 00
0000	1 65	2 00	1,200,000	9 00	10 50
250,000	1 95	2 35	1,300,000	9 75	11 00
300,000	2 25	2 75	1,400,000	10 50	12 00
350,000	2 60	3 00	1,500,000	11 20	12 50
400,000	3 00	3 75	1,600,000	12 00	13 50
450,000	3 40	4 25	1,700,000	12 75	13 75
500,000	3 90	4 80	1,800,000	13 50	14 50
550,000	4 40	5 20	1,900,000	14 25	15 00
600,000	4 80	6 00	2,000,000	15 00	16 00
650,000	5 25	6 50	2,500,000	18 00	19 00
700,000	5 60	7 00			

*Wire and cable numbers are B. and S. standard gauge.

See table following lists of connectors for diameter of solid wire or stranded cable for which the standard terminals above listed are provided.

ELBOWS

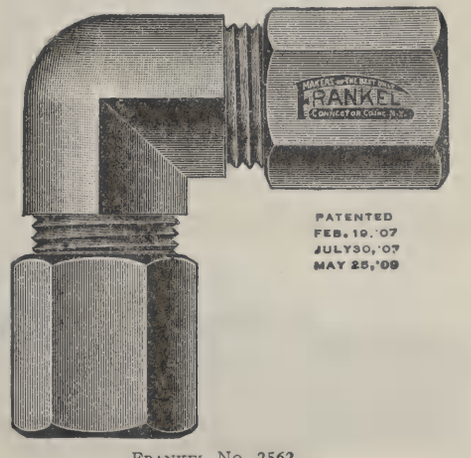
Elbow connectors are used to connect conductors at right angles, these conductors being of the same or any two different sizes. All elbow connectors are special, owing to the possible combinations of sizes. Order should specify "Elbow connectors, FRANKEL STYLE No. 2562, for.....(giving number or size of solid wire or cable for each end.)"

State whether plain or polished finish is wanted.

List price covers connector with both ends of the same size. To ascertain the list price of connectors having different size ends, take ½ the list price of each of the two required sizes and the sum of these results will be the total list price.

For example, the list price of an elbow to connect a No. 0000 cable to a No. 0 cable is obtained as follows:

½ list price for No. 0000 (list price $1.10) =	$ .55
½ list price for No. 0 (list price .60) =	.30
Total list price	$ .85



FRANKEL No. 2562

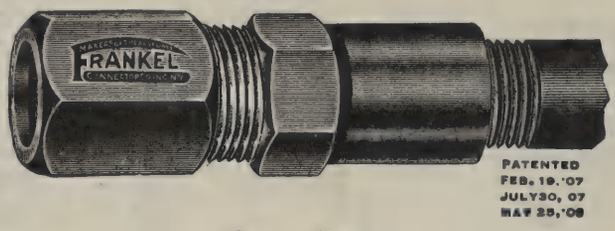
Size of Wire or Cable*	Plain Finish List Price	Polished Finish List Price	Size of Wire or Cable*	Plain Finish List Price	Polished Finish List Price
14 to 6	$ 35	$ 45	750,000	$ 4 00	$ 4 50
5 to 3	40	50	800,000	4 25	4 75
2	45	55	850,000	4 50	5 00
1	50	75	900,000	4 75	5 50
0	60	85	950,000	5 00	6 00
00	75	1 00	1,000,000	5 25	6 25
000	90	1 20	1,100,000	5 50	6 50
0000	1 10	1 50	1,200,000	5 75	6 75
250,000	1 30	1 90	1,300,000	6 25	7 25
300,000	1 50	2 20	1,400,000	7 00	8 00
350,000	1 75	2 50	1,500,000	7 75	8 75
400,000	2 00	2 75	1,600,000	8 50	9 50
450,000	2 25	3 00	1,700,000	9 25	10 25
500,000	2 60	3 25	1,800,000	10 00	11 00
550,000	2 90	3 50	1,900,000	10 75	12 00
600,000	3 25	3 75	2,000,000	11 50	12 50
650,000	3 50	4 00	2,500,000	12 25	13 50
700,000	3 75	4 25			

*Wire and cable numbers are B. and S. standard gauge.

See table following lists of connectors for diameter of solid wire or stranded cable for which the standard terminals above listed are provided.

FRANKEL SOLDERLESS CONNECTORS—Continued

PLUG-STUD CONNECTORS



FRANKEL No. 2563

Plug-stud connectors are used for connecting stranded cable or solid wire to a threaded stud or rod. All plug-stud connectors are special owing to the possible combinations of sizes.

Orders should specify, "Plug-stud connectors. FRANKEL STYLE No. 2563, for .....(giving number or size of cable or solid wire for connector end) and..... (giving diameter or threads per inch of the stud to which the connector is to be attached)."

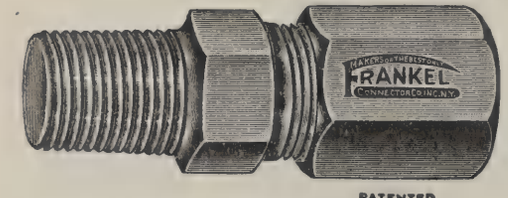
State whether plain or polished finish is wanted.

List price covers connector in which the diameter of stud specified is not greater than the diameter of wire or cable. Special prices will be quoted for plug-stud connectors drilled and tapped for larger diameter studs than the size specified for wire or cable.

Size of Wire or Cable*	Plain Finish List Price	Polished Finish List Price
14 to 6	$ 30	$ 40
5 to 3	35	45
2	40	50
1	45	55
0	50	60
00	60	70
000	70	85
0000	80	1 00
250,000	1 00	1 20
300,000	1 20	1 50
350,000	1 40	1 75
400,000	1 60	1 90
450,000	1 80	2 10
500,000	2 00	2 40
550,000	2 30	2 75
600,000	2 60	3 00
650,000	2 80	3 20
700,000	3 00	3 40
750,000	3 20	3 75
800,000	3 40	4 00
850,000	3 60	4 10
900,000	3 80	4 30
950,000	4 00	4 50
1,000,000	4 20	4 70
1,100,000	4 40	4 90
1,200,000	4 60	5 10
1,300,000	5 00	5 50
1,400,000	5 60	6 10
1,500,000	6 20	6 70
1,600,000	6 40	6 90
1,700,000	6 80	7 30
1,800,000	7 20	7 70
1,900,000	7 60	8 10
2,000,000	8 00	8 50
2,500,000	9 80	10 30

*Wire and cable numbers are B. and S. standard gauge. See table following lists of connectors for diameter of solid wire or stranded cable for which the standard terminals above listed are provided.

STUD CONNECTORS



FRANKEL No. 2564

Stud connectors are used to connect wire or cable to block terminals by screwing the stud end of the connector into a threaded hole, or to strap terminals by inserting the stud end through a hole in the strap and clamping by a nut on the end of the stud.

All stud connectors are special owing to the possible combinations of sizes. Order should specify, "Stud connectors, FRANKEL STYLE No. 2564, for.....(giving number or size of cable or solid wire) and.....(giving length and diameter of plug wanted and number of threads per inch)."

List price covers connector for size of wire or cable as listed and with ordinary diameter and length of stud. For extra large diameter or length of stud special prices will be quoted.

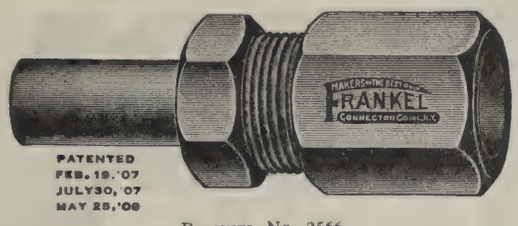
Size of Wire or Cable*	Plain Finish List Price	Polished Finish List Price
14 to 6	$ 30	$ 35
5 to 3	35	40
2	40	45
1	45	50
0	50	60
00	60	70
000	70	85
0000	80	1 00
250,000	1 00	1 20
300,000	1 20	1 50
350,000	1 40	1 75
400,000	1 60	1 90
450,000	1 80	2 10
500,000	2 00	2 40
550,000	2 30	2 75
600,000	2 60	3 00
650,000	2 80	3 20
700,000	3 00	3 40
750,000	3 20	3 75
800,000	3 40	4 00
850,000	3 60	4 10
900,000	3 80	4 30
950,000	4 00	4 50
1,000,000	4 20	4 70
1,100,000	4 40	4 90
1,200,000	4 60	5 10
1,300,000	5 00	5 50
1,400,000	5 60	6 10
1,500,000	6 20	6 70
1,600,000	6 40	6 90
1,700,000	6 80	7 30
1,800,000	7 20	7 70
1,900,000	7 60	8 10
2,000,000	8 00	8 50
2,500,000	9 80	10 30

*Wire and cable numbers are B. and S. standard gauge.

See table following lists of connectors for diameter of solid wire or cable for which the standard terminals above listed are provided.

FRANKEL SOLDERLESS CONNECTORS—Continued

SERVICE BOX PLUGS



FRANKEL No. 2566

Service box plug connectors are used for making connections to fuses where a round stud is required on the connector for use in a screw clamp terminal.

All service box plug connectors are special. Order should specify "Service box plug connectors, FRANKEL STYLE No. 2566, for.....(giving number and size of cable or solid wire) and.....(giving diameter and length of plug)."

State whether plain or polished finish is wanted.

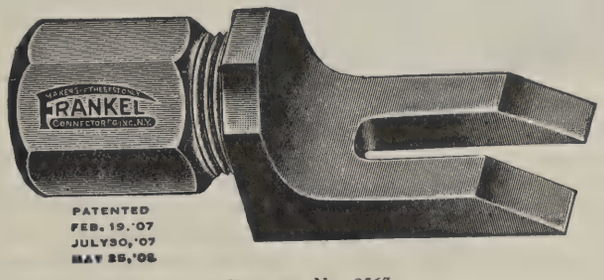
List price covers connector of size specified. Special prices will be quoted on connectors of larger sizes.

Size of Wire or Cable*	Length of Plug Inches	Diameter of Plug Inches	Plain Finish List Price	Polished Finish List Price
14 to 4	5/8	3/8	$ 25	$ 35
3 to 1	3/4	3/8	30	40
0	3/4	3/8	40	55
00	3/4	3/8	50	70
000	1	1/2	60	80
0000	1	1/2	65	85

*Wire and cable numbers are B. and S. standard gauge

See table following lists of connectors for diameter of solid wire or cable for which the standard terminals above listed are provided.

SERVICE BOX LUGS



FRANKEL No. 2567

Service box lugs are used for connecting wires or cables to fuses where the terminal is a stud with a clamping nut or binding screw. The contact surface is slotted so that it can be slipped over the stud or screw without removing the screw or nut. The lug ends are tapered to slip under the washer.

All service box lugs are special. When ordering specify "Service box lug connectors, FRANKEL STYLE No. 2567, for.....(giving number and size of cable or solid wire) and.....(giving length and width of base and size of slot)."

State whether plain or polished finish is wanted.

List price covers connector of the size listed with any size slot as ordered.

Size of Wire or Cable*	Base Width Inches	Base Length Inches	Plain Finish List Price	Polished Finish List Price
14 to 4	3/4	3/4	$ 25	$ 35
3 to 1	3/4	3/4	30	40
0	3/4	1	40	50
00	7/8	1	50	70
000	1	1 1/2	60	80
0000	1	1 1/2	70	1 00

*Wire and cable numbers are B. and S. standard gauge.

See table following lists of connectors for diameter of solid wire or cable for which the standard terminals above listed are provided.

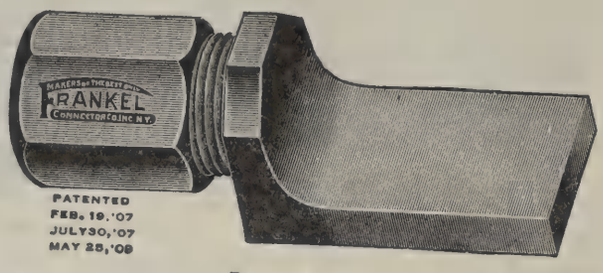
FRANKEL SOLDERLESS CONNECTORS—Continued

FRONT CONNECTOR LUGS

Front connector lugs are used for connecting solid wire or cable to generator terminals on large machines or to flat bus-bars or front-connected switches. These connectors are made with rectangular contact surface undrilled, but will be furnished drilled when so specified, without addition to list price.

Orders should specify "Front connector lugs, FRANKEL STYLE NO. 2568, for..... (giving number and size of cable or solid wire) and.....(giving length and width of contact surface, if special size is required, and diameter of hole in surface if desired)."

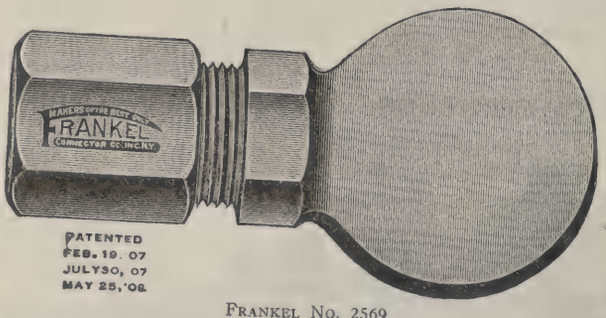
State whether plain or polished finish is wanted.



FRANKEL NO. 2568

List price covers connector of the size listed with contact surface undrilled or, where specified, drilled as desired. See price table below.

BACK CONNECTOR LUGS



FRANKEL NO. 2569

Back connector lugs are used for connecting solid wire or stranded cable to bolts or studs, and are made with round contact surface. Contact surfaces are undrilled, but where desired they will be furnished drilled when so specified, without addition to list price.

Orders should specify "Back connector lugs, FRANKEL STYLE NO. 2569, for..... (giving number and size of cable or solid wire) and.....(giving diameter of contact surface if special size is required, and diameter of hole in surface if desired)."

State whether plain or polished finish is wanted.

List price covers connector of the size listed with surface undrilled, or, where specified, drilled as desired. See price table below.

PRICES

Front and Back Connector Lugs

Size of Wire or Cable*	Front and Back Connectors — Plain Finish List Price	Front and Back Connectors — Polished Finish List Price
14 to 6	$ 25	$ 40
5 to 3	30	50
2	35	55
1	40	60
0	45	75
00	55	85
000	65	1 00
0000	80	1 20
250,000	95	1 35
300,000	1 10	1 50
350,000	1 30	1 70
400,000	1 45	1 90
450,000	1 65	2 15
500,000	1 80	2 40
550,000	2 00	2 50
600,000	2 30	3 00
650,000	2 50	3 20
700,000	2 70	3 50
750,000	$2 90	$3 70
800,000	3 10	4 00
850,000	3 30	4 20
900,000	3 50	4 50
950,000	3 70	4 70
1,000,000	3 90	5 00
1,100,000	4 10	5 20
1,200,000	4 30	5 50
1,300,000	4 60	5 60
1,400,000	4 90	6 00
1,500,000	5 20	6 25
1,600,000	5 60	6 75
1,700,000	6 00	7 25
1,800,000	6 50	8 00
1,900,000	7 00	8 50
2,000,000	7 50	9 00
2,500,000	9 50	11 00

*Wire and cable numbers are B. and S. standard gauge.
See table following lists of connectors for diameter of solid wire or stranded cable for which the standard terminals above listed are provided.

GROUNDING TAP CONNECTORS

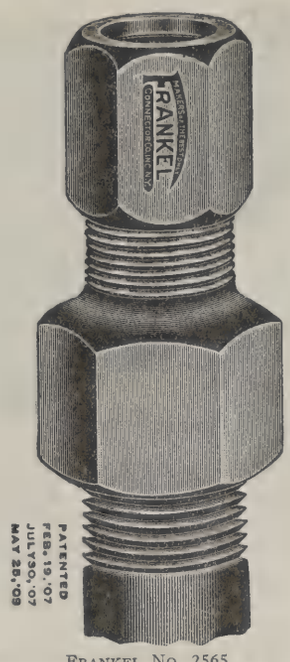
Grounding tap connectors are used to connect wire or cable to a gas pipe for grounding a circuit. The pipe end of the connector is threaded to receive a standard gas pipe of size specified. All grounding tap connectors are special owing to the possible combinations of sizes. Order should specify, "Grounding tap connectors, FRANKEL STYLE No. 2565, for.....(giving number and size of cable or solid wire) and.....(giving standard size of gas pipe)."

State whether plain or polished finish is wanted.

Special prices will be quoted on grounding tap connectors of sizes other than listed below.

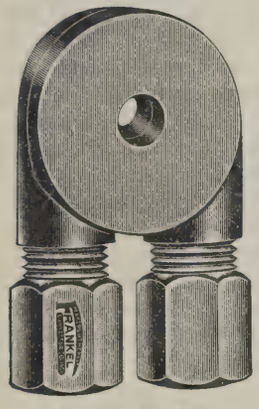
Size of Wire or Cable*	Size of Pipe Inches	Plain Finish List Price	Polished Finish List Price
14 to 1	⅜	$ 40	50
14 to 1	½	45	55
14 to 1	¾	60	75
14 to 1	1	75	90
0 to 0000	½	75	90
0 to 0000	¾	80	1 00
0 to 0000	1	85	1 10

*Wire and cable numbers are B. and S. standard gauge.
See table following lists of connectors for diameter of solid wire or cable for which the standard terminals above listed are provided.



FRANKEL No. 2565

SWIVEL LUGS



FRANKEL No. 2574

Swivel lugs consist of a combination of two round-surface lugs having the contact surface of one mounted on the contact surface of the other in such a way that a swiveling motion is permitted, and cables or wires of any size coming from any two different directions may be connected.

All swivel lugs are special because of the possible combinations of sizes. Orders should specify "Swivel lugs, FRANKEL STYLE No. 2574, for.....(giving number or size of solid wire or cable for each end)."

State whether plain or polished finish is wanted.

The list price covers lug with both ends of the same size. To ascertain the list price of lugs having different size ends, take ½ the list price of each of the two required sizes and the sum of these results will be the total list price.

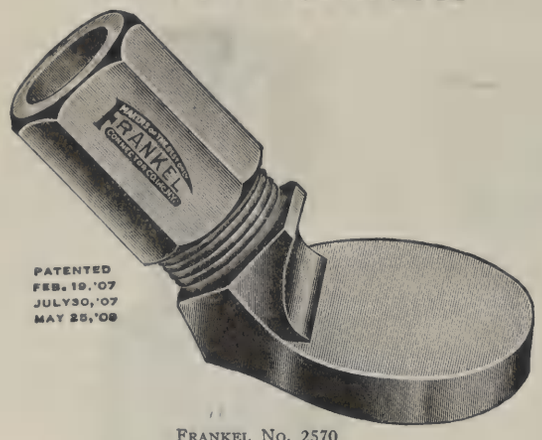
For example, the list price of a lug to connect No. 0000 cable to a No. 0 cable is obtained as follows:

½ list price for No. 0000 (list price $1.60)	=	$ .85
½ list price for No. 0 (list price .90)	=	.45
		$1.25

Size of Wire or Cable*	Plain Finish List Price	Polished Finish List Price
14 to 6	$ 50	80
5 to 3	60	1 00
2	70	1 10
1	80	1 20
0	90	1 50
00	1 10	1 70
000	1 30	2 00
0000	1 60	2 40
250,000	1 90	2 70
300,000	2 20	3 00
350,000	2 60	3 40
400,000	2 90	3 80
450,000	3 30	4 30
500,000	3 60	4 80
550,000	4 00	5 00
600,000	4 60	6 00
650,000	5 00	6 40
700,000	5 40	7 00
750,000	5 80	7 40
800,000	6 20	8 00
850,000	6 60	8 40
900,000	7 00	9 00
950,000	7 40	9 40
1,000,000	7 80	10 00
1,100,000	8 20	10 40
1,200,000	8 60	11 00
1,300,000	9 20	11 20
1,400,000	9 80	12 00
1,500,000	10 40	12 50
1,600,000	11 20	13 50
1,700,000	12 00	14 50
1,800,000	13 00	16 00
1,900,000	14 00	17 00
2,000,000	15 00	18 00
2,500,000	19 00	22 00

*Wire and cable numbers are B. and S. standard gauge.
See table following lists of connectors for diameter of solid wire or stranded cable for which the standard terminals above listed are provided.

ANGLE CONNECTOR LUGS



FRANKEL No. 2570

Angle connector lugs are made with round or rectangular contact surface at an angle of 45° to the connector. Contact surfaces are undrilled but where desired they will be furnished drilled without addition to list price.

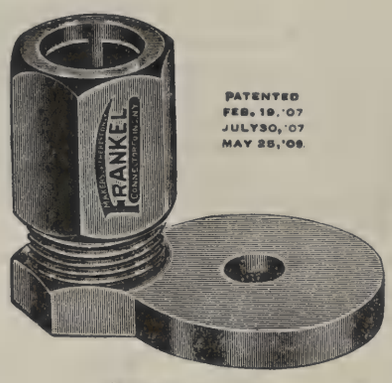
Frankel No. 2570 has round contact surface; No. 2571 has rectangular contact surface.

Orders for round-surface lugs should specify "Angle connector lugs with round surface, FRANKEL STYLE No. 2570, for .....(giving number and size of cable or solid wire) and.....(giving diameter of contact surface if special size is required, and diameter of hole in surface if desired)." Orders for rectangular surface lugs should specify "Angle connector lugs with rectangular surface, FRANKEL STYLE No. 2571, for.....(giving number and size of cable or solid wire) and.....(giving length and width of contact surface if special size is required, and diameter of hole in surface if desired)."

State whether plain or polished finish is wanted.

List price covers connector of the size listed with contact surface undrilled or, where specified, drilled as desired.

RIGHT ANGLE LUGS



FRANKEL No. 2572

Right angle connector lugs are made with round or rectangular contact surface at an angle of 90° to the connector. Contact surfaces are undrilled but where desired they will be furnished drilled when so specified, without addition to list price.

Frankel No. 2572 has round contact surface; No. 2573 has rectangular contact surface.

Orders for round-surface connectors should specify "Right angle connector lugs with round surface, FRANKEL STYLE No. 2572, for..... (giving number and size of cable or solid wire) and .....(giving diameter of contact surface if special size is required, and diameter of hole in surface if desired)." Orders for rectangular-surface connectors should specify "Right angle connector lugs with rectangular surface, FRANKEL STYLE No. 2573, for.....(giving number and size of cable or solid wire) and.....(giving length and width of contact surface if special size is required, and diameter of hole in surface if desired)."

State whether plain or polished finish is wanted.

List price covers connector of the size listed with contact surface undrilled or, where specified, drilled as desired.

PRICES

Angle Connector Lugs and Right Angle Lugs

Size of Wire or Cable*	Plain Finish List Price	Polished Finish List Price	Size of Wire or Cable*	Plain Finish List Price	Polished Finish List Price
14 to 6	25	40	750,000	2 90	3 70
5 to 3	30	50	800,000	3 10	4 00
2	35	55	850,000	3 30	4 20
1	40	60	900,000	3 50	4 50
0	45	75	950,000	3 70	4 70
00	55	85	1,000,000	3 90	5 00
000	65	1 00	1,100,000	4 10	5 20
0000	80	1 20	1,200,000	4 30	5 50
250,000	95	1 35	1,300,000	4 60	5 60
300,000	1 10	1 50	1,400,000	4 90	6 00
350,000	1 30	1 70	1,500,000	5 20	6 25
400,000	1 45	1 90	1,600,000	5 60	6 75
450,000	1 65	2 15	1,700,000	6 00	7 25
500,000	1 80	2 40	1,800,000	6 50	8 00
550,000	2 00	2 50	1,900,000	7 00	8 50
600,000	2 30	3 00	2,000,000	7 50	9 00
650,000	2 50	3 20	2,500,000	9 50	11 00
700,000	2 70	3 50			

*Wire and cable numbers are B. and S. standard gauge.

See table following lists of connectors for diameter of solid wire or cable for which the standard terminals above listed are provided.

FRANKEL SOLDERLESS CONNECTORS—Continued

CABLE TAPS

Cable taps are used to connect a branch of solid wire or stranded cable to main cable or wire. The tap consists of a hook for clamping on the main, and a connector attached to the shank of the hook for taking the branch. The hook is provided with an inner shoe, which can be adjusted by turning the shank or post of the tap.

The cable tap is connected to the main by placing the hook over the wire or cable from which the insulation has been removed and then inserting the shoe and screwing up the post until contact is made. The branch is connected up by inserting the bared end of the wire or cable in the connector and tightening up the compression screw.

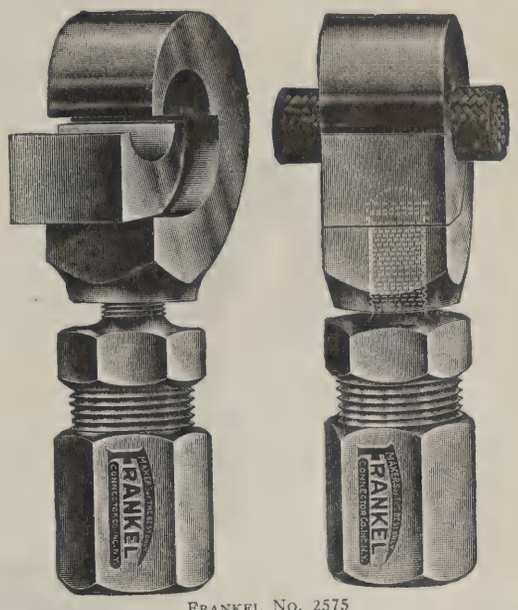
The style number covers cable taps for same size main and branch with plain finish only. When ordering taps with polished finish at list price specified, follow instructions for special taps.

Taps differing from the standard listed style numbers should be specified as "FRANKEL STYLE No. 2575, for.....(giving number or size of solid wire or cable of both main and branch)."

The list price covers cable taps for branch and main of same size. To ascertain the list price of taps for different size and branch, take ⅔ the list price of the main plus ⅓ the list price of the branch.

For example, the list price of a tap for ■ 400,000 c. m. main with a No. 0000 branch is obtained as follows:

⅔ list price 400,000 C. M. main	(list price $3.00) =	$2.00
⅓ list price No. 0000 branch	(list price $1.65) =	.55
	Total list price	$2.55



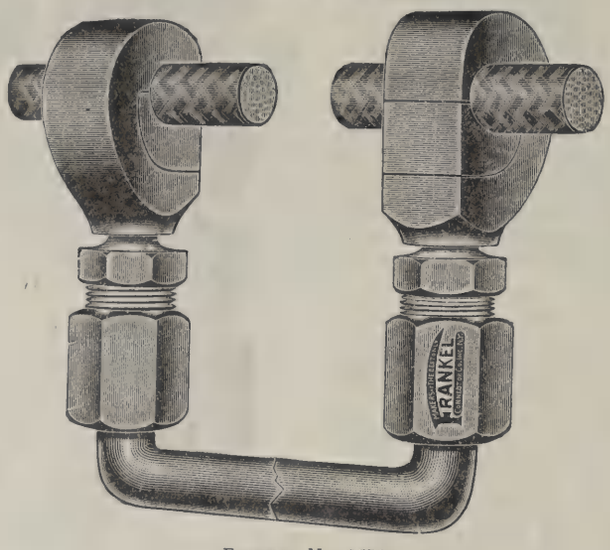
FRANKEL No. 2575

Size of Wire or Cable*	Style No.	Plain Finish List Price	Polished Finish List Price
No. 14 Stranded	276090	$0 55	$0 75
No. 12 Stranded	276091	55	75
No. 10 Stranded	276092	55	75
No. 9 Stranded	276093	55	75
No. ■ Stranded	276094	55	75
No. 7 Stranded	276095	55	75
No. 6 Stranded	276096	55	75
No. 5 Stranded	276097	60	80
No. 4 Stranded	276098	60	80
No. 3 Stranded	276099	60	80
No. 2 Stranded	276100	70	1 00
No. ■ Stranded	276101	85	1 15
No. 0 Stranded	276102	90	1 25
No. 00 Stranded	276103	1 10	1 50
No. 000 Stranded	276104	1 35	1 75
No. 0000 Stranded	276105	1 65	■ 00
80,000 C. M. Stranded	276106	85	1 15
100,000 C. M. Stranded	276107	90	1 25
150,000 C. M. Stranded	276108	1 30	1 70
200,000 C. M. Stranded	276109	1 60	1 95
250,000 C. M. Stranded	276110	1 95	2 35
300,000 C. M. Stranded	276111	2 25	2 75
350,000 C. M. Stranded	276112	2 60	3 00
400,000 C. M. Stranded	276113	3 00	3 75
450,000 C. M. Stranded	276114	3 40	4 25
500,000 C. M. Stranded	276115	3 90	4 80
550,000 C. M. Stranded	276116	4 40	5 20
600,000 C. M. Stranded	276117	4 80	6 00
650,000 C. M. Stranded	276118	5 25	6 50
700,000 C. M. Stranded	276119	5 60	7 00
750,000 C. M. Stranded	276120	■ 00	7 20
800,000 C. M. Stranded	276121	6 40	7 50
850,000 C. M. Stranded	276122	■ 75	■ 00
900,000 C. M. Stranded	276123	7 00	8 50
950,000 C. M. Stranded	276124	7 50	9 00
1,000,000 C. M. Stranded	276125	7 80	9 40
1,050,000 C. M. Stranded	276126	8 00	■ 65
1,100,000 C. M. Stranded	276127	$8 25	$10 00
1,150,000 C. M. Stranded	276128	■ 65	10 25
1,200,000 C. M. Stranded	276129	■ 00	10 50
1,250,000 C. M. Stranded	276130	9 40	10 75
1,300,000 C. M. Stranded	276131	9 75	11 00
1,350,000 C. M. Stranded	276132	10 15	11 50
1,400,000 C. M. Stranded	276133	10 50	12 00
1,450,000 C. M. Stranded	276134	10 85	12 25
1,500,000 C. M. Stranded	276135	11 20	12 50
1,550,000 C. M. Stranded	276136	11 60	13 00
1,600,000 C. M. Stranded	276137	12 00	13 50
1,650,000 C. M. Stranded	276138	12 40	13 65
1,700,000 C. M. Stranded	276139	12 75	13 75
1,750,000 C. M. Stranded	276140	13 15	14 15
1,800,000 C. M. Stranded	276141	13 50	14 50
1,850,000 C. M. Stranded	275142	13 90	14 75
1,900,000 C. M. Stranded	276143	14 25	15 00
1,950,000 C. M. Stranded	276144	14 65	15 50
2,000,000 C. M. Stranded	276145	15 00	16 00
2,500,000 C. M. Stranded	276146	18 00	19 00
No. 18 Solid	276147	55	75
No. 16 Solid	276148	55	75
No. 14 Solid	276149	55	75
No. 12 Solid	276150	55	75
No. 10 Solid	276151	55	75
No. ■ Solid	276152	55	75
No. ■ Solid	276153	55	75
No. 7 Solid	276154	55	75
No. 6 Solid	276155	55	75
No. 5 Solid	276156	60	80
No. 4 Solid	276157	60	80
No. 3 Solid	276158	60	80
No. ■ Solid	276159	70	1 00
No. ■ Solid	276160	85	1 15
No. 0 Solid	276161	90	1 25
No. 00 Solid	276162	1 10	1 50
No. 000 Solid	276163	1 35	1 75
No. 0000 Solid	276164	1 65	■ 00

*Wire and cable numbers are B. and S. standard gauge.

See table following lists of connectors for diameter of solid wire or cable for which the standard terminals listed above are provided.

EQUALIZERS



FRANKEL No. 2576

FRANKEL No. 2577

Equalizers are used to equalize the load on two power cables that run parallel or at right angles to each other. They are made by combining two cable taps and are installed in the same manner that a cable tap is connected to a main. They are furnished with connecting rod straight or bent, as desired.

All equalizers are special because of the possible combinations of sizes. Orders for equalizers should specify "Equalizer, FRANKEL STYLE No. 2576, (or STYLE No. 2577) for.....(giving number or size of solid wire or stranded cable for each end) and.....(giving shape of connecting rod, distance between center of cables, and stating whether parallel or at right angles)."

State whether plain or polished finish is wanted.

The price of equalizers is the same as that of two cable taps (see preceding page) of corresponding size plus a special price on connecting rods, which may be obtained on application.

BINDING POSTS AND TERMINAL CONNECTORS

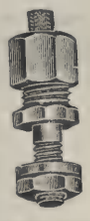
Binding Posts

These binding posts are fitted with a Frankel solderless connector which grips the wire. They are made of brass and are of two forms as illustrated.

Orders should specify "Binding post and terminal connector, FRANKEL STYLE NO. (2578 or 2579), for.....(giving number of wire and stating whether solid or stranded)."

State whether plain or polished finish is wanted.

The list prices cover binding post and connector of the styles and sizes listed.



FRANKEL NO. 2578

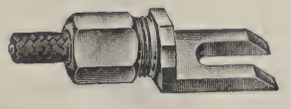
FRANKEL NO. 2579

Size of Wire*	No. 2578 Plain Finish List Price, Each	No. 2578 Polished Finish List Price, Each	Size of Wire*	No. 2579 Plain Finish List Price, Each	No. 2579 Polished Finish List Price, Each
18 to 16	$ 25	$ 35	18 to 16	$ 25	$ 30
14 to 12	30	40	14 to 12	25	35
10 to 8	35	45	10 to 8	30	40

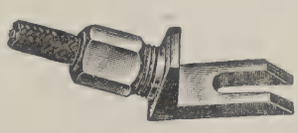
*Wire and cable numbers are B. and S. standard gauge.
See table following lists of connectors for diameter of solid wire or cable for which the standard terminals above listed are provided.

Terminal Lug Connectors

FRANKEL NO. 2580



FRANKEL NO. 2581



FRANKEL NO. 2582

These terminal lugs are made for use on panel boards, knife switches, bell and telephone construction, etc. The wire end of the lug is equipped with a Frankel solderless connector which grips the wire or cable and makes electrical contact. They are made in three different styles.

Frankel No. 2580 has a rectangular contact surface which is regularly furnished undrilled. However, lugs will be drilled where specified without addition to list price.

Frankel No. 2581 is made with slotted contact surface tapered for slipping under the binding post clamping nut or screw head. The size of slot must be specified on order.

Frankel No. 2582 is an angle lug with slotted contact surface and specially adapted for panel work. The size of slot must be specified on order.

Order should specify "Terminal lug connectors, FRANKEL STYLE NO.....(giving style desired), for.....(giving number of wire and stating whether solid or stranded)."

State whether plain or polished finish is wanted.

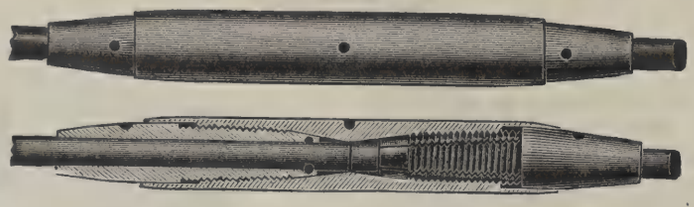
The list prices cover terminal lug connector of the styles and sizes listed.

Frankel No.	Size of Wire	Plain Finish List Price, Each	Polished Finish List Price, Each
2580	18 to 16	$ 20	$ 30
2581	14 to 12	25	35
2582	10 to 8	30	40

*Wire numbers are B. and S. standard gauge.
See table following lists for diameter of solid wire or stranded cable for which the standard terminals above listed are provided.
Binding posts and terminal connectors can be furnished to fit wire up to No. 26 B. and S. standard gauge; prices on application.

FRANKEL SOLDERLESS CONNECTORS—Continued

TROLLEY WIRE SPLICING SLEEVES



Frankel No. 2583

Frankel splicing sleeves are used for splicing trolley wires without using solder. They consist of a center sleeve or nut having a right-hand thread in one end and a left-hand thread in the other, and two end pieces that screw in the sleeve, or nut, and clamp the ends of the wire. The end pieces have slotted tapering jaws with an open steel ring on the inside of the jaws. When the strain is applied, this ring forms and is upset.

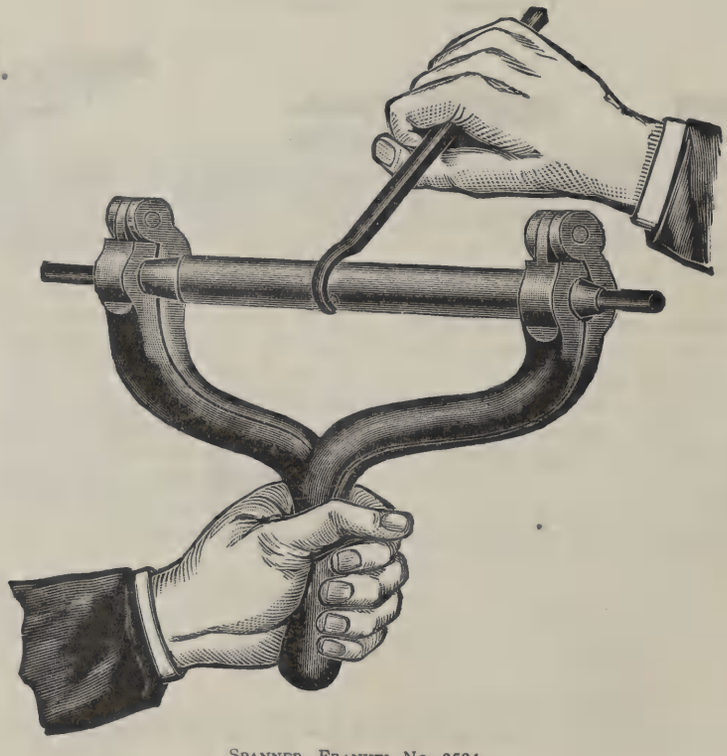
These sleeves are made of drawn brass or bronze.

Orders should specify "Trolley wire splicing sleeve, FRANKEL STYLE No. 2583, for..... (giving size of wire) and.....(giving material, brass or bronze)."

Size of Wire*	Brass List Price, Each	Bronze List Price, Each
0 Round Wire	$1 60	$2 00
00 Round Wire	2 00	2 40
000 Round Wire	2 40	2 80
0000 Round Wire	2 80	3 20

*Wire numbers are B. and S. standard gauge.
See table on next page for diameter of solid wire for which the splicing sleeves above listed are provided.

SPANNER AND WRENCH



SPANNER, FRANKEL No. 2584
WRENCH, FRANKEL No. 2585

The spanner and spanning wrench are used for installing trolley wire splicing sleeves, as shown.

Order should specify "Spanner, FRANKEL STYLE No. 2584" or "Spanning wrench, FRANKEL STYLE No. 2585."

Frankel No.	Description	List Price
2584	Spanners, Cast Iron	$4 00
2585	Spanning Wrench	1 00

DIAMETER OF STRANDED CABLE AND SOLID WIRE

Stranded Cable

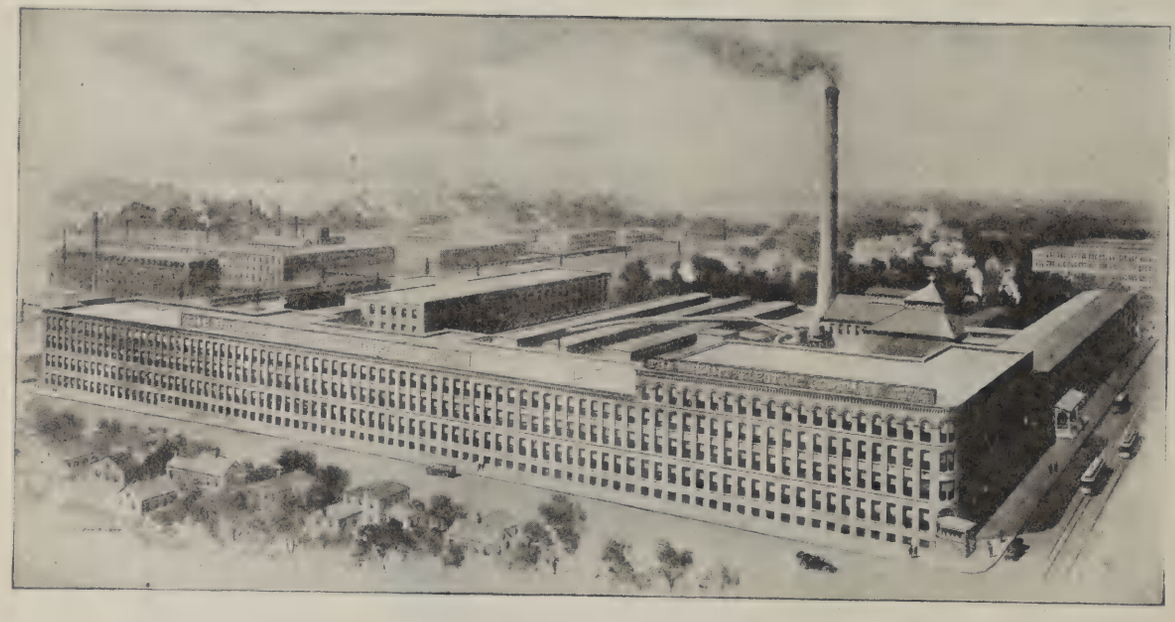
No. B. and S. Gauge or Circular Mills	Diameter in Inches	No. B. and S. Gauge or Circular Mills	Diameter in Inches	No. B. and S. Gauge or Circular Mills	Diameter in Inches
14	.073	200,000	.515	1,150,000	1.236
12	.092	250,000	.575	1,200,000	1.263
10	.115	300,000	.630	1,250,000	1.289
9	.130	350,000	.680	1,300,000	1.315
8	.145	400,000	.727	1,350,000	1.340
7	.164	450,000	.772	1,400,000	1.364
6	.184	500,000	.815	1,450,000	1.388
5	.206	550,000	.854	1,500,000	1.412
4	.231	600,000	.892	1,550,000	1.436
3	.260	650,000	.929	1,600,000	1.459
2	.293	700,000	.964	1,650,000	1.482
1	.332	750,000	.997	1,700,000	1.504
0	.375	800,000	1.031	1,750,000	1.526
00	.420	850,000	1.062	1,800,000	1.548
000	.472	900,000	1.093	1,850,000	1.569
0000	.528	950,000	1.122	1,900,000	1.590
80,000	.325	1,000,000	1.152	1,950,000	1.611
100,000	.363	1,050,000	1.181	2,000,000	1.632
150,000	.444	1,100,000	1.209	2,500,000	1.850

Solid Wire

No. B. and S. Gauge	Diameter in Inches
18	.040
16	.050
14	.064
12	.081
10	.102
9	.115
8	.128
7	.144
6	.162
5	.182
4	.204
3	.229
2	.258
1	.289
0	.325
00	.365
000	.410
0000	.460

The Bryant Electric Company
Bridgeport, Conn.

Makers of
ELECTRIC WIRING DEVICES



325,000 square feet of floor space—the largest plant in the world devoted exclusively to the manufacture of electric wiring devices

Address all correspondence and orders to

The Bryant Electric Company
Bridgeport, Conn.

or to nearest Branch Office

NEW YORK
51 East 42nd Street

CHICAGO
323 West Jackson Blvd.

SAN FRANCISCO
149 New Montgomery Street

DEVELOPMENT OF SAFETY APPARATUS

The Krantz Manufacturing Company, whose apparatus is listed herein, has been a leader in the development of all forms of low-voltage safety apparatus.

For a long time the low voltages in constant use in homes, business places, and industrial plants, even including voltages as high as 500 in some cases, were considered not dangerous. About 1909 so many cases of serious accident from contact with these voltages were made public that the necessity of safety apparatus became more generally recognized, along with the movement of the insurance companies to require protection against wheels, gears, belts, etc. It was pointed out that while wiring was covered by insulation and enclosed in steel conduits partly because of fire and life hazard, the switch and other devices with which the operators came most in contact were left alive, although operated mostly by persons unfamiliar with electrical apparatus. The very fact that the voltage was low and not fatal or dangerous to everybody tended to make the average person more careless.

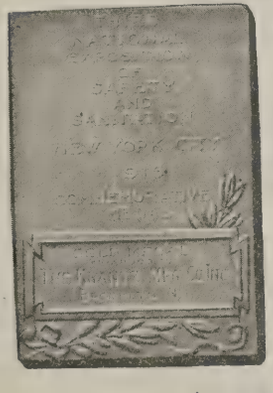
The Department of Commerce, Bureau of Standards, and the National Safety Council took up the question and showed the dangers of open installations of electrical apparatus, and at the present time the Bureau of Standards is on record in the National Safety Code as favoring the use of safety apparatus wherever suitable apparatus is available.

The tendency of the states has been to adopt this proposed Code as a required standard, and in some cases to go further in the requirements by preventing the possibility of touching any live part in the ordinary operation of a switch or the re-fusing of a circuit.

The necessity of safety apparatus is further emphasized by the accident liability clause of various states making the state or employer responsible for accidents to industrial employees. While the main reason for protection of employees is a humanitarian one, and most industrial plants go beyond legal requirements in the provisions for protection, there is thus provided a financial justification for the use of safety apparatus at a higher first cost than would apply to previous standard apparatus, such as open switches and live-face panel boards.

It has remained, therefore, for the manufacturer to provide apparatus which includes adequate safety features.

Attention is called to the details of the Krantz safety apparatus, with especial reference to the high degree of safety provided as combined with the high degree of mechanical strength and excellence of electrical design. Safety apparatus must inherently be more difficult to inspect than open apparatus, consequently ruggedness of parts and long life of contacts are necessary to satisfactory operation. Above all, where safety is sought after, the only degree that should be considered satisfactory is 100 per cent safety.



AWARDED GOLD MEDAL AND SPECIAL MENTION
AMERICAN MUSEUM OF SAFETY
NEW YORK.

TYPE WK-100 SAFETY MOTOR-STARTING SWITCHES

WITH AUTOMATIC OVERLOAD AND UNDERVOLTAGE TRIP FOR A. C. MOTORS UP TO 10 H. P.

Single-Throw—Quick-Make and Quick-Break

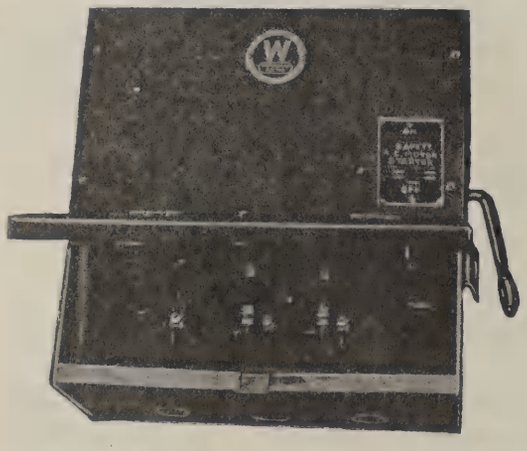
The type WK-100 Safety Motor-Starting Switch affords absolute protection to the operator (regardless of experience) as well as to the motor, and at the same time, costs so little as to warrant its installation with every induction motor of one to ten hp. capacity, single or polyphase. These starters connect the motor directly to the line without the use of resistance or auto-transformers.

Extreme simplicity of construction is particularly noticeable in the design of this switch; its first cost is low; and at the same time it possesses an unusual number of protective features that make it especially desirable for general use. Prominent among these are the following:

1. Perfect Safety to the operator.
2. Full protection to the motor in starting.
3. Undervoltage release.
4. Inverse time-element overload release.
5. Quick-make and quick-break, preventing teasing motor and burning switch contacts.
6. Switch will not remain closed on undervoltage or overload.
7. Switch is opened or closed by hand by moving operating handle to "OFF" or "ON" position.
8. Switch can be locked in "OFF" position.
9. Door is interlocked with switch mechanism so that it can be opened only when switch is in "OFF" position.
10. When door is open all accessible parts are dead and switch is locked "OFF."
11. Switch can be inspected by removing screws which hold on cover.
12. Entire switch mechanism can be removed and replaced without disturbing box or conduits.

TYPE WK-100 SWITCH WITH OPERATING HANDLE LOCKED IN "OFF" POSITION
(LOCK NOT INCLUDED IN STYLE NUMBER AND LIST PRICE)

13. Capacity of switch can be readily changed by substituting proper relays.
14. Operating mechanism and under-voltage coil are easily removed from front without disturbing other switch parts.
15. Current relays automatically reset themselves.
16. Switches are double break, dividing the arc between two points.
17. Knockouts provided in top, bottom and sides of box.
18. Box is made dust-proof by overlapping cover.
19. Line terminals and motor terminals are plainly indicated on slate base.
20. Each switch, complete with proper current relays, is packed in a neat, corrugated-paper shipping carton making repacking unnecessary.
21. Switch has approval of Board of Fire Underwriters.
22. Switches have ample capacity to interrupt locked current of motors up to 10 hp. 600 volts.



TYPE WK-100 SWITCH WITH DOOR OPEN, SHOWING ACCESS TO PROTECTIVE DEVICES—ALL ACCESSIBLE PARTS ARE "DEAD"

Operation

The operation of the Type WK-100 switch is the simplest possible—there are no complicated directions to remember. The switch is closed and opened by moving the operating handle to the "ON" and "OFF" positions.

Construction

The switch mechanism is enclosed in a steel box, which is arranged for wall mounting. The cover consists of two parts, connected together by hinges, the upper part being held in place by screws, while the lower part forms a door which gives access to

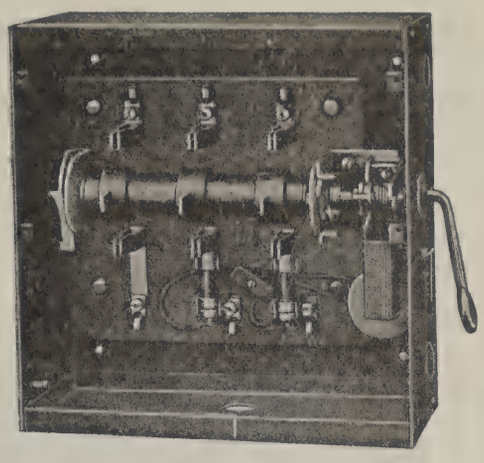
the protective devices. This door is so arranged that it can be opened only when the switch is in the "OFF" position, and when the door is open the switch cannot be thrown "ON." Hence all parts accessible when the door is open are electrically dead.

A complete unit is formed by mounting the switch mechanism on a slate base and this unit may be removed or replaced without disturbing the box or the conduits. A damaged switch can, therefore, be readily renewed.

The movable knife blades are moulded into Bakelite hubs which are mounted on a square steel shaft and separated by Bakelite Micarta spacers. On 550 and 600-volt starters, parts of opposite polarity are separated by ½-inch slate barriers, which are rigidly mounted on the slate base.

The operating handle rotates the blade shaft through a spring actuated mechanism, which provides a quick-make and quick-break, regardless of the speed with which the handle is operated. The switch blades are double break, affording the maximum breaking capacity for the switch.

The undervoltage release consists of a magnetically-operated catch, which holds the switch in the closed position only when the line voltage is sufficiently high. Should the voltage fail, the switch opens automatically.



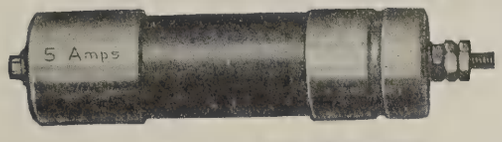
TYPE WK-100 SWITCH WITH COVER REMOVED—SHOWING OPERATING MECHANISM AND PROTECTIVE DEVICES

Current Relays

The inverse-time-element overload release consists of one or more current relays (the number depending on the number of the phases) which resemble cartridge fuses in appearance. Momentary overloads do not effect these relays, but should the load become so heavy as to endanger the motor, the relelays operate to open the switch. Standard relays are rated the same as N. E. C. fuses, up to and including 35 amperes, and should be ordered for rated capacity required.

The capacity of the switch depends solely on the relays, as all other parts of the mechanism are the same for all capacities (although the magnet coil is suitable for use on its rated voltage and frequency only). Hence, to change the capacity of the switch all that is necessary is to change the relays to the required size, in which case the switch name plate should also be changed.

In cases where motors do not have normal overload capacity smaller relays should be used than regularly supplied. Where motors are underrated and have greater overload capacity larger relays may be used.



CURRENT RELAY FOR WK-100 SWITCHES

Capacity of Current Relays Required

H. P.	SINGLE PHASE — One Relay Required Per Switch — Voltage				TWO PHASE — Two Relays Required Per Switch — Voltage				THREE PHASE — Two Relays Required Per Switch — Voltage			
	110 Amp.	220 Amp.	440 Amp.	550 Amp.	110 Amp.	220 Amp.	440 Amp.	550 Amp.	110 Amp.	220 Amp.	440 Amp.	550 Amp.
¼	6	3	2	2	..	..	..	..	..	..	..	..
½	12	6	3	2	5	3	2	1	6	3	2	1
¾	15	8	4	3	7	3	2	2	8	4	2	2
1	20	10	5	4	10	5	3	2	12	6	3	2
1½	25	15	7	6	12	6	3	3	15	7	4	3
2	35	20	9	7	15	7	4	3	20	9	5	4
3	..	25	12	10	20	10	5	4	25	12	6	5
4	..	30	15	12	30	15	7	6	35	15	9	7
5	..	..	20	15	35	20	9	8	..	20	10	9
7½	..	..	..	..	..	25	15	12	..	30	15	12
10	..	..	..	..	..	35	20	15	..	35	20	15

The above relays are figured for 1½ times full load current. This normally allows slightly over 25% overload on the motor without the switch trippings.

In ordering extra current relays specify capacity in amperes.

Current Relays 1 to 35 Amps. Specify Capacity Wanted. List Price Each $1.50

TYPE WK-100 SAFETY MOTOR-STARTING SWITCHES—Continued

Style number and list price include type WK-100 safety motor-starting switch complete with current relays and undervoltage-release coil.

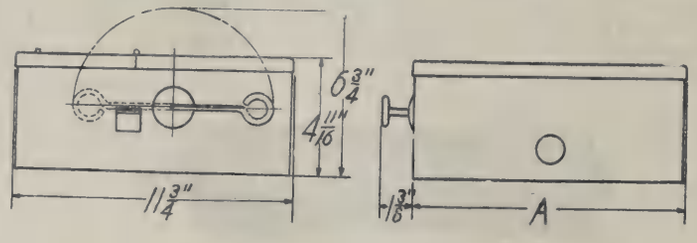
HP	Cycles	SINGLE-PHASE TWO-POLE Style No. 110 V	220 V	List Price	TWO-PHASE FOUR-POLE Style No. 110 V	220 V	440 V	550 V	List Price	THREE-PHASE THREE-POLE Style No. 110 V	220 V	440 V	550 V	List Price
¼	25	K-52052	K-52108	$21.00	.....	.....	.....	.....	$25.50	.....	.....	.....	.....	$22.50
¼	60	K-52089	K-52137	21.00	.....	.....	.....	.....	25.50	.....	.....	.....	.....	22.50
½	25	K-52053	K-52109	21.00	.....	K-52128	.....	.....	25.50	.....	K-52117	.....	.....	22.50
½	60	K-52090	K-52138	21.00	.....	K-52155	.....	.....	25.50	.....	K-52145	.....	.....	22.50
¾	25	K-52054	K-52110	21.00	.....	K-52128	.....	K-52201	25.50	.....	K-52118	.....	K-52193	22.50
¾	60	K-52091	K-52139	21.00	.....	K-52155	.....	K-52217	25.50	.....	K-52146	.....	K-52209	22.50
1	25	*K-52055	*K-52111	21.00	K-52066	*K 52129	K-52172	K-52201	25.50	K-52061	*K 52119	*K-52164	K-52193	22.50
1	60	*K-52092	*K-52140	21.00	K-52100	*K-52156	K-52186	K-52217	25.50	K-52095	*K-52147	*K-52179	K-52209	22.50
1½	25	*K-52056	*K-52112	21.00	K-52067	*K-52130	K-52172	K-52202	25.50	K-52062	*K-52120	*K-52165	K-52194	22.50
1½	60	*K-52093	*K-52141	21.00	K-52102	*K-52157	K-52186	K-52218	25.50	K-52096	*K-52148	*K-52180	K-52210	22.50
2	25	*K-52057	*K-52113	21.00	K-52068	*K-52131	K-52173	K-52202	25.50	K-52063	*K-52121	*K-52166	K-52195	22.50
2	60	*K-52094	*K-52142	21.00	K-52103	*K-52158	K-52187	K-52218	25.50	K-52097	*K-52149	*K-52181	K-52211	22.50
3	25	.....	*K-52114	21.00	K-52069	*K-52132	K-52174	K-52203	25.50	K-52064	*K-52122	*K-52167	K-52196	22.50
3	60	.....	*K-52143	21.00	K-52104	*K-52159	K-52188	K-52219	25.50	K-52098	*K-52150	*K-52182	K-52212	22.50
4	25	.....	K-52115	21.00	K-52071	K-52133	K-52175	K-52205	25.50	K-52065	K-52123	K-52168	K-52197	22.50
4	60	.....	K-52143	21.00	K-52106	K-52160	K-52189	K-52220	25.50	K-52099	K-52151	K-52183	K-52213	22.50
5	25	.....	.....	21.00	K-52072	*K-52134	K-52176	K-52206	25.50	.....	*K-52124	*K-52169	K-52198	22.50
5	60	.....	.....	21.00	K-52107	*K-52161	K-52190	K-52221	25.50	.....	*K-52152	*K-52101	K-52214	22.50
7½	25	.....	.....	21.00	.....	*K-52135	K-52177	K-52207	25.50	.....	*K-52126	*K-52170	K-52199	22.50
7½	60	.....	.....	21.00	.....	*K-52162	K-52191	K-52222	25.50	.....	*K-52153	*K-52184	K-52215	22.50
10	25	.....	.....	21.00	.....	*K-52136	K-52178	K-52208	25.50	.....	*K-52127	*K-52171	K-52200	22.50
10	60	.....	.....	21.00	.....	*K-52163	K-52192	K-52226	25.50	.....	*K-52154	*K-52185	K-52216	22.50

*Stock Sizes. When ordering specify style number of switch. For 40 and 50 cycles, specify same style number as 60 cycles except to be arranged for 40 or 50 cycles as the case may be. Prices same as for 60 cycles.

These switches are arranged for 50 per cent overload current to cover a normal motor with 25 per cent overload guarantee.

Order by Style Number

WEIGHTS AND OUTLINE DIMENSIONS

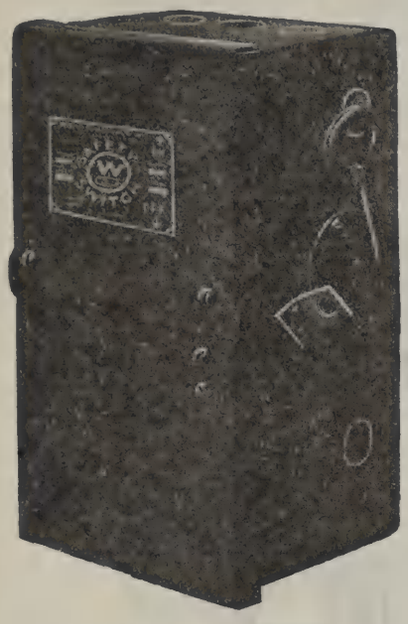


	Dimensions A-Inches	Approximate Weight, Pounds Net	Shipping
Two-Pole	8¾	18	27
Three-Pole	11	21	30
Four-Pole	13¼	24	33

These dimensions are for reference only. For official dimensions apply to the nearest district office.

TYPE WK-53 FULL-SAFETY ENTRANCE SWITCHES

CAPACITIES UP TO 30 AMPERES 125 VOLTS



TYPE WK-53 SWITCH WITH COVER CLOSED IN "ON" POSITION

TYPE WK-53 SWITCH IN "OFF" POSITION, WITH LOWER-HALF OF COVER OPEN, SHOWING ACCESS TO FUSE COMPARTMENT AND BARRIER TO SWITCH COMPARTMENT

The type WK-53 entrance switches meet the increasing demand for a truly safety switch that can be used as an entrance switch in residences, as low-capacity switches in industrial plants and at the same time is comparatively low in price. They are built in the same substantial way as all other Krantz products; their workmanship and rigidity is the highest grade.

Construction

The design is simple and it is not necessary to dismantle the entire switch and then re-assemble it to install it.

The switch is of knife type, mounted on a porcelain base; it is quick-break, and may be removed from the front without taking the box from the wall. The yoke of the switch is connected directly to the operating handle and there is a provision for locking the switch in the "OFF" position. The base is marked for the line side.

The enclosing box is made of 16-gauge metal finished in black and it is practically dust-proof, the cover over-lapping the box on four sides. The switch-operating handle is substantial and rigid and is mounted conveniently on the side of the box. The cover consists of two parts, hinged together at the center. The upper part, which covers the switch, is held in place by screws and can be protected from unauthorized interference by a seal. The lower part forms a door giving access to the fuses.

The cover has two special features: (1) The upper part is so shaped that it provides a complete barrier between the fuse compartment and the switch compartment, so that it is impossible to reach the switch blades or the line connections when the fuse compartment is open. (2) A lug on the fuse-compartment cover interlocks with the handle so that the cover cannot be opened except when the switch is in the "OFF" position and the fuses dead; and if the switch is closed while this door is open, the cover automatically closes. The result of this arrangement is that it is impossible to reach live parts of the switch at any time, except by removing the entire cover. To guard against

TYPE WK-53 FULL-SAFETY ENTRANCE SWITCHES—Continued

the removal of this cover by unauthorized persons, a provision is made for a meter seal. This is exclusive with the type WK-53 switch and is a decided advantage.

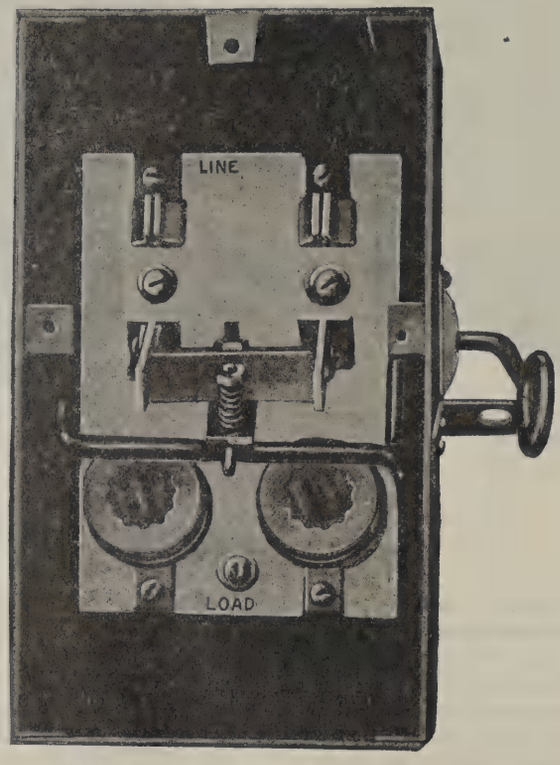
Further protection against theft of current, when the switch is locked in the open position, is afforded by the barrier which prevents tapping off the live terminals.

If examination or inspection is to be made, it is simply necessary to remove two screws and the meter seal (if used), thus exposing the switch and fuses and giving ready access to the entire switch. This design is thoroughly protected by patents.

Ten knockouts for conduit entrance are provided in ends and sides of box. Since the switch does not close by gravity, it may be mounted in any position.

Poles	Size of Box	Shipping Wt. Lbs. Each	Style No.	List Price Each
2	$9 \times 4\frac{7}{16} \times 3\frac{13}{16}$	10	K-53000	$2 40
3	$9 \times 6\frac{1}{2} \times 3\frac{13}{16}$	13	K-53001	3 75

Style numbers and prices do not include fuses.



TYPE WK-53 SWITCH WITH COVER REMOVED SHOWING WORKING PARTS

Order by Style Number

KRANTZ SAFETY ENCLOSED AUTO-LOCK BRUSH SWITCHES

For Capacities up to 1000 Amperes, and for Voltages up to 600 A.C.

KRANTZ AUTO-LOCK SWITCH WITH COVER LOCKED IN CLOSED POSITION

Application

Enclosed switches are used wherever the ordinary open knife switches may be applied, with the difference that the enclosed switch provides safety to the operator. They are desirable in steel mills, factories, mines and similar places employing men having practically no knowledge of electricity and its attendant risk, and where switches must be placed in exposed locations subject to damage from loaded trucks or from heavy material being carried by employees through a shop or mine.

The Krantz safety enclosed switches offer particular advantages in that they are 100 per cent safe under all conditions, and brush moving contacts are made use of in place of the knife blade form of contact which has previously been standard for all switches. These advantages are described in full in the following pages under "Operating Characteristics" and "Construction."

Special attention is called to the very strong recommendations made by the United States Department of Commerce, Bureau of Standards, in the Safety Code adopted by them for the use of enclosed switches. These specifications, intact or similarly worded, have been adopted by a number of states, and in some of these states 100 per cent safety, such as provided by Krantz switches, is an absolute requirement.

KRANTZ AUTO-LOCK SWITCH FOR 550 OR 600 VOLTS, A. C. WITH COVER OPEN—ALL PARTS EXPOSED ARE DEAD

All Kranz safety enclosed switches are approved by the Underwriters' Laboratories under classification "A" meaning "Accomplished Safety."

Distinctive Features

Krantz safety enclosed switches have the following distinctive features which make them especially suitable to the purpose for which they are intended:

100 per cent safety to operator, due to impossibility of coming in contact with a live part either in operating the switch or in replacing the fuse; the use of double-break brush-type movable switch contacts, which cannot weld shut from slow closing by careless operators; arcing tips on brushes, which protect brush leaves; easily replaceable contacts; heavy sheet steel box of No. 12 gauge steel (or of heavy cast iron on special order).

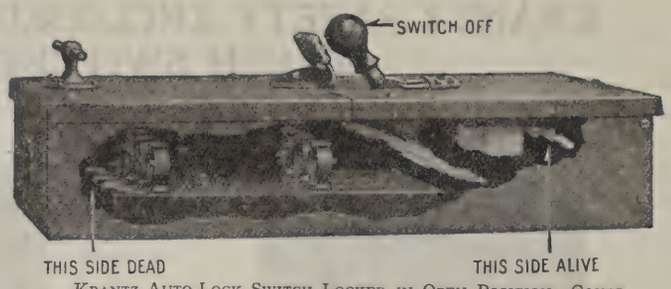
Operating Characteristics

The safety auto-lock enclosed switch was developed to supply the need for a switch which would be 100 per cent safe in operation under all conditions; which would have brush-type contacts representing the same improvement over ordinary knife-blade switch construction as has always been represented by brush-type carbon circuit-breakers; and which would have the improved operating characteristics possible only by eliminating most of the contact joints between incoming and outgoing terminals.

The switch parts are so mounted inside of the box that the door over the fuses is automatically locked when the switch is in the closed position. When the switch contacts are open, the door can be opened after turning the handle to the "off"

KRANTZ SAFETY ENCLOSED AUTO-LOCK BRUSH SWITCHES—Continued

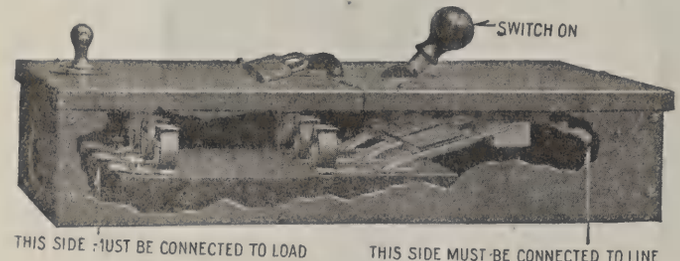
position thus opening the "auto-lock" device. With the door open, in which position it is held by means of a catch, the switch cannot be closed. When the switch is in the open position, the brushes completely obstruct the passage between the fuse chamber and live contact chamber, making it impossible to reach the hand in far enough to touch the live stationary contacts.



KRANTZ AUTO-LOCK SWITCH LOCKED IN OPEN POSITION—COVER LOCKED CLOSED

The switches are all made with fuse holders at the bottom, which is the outgoing end so that the fuse holders are always "dead" when the switch door is opened, and fuses can be replaced, therefore, in perfect safety.

This type of switch is called 100 per cent safe as compared with an ordinary enclosed switch, in which the switch and fuses are in the same compartment and the live parts are exposed when the door is open.



CONTACTS CLOSED—COVER CANNOT BE OPENED

The door of the safety auto-lock switch may be locked shut by a padlock, thus making it possible for the switch to be operated by inexperienced persons, but confining the re-fusing operation to only those persons who have access to the key. A padlock may also be used to lock the switch in the "off" position. By locking the switch "off", safety is provided to workmen who might be injured when making repairs to apparatus if the switch were accidentally closed. Upon special order these switches will be provided so that they may be padlocked in the "on" position. Yale and Towne padlock No. 815 will fit the holes provided in these switches and are listed on the next page.

The moving contacts are of the laminated double-ended brush type, and make contact with the flat stationary terminal pieces at each end. In this operation the leaves of the brushes spread apart and each leaf makes its individual contact, giving ample carrying capacity for much more than the rated current of the switch. The spreading of the brush provides a wiping or self-cleaning action, which keeps the surface of both the brush ends and stationary contacts clean, and provides for continual good contact with an exceptionally low resistance.

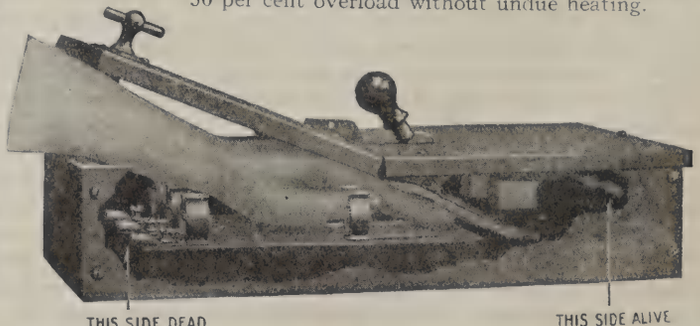
The double-ended brushes provide a double break, dividing the arc between the two ends. As each end is provided with a separate arcing tip, the brushes, and the main stationary contact surfaces are protected from arcing, giving an extremely long life to these contacts without replacement.

The electric path through one of these switches is from the entrance terminal to the upper stationary contact, to the brush, to the lower stationary contact, and thence through the fuse to the out-going terminals. A simplified path of many less contact joints is thus provided as compared with the construction of the old style standard knife blade switch.

In the closed position the switch is held in positive position by throwing a toggle over center. Thus, full contact is always secured and the switch cannot be left in the partly closed position. In opening the switch the spring pressure of the brush laminations assists the main spring and provides for a very quick break. The mechanism operates independently of the switch handle, which cannot therefore retard the quick break of the switch contacts.

The maximum current density of any conducting part is 750 amperes per square inch of cross section.

These switches will carry their rated current plus 50 per cent overload without undue heating.



IMPOSSIBLE TO TOUCH LIVE PARTS

KRANTZ SAFETY ENCLOSED AUTO-LOCK BRUSH SWITCHES—Continued

Construction

The Krantz safety auto-lock switch is enclosed in a sheet steel box made of No. 12 gauge steel, thus providing exceptional strength to resist rough handling and the jolts from loads on passing trucks, cars, etc., when used especially in steel mills, shops and mines. The boxes are enameled green, this color representing safety.

The stationary contacts are of hard-drawn copper and with the fuse clips and terminals are mounted on slate bases free from metallic veins.

The moving contacts are laminated spring copper brushes, double-ended, with auxiliary arcing contacts at each end. Bronze outer leaves are provided for additional spring pressure.

The brushes in multipole switches are rigidly held together by being riveted through proper insulation to galvanized steel cross bars.

All fuse connections are provided for the use of N. E. C. enclosed fuses up to 400 amperes inclusive. Switches of capacities above 400 amperes are arranged to take copper link fuses.

The movement is galvanized steel of toggle type, and is attached to the stationary end of the switch cover. It is easily removable for inspection by removing the top cover, which is held on by machine screws.

The insulation of the brushes from cross bar and movement is water and acid-proof, and does not warp or shrink.

The handle is of black-enameled wood.

Holes are provided in the ends of the switch boxes for a single conduit for the incoming and outgoing leads. These end pieces are easily removable and may be replaced by others for different size or arrangement of conduit. (See dimension table for size of conduit holes in standard switches.)

For 550 and 600-volts A.C. service Standard Auto-Lock Switches are provided with slate barriers between opposite polarity. Dimensions same as shown for 500-volt A.C. switches.

PRICES

Krantz Safety Auto-Lock Switches

Style numbers and list prices include switches complete ready for operation, but without fuses or padlocks. Switches with other than standard size or arrangement of conduit holes will be supplied on special order without extra price.

Capacity Amperes	Single-Pole Style No.	Single-Pole List Price	Double-Pole Style No.	Double-Pole List Price	Three-Pole Style No.	Three-Pole List Price	Four-Pole Style No.	Four-Pole List Price
250 Volts A. C. or D. C., Fused								
30	K-37501	$ 8 90	K-37511	9 10	K-37521	$ 10 35	K-37531	$ 14 40
60	K-37502	10 00	K-37512	10 60	K-37522	12 75	K-37532	18 20
100	K-37503	15 00	K-37513	16 65	K-37523	22 00	K-37533	27 00
200	K-37504	23 50	K-37514	25 60	K-37524	30 00	K-37534	42 50
400	K-37505	40 00	K-37515	44 00	K-37525	55 00	K-37535	72 00
600*	K-37506	64 00	K-37516	70 00	K-37526	91 00	K-37536	111 00
800*	K-37507	105 00	K-37517	115 00	K-37527	148 00	K-37537	200 00
1000*	K-37508	150 00	K-37518	167 00	K-37528	200 00	K-37538	260 00
500 Volts A. C., Fused								
30	K-37541	11 50	K-37551	11 75	K-37561	13 60	K-37371	18 00
60	K-37542	12 50	K-37552	12 90	K-37562	15 15	K-37572	20 00
100	K-37543	18 00	K-37553	19 50	K-37563	24 20	K-37573	30 00
200	K-37544	28 00	K-37554	32 00	K-37564	36 40	K-37574	48 50
400	K-37545	46 00	K-37555	52 00	K-37565	66 00	K-37575	80 00
250 Volts D. C. and 500 Volts A. C., Unfused								
30	K-37581	8 50	K-37591	8 80	K-37601	10 00	K-37611	13 50
60	K-37582	9 50	K-37592	9 90	K-37602	12 00	K-37612	16 00
100	K-37583	13 00	K-37593	14 40	K-37603	18 00	K-37613	23 00
200	K-37584	20 00	K-37594	21 00	K-37604	26 00	K-37614	34 00
400	K-37585	36 00	K-37595	40 00	K-37605	47 00	K-37615	62 00
600	K-37586	58 00	K-37596	64 00	K-37606	78 00	K-37616	100 00
800	K-37587	95 00	K-37597	105 00	K-37607	124 00	K-37617	160 00
1000	K-37588	135 00	K-37598	150 00	K-37608	170 00	K-37618	220 00

*Supplied with fuse connections for copper link fuses.
For price of 550 or 600-volt A.C. switches add 5% to prices of 500-volt switches.
For outline dimensions see following page.

Padlock for Use with Auto-Lock Switch

Description	Net Price
Yale and Towne Padlock No. 815, Bronze, with two Keys to Each Lock	$20 00 Per Doz. 2 00 Each

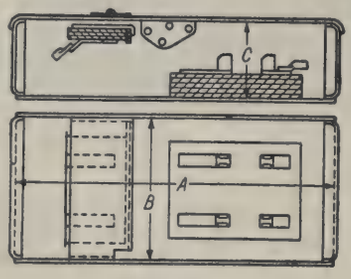
Replacing Brushes for Auto-Lock Switches

Style number and price includes laminated brushes complete with cross bars and saddles. The same brushes are used for fused and unfused switches for 250 or 500-V.

Style No	Amperes	Poles	List Price	Style	Amperes	Poles	List Price
52073	30 and 60 amp.	1	$ 3 00	52081	200 amp.	1	$ 6 40
52074	30 and 60 amp.	2	4 50	52082	200 amp.	2	9 00
52075	30 and 60 amp.	3	5 50	52083	200 amp.	3	11 00
52076	30 and 60 amp.	4	6 80	52084	200 amp.	4	13 70
52077	100 amp.	1	4 50	52085	400 amp	1	11 40
52078	100 amp.	2	6 80	52086	400 amp.	2	15 00
52079	100 amp.	3	8 40	52087	400 amp.	3	19 60
52080	100 amp.	4	10 60	52088	400 amp.	4	24 00

KRANTZ SAFETY ENCLOSED AUTO-LOCK BRUSH SWITCHES—Continued

OUTLINE DIMENSIONS
Krantz Safety Auto-Lock Switch



DIMENSIONS IN INCHES CORRESPONDING TO LETTERS IN ABOVE OUTLINE

Amperes†	SINGLE-POLE				DOUBLE-POLE				THREE-POLE				FOUR-POLE			
	A	B	C	Net* Wt. Lb.	A	B	C	Net* Wt. Lb.	A	B	C	Net* Wt. Lb.	A	B	C	Net* Wt. Lb.
250 Volts D. C., Fused																
30	13½	6	3 15/16	14½	13½	6	3 15/16	19	13½	9	3 15/16	24	13½	12	3 15/16	33
60	16½	6	3 15/16	16	16½	6	3 15/16	21½	16½	9	3 15/16	28	16½	12	3 15/16	40
100	21	6	3 15/16	20	21	6	3 15/16	26½	21	9	3 15/16	36	21	12	3 15/16	50
200	29	7½	4 9/16	36	29	7½	4 9/16	46	29	10½	4 9/16	60	29	13¼	4 9/16	74
400	33½	7½	4 9/16	65	33½	9	4 9/16	80	33½	12	4 9/16	100	33½	16½	4 9/16	120
250 Volts D. C. and 500 Volts A. C., Unfused																
30	13½	6	3 15/16	14	13½	6	3 15/16	19	13½	9	3 15/16	24	13½	12	3 15/16	33
60	13½	6	3 15/16	16	13½	6	3 15/16	20½	13½	9	3 15/16	28	13½	12	3 15/16	40
100	13½	6	3 15/16	16	13½	6	3 15/16	21½	13½	9	3 15/16	28½	13½	12	3 15/16	40½
200	20⅜	7½	4 9/16	27	20⅜	7½	4 9/16	34	20⅜	10½	4 9/16	44	20⅜	13¼	4 9/16	58
400	23¾	7½	4 9/16	50	23¾	9	4 9/16	60	23¾	12	4 9/16	75	23¾	16½	4 9/16	100
500 Volts A. C., Fused																
30	18⅝	6	3 15/16	20	18⅝	6	3 15/16	24	18⅝	9	3 15/16	34	18⅝	12	3 15/16	46
60	18⅝	6	3 15/16	24	18⅝	6	3 15/16	30	18⅝	9	3 15/16	40	18⅝	12	3 15/16	50
100	23½	6	3 15/16	32	23½	6	3 15/16	40	23½	9	3 15/16	50	23½	12	3 15/16	60
200	32¼	7½	4 9/16	45	32¼	7½	4 9/16	58	32¼	10½	4 9/16	71	32¼	13¼	4 9/16	84
400	36½	7½	4 9/16	85	36½	9	4 9/16	100	36½	12	4 9/16	120	36½	16½	4 9/16	140

*For shipping weight add 20% to net weight.
†Dimensions for switches above 400 amperes furnished on request.

DRILLING DATA

Cabinets will be drilled for conduits in accordance with specifications without charge.

Cabinets for switches of 600-ampere capacity and higher will be shipped without drilling unless drilling data accompanies order. Maximum size of conduit 3½ inches.

Unless otherwise ordered, cabinets are drilled top and bottom as follows:

Amperes	DIAMETER IN INCHES			
	Single Pole	Double Pole	Three Pole	Four Pole
30-60	½	½	¾	¾
100	¾	1	1¼	1½
200	1	1½	1½	2
300	1½	2	2½	3
400	2	2½	3	3½

SAFETY MINE DISCONNECTING SWITCHES

600 VOLTS

SINGLE-POLE BRUSH-TYPE

For A. C. or D. C. Circuits

The safety mine disconnecting switches have all the features of the safety enclosed auto lock switches and are mounted in *cast iron boxes* to withstand the severe atmospheric conditions prevalent in underground service. They are gas and vapor proof. They may be made water-proof by the use of rubber gaskets under the box cover, at an additional charge of 10 per cent to the list price of switch.

Construction

The handle of the switch is removable only in the "OFF" position, thus compelling the operator to throw-off the switch in order to turn in the handle when leaving the mine.

The box is painted inside with P. and B. paint.

The switch blades are of the laminated type, mounted on a very heavily insulated carrier, and make contact with flat stationary copper terminals. The switch carrier is supported by a steel bracket which is mounted on a one-inch slate base, thereby increasing the insulation between the switch blades and the box.

All switches are of the double-break quick-break type and are equipped with arcing tips. Since the mechanism is operated independently of the switch handle, it is impossible to retard the quick-break of the switch contacts.

The brushes are easily removed for repair or replacement without disturbing the conduit or switch parts, by removing the two screws which clamp the brush to the crossbar.

Amps.	Poles	Volts	Style No.	List Price
100	1	600	K-52518	$40 00
200	1	600	K-52519	50 00
400	1	600	K-52520	60 00
600	1	600	K-52521	90 00

APPROXIMATE DIMENSIONS AND WEIGHTS

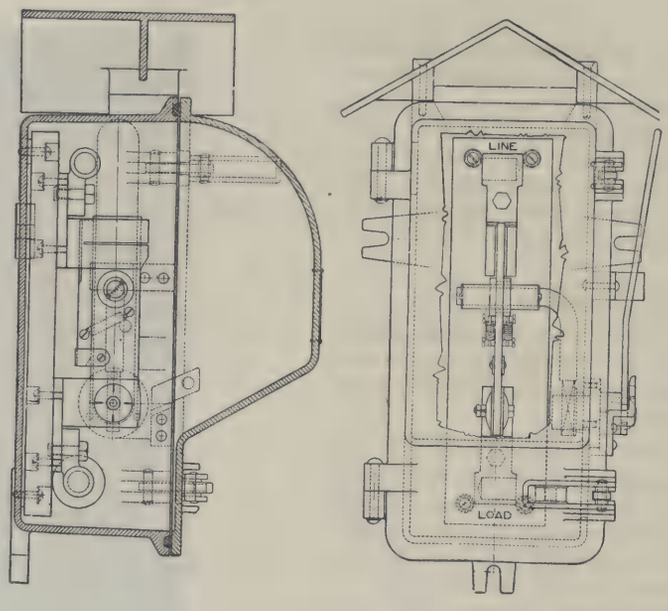
Amps.	Outside Dimensions			Approximate Weights	
	Length	Width	Depth	Net	Shipping
100	23 inches	9 inches	6 inches	57 pounds	75 pounds
200	23 inches	9 inches	6 inches	57 pounds	75 pounds
400	26½ inches	10¾ inches	6 inches	75 pounds	95 pounds
600	26½ inches	10¾ inches	6 inches	87 pounds	105 pounds

Fused switches and two or three pole switches for this service are special and prices will be quoted on application.

Order by Style Number

SAFETY ORE-MINE SWITCHES

KNIFE-TYPE



This is an ideal safety switch for ore mine use where the voltage is 250 direct current or 500 alternating current and is somewhat different from the "mine-type" disconnecting switch shown on the previous page. It is a knife switch inclosed in a cast iron water-proof box with a shed top to protect the box against "drip."

Construction

Two coats of P. and B. paint are given the box both inside and out and for further insulation it is lined with asbestos paper. Two ice-box type catches clamp down the cover against a rubber gasket. The handle is of galvanized steel rod mounted on the outside of the box and can be locked in the off position; it is directly connected to the yoke of the switch. All bolts and rivets inside and outside of the box are brass or bronze so that the possibility of rust or corrosion has been reduced to a minimum. The switch is of the knife type, quick-break, mounted on a slate base with wire terminals, top and bottom. Up to time of issue of this catalogue these switches have been developed for only capacities listed below. Other sizes can be completed for orders where the quantity would warrant such development.

Single-Pole Single-Throw Unfused

Amp.	Volts	Net Weight	Style No.	Price
200	{ 250 D.C. / 500 A.C. }	65	52350	$60 00
400	{ 250 D.C. / 500 A.C. }	70	52227	70 00

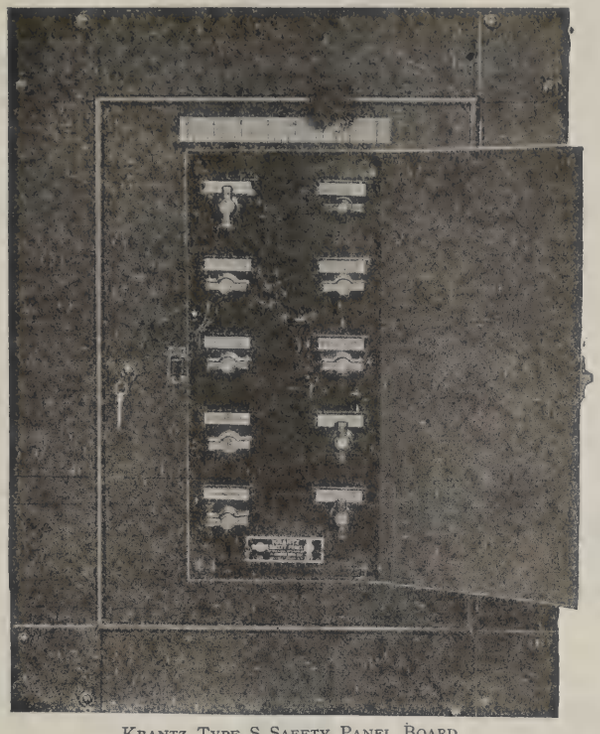
Order by Style Number

KRANTZ TYPE S SAFETY PANEL BOARDS

DEAD-FRONT—HEAVY-DUTY SWITCH

For Capacities up to 200 Amperes, and for Voltages up to 250

30-Ampere Branches



KRANTZ TYPE S SAFETY PANEL BOARD

Application

The Krantz type S safety panel boards were developed to supply the existing demand for electrical devices that can be safely handled by persons inexperienced in the use of such apparatus. Panel boards for the control of lighting circuits are essentially in this class of apparatus, due to their application in private houses, apartment houses, stores, factories, etc.

Since the introduction of these panel boards the demand for safety apparatus has greatly increased, especially in the applications on lower voltages which are ordinarily considered not dangerous. This demand is featured by the Safety Code adopted by the United States Department of Commerce, Bureau of Standards, and by the various state Safety Codes.

These type S panel boards are standardized in such form as to make them applicable wherever the standard form of live-face panel board has heretofore been applied.

All Krantz type S safety panel boards have been approved by the Underwriters' Laboratories, for 30-ampere 250-volt branches.

Distinctive Features

The following distinctive features apply to the type S safety panel boards:

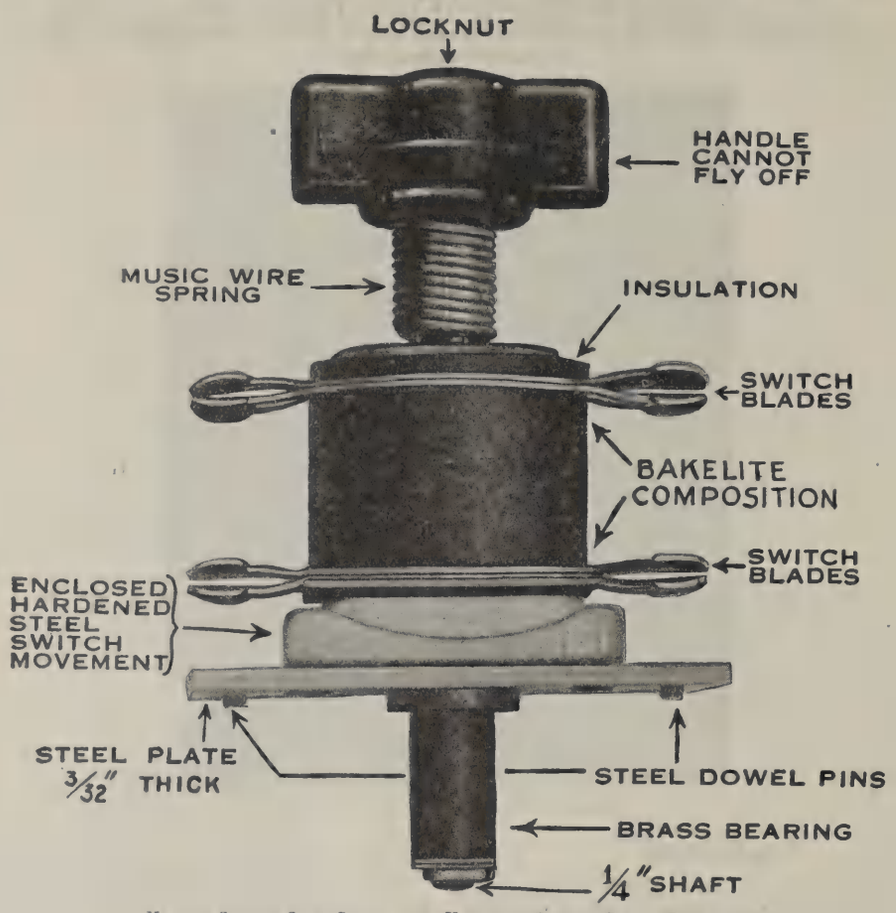
100 per cent safety to the operator in the ordinary operation of branch or main switches; fuses in separate locked compartment; all branch switches are of quick-break and quick-make snap switch type, of extra heavy construction and large capacity; main switches, where used, of Krantz quick-break brush-type construction; especially good appearance of panels, cabinets, and trims.

Operating Characteristics

In the construction of these panel boards the branch switches, and, when used, the main switches are covered by a safety cover of ⅜-inch slate with only the operating handles of the switches projecting through this cover. A ⅜-inch slate frame surrounds the cover forming a separate safety compartment for the switch handles covered by a steel or wood door provided with a catch. The fuse holders are mounted on the base outside of the safety frame, and are covered by a steel or wood door, according to trim selected. This door over the fuse compartment is provided with a Yale lock, thus preventing any but authorized persons from having access to the fuse compartment.

In the operation of the branch switches the quick-make and quick-break features make it impossible for a careless operator to leave a switch only partly closed, and the extra heavy construction of these switches provides for an extra long life without the necessity of renewing parts.

KRANTZ TYPE S DEAD-FRONT SAFETY PANEL BOARDS—Continued

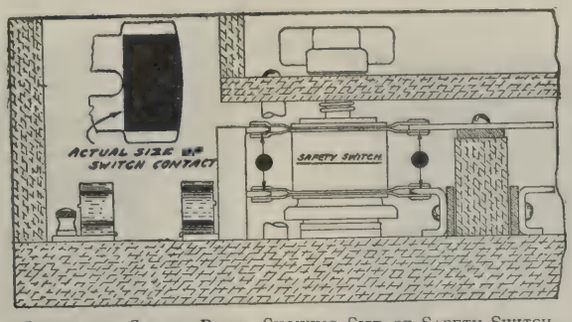


KRANTZ SAFETY SNAP SWITCH FOR USE WITH SAFETY PANEL BOARDS

METHOD OF MOUNTING KRANTZ SAFETY SNAP SWITCH

All switches are mounted on a steel plate, which is secured to a continuous steel base by two screws and hardened split steel lock washer of positive pattern, also two dowel pins.

KRANTZ TYPE S DEAD-FRONT SAFETY PANEL BOARDS—Continued



SECTION OF SAFETY PANEL SHOWING SIZE OF SAFETY SWITCH CONTACT, WHICH IS SEVERAL TIMES THAT OF THE USUAL SNAP OR PUSH BUTTON USED IN SAFETY PANEL CONSTRUCTION

The main switch, when provided, is of standard Krantz brush type, and operates as a quick-break switch, the break being independent of the operating handle, thus insuring against any excessive burning of the contacts due to careless operation.

Construction

The Krantz type S safety panel boards are regularly sold only as complete boards with enclosing cabinets, since only in this way can the safety provisions be properly insured.

General Specifications—The specifications for these safety panel boards are as follows:

Base—1-inch black slate.

Frame—½-inch black slate slotted for mains and branches. Held together by dull black finished corners, which conceal all joints of frame.

Safety Cover—⅜-inch black slate surrounded by ⅜-inch black slate frame held by dull black finished corner pieces.

Card Holder—Dull black finish. One for each circuit.

Corner Iron—⅛-inch steel with round corners, clamping slate frame and corner pieces by one screw.

Gutter—3¼-inch; add 6½ inches to panel size to get size inside of box. Standard gutters 3¼ inches, 4 inches, 4¾ inches, 5½ inches.

Bus-bars—98% conductivity drawn copper.

Clips—98% conductivity drawn copper one piece.

Branch Bars—98% conductivity drawn copper one piece.

Terminal Lugs—98% conductivity drawn copper; no castings used.

Current Density and Spacings—As per rules and regulations of the National Board of Fire Underwriters.

Capacity—Mains are figured:

3 amperes per circuit for 3-2 wire 125 volts.

6 amperes per circuit for 2-2 wire 125 volts.

3 amperes per circuit for 2-2 wire 250 volts.

Mains of larger capacity are listed on a following page.

Branch Circuit Terminals—Provided with special washers confining and retaining the wires.

Branch Circuit Switches—Special Krantz 30-amp. snap switches. Absolutely strongest panel switch on the market.

Fuse Arrangement—N. E. C. with phosphor bronze clips. Edison plug with black-enameled porcelain shell.

Main and Feeder Switches—Krantz safety brush switches, quick-break, double-break.

Through Feed Panels—Listed on a following page.

Cabinets—Mitred channel construction not less than No. 12 gauge riveted.

Panels are held in position by four adjustable clamps, held to the box by two screws each. Weight of panels is supported on angle iron, riveted to box.

Flush boxes are covered with two coats of paint. Surface boxes are dull black finish.

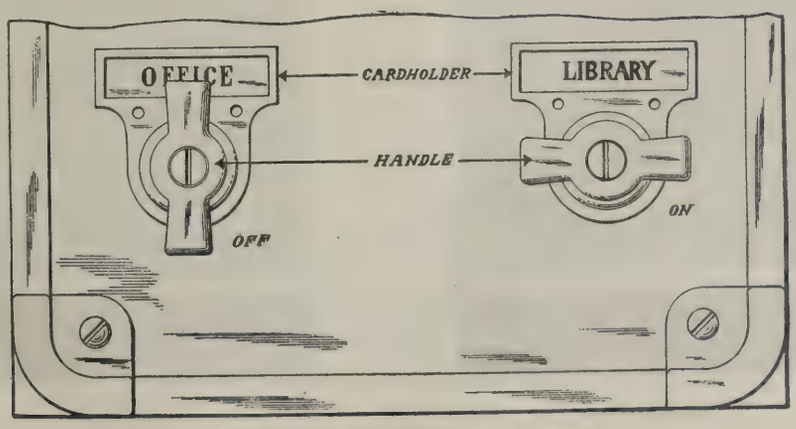
Doors and Trims—Doors are equipped with Yale lock on fuse compartment and catch over switch compartment.

Steel trims are of No. 10 gauge, with concealed hinges and dull black finish.

Wood trims are ⅞" plain oak, filled and rubbed to a smooth even finish. Lined with sheet iron over gutter.

Special boxes, steel or wood trims, and panels with marble bases can be furnished on special order—prices on request.

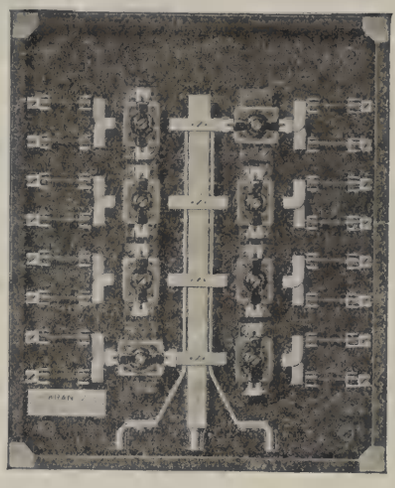
Branch Switches—The branch switches used on these panels are a special feature, as they consist of double-pole, double-break snap switches of extra large size and ruggedness of design. The contacts have ample carrying capacity and interrupting



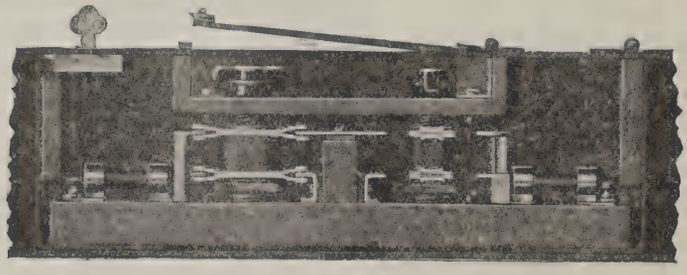
HALF-SIZE VIEW OF SWITCH COMPARTMENT

KRANTZ TYPE S DEAD-FRONT SAFETY PANEL BOARDS—Continued

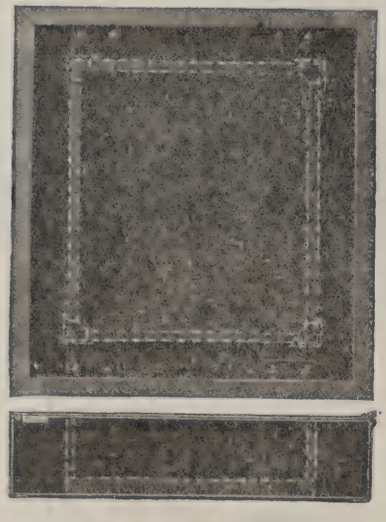
SAFETY PANEL BOARD IN STEEL BOX WITHOUT TRIM OR DOOR



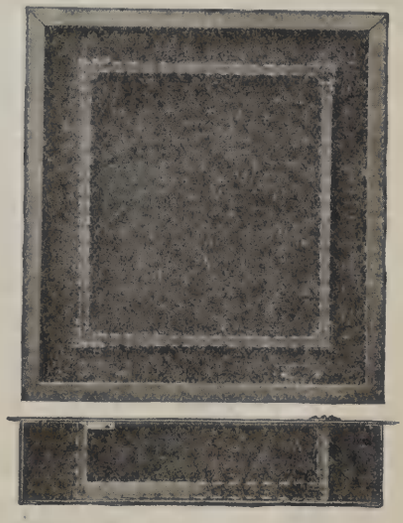
SAFETY PANEL BOARD WITH PROTECTING COVER REMOVED



HORIZONTAL SECTION THROUGH SAFETY PANEL BOARD



SURFACE BOX



FLUSH BOX

STEEL TRIM

WOOD TRIM

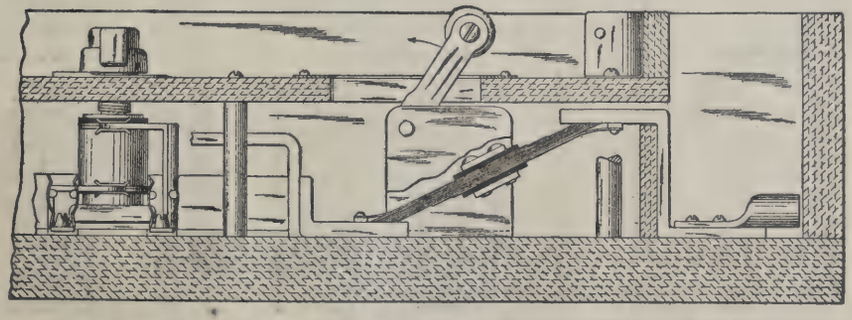
capacity to handle 30 amperes continuously. These switches are both quick-make and quick-break, and are mounted upon individual steel bases, making the complete unit easily replaceable. In assembly of the panel the individual switches are firmly fastened to a continuous steel base providing absolute insurance against their getting out of alignment.

Branch Switch Stationary Contacts—Contact from the switch blade is made directly on one side to copper straps connected by a single joint to the mains, and on the other side to bent copper straps connected directly to the fuse clips. The number of connection joints, therefore, is greatly reduced in this construction as compared with the use of the ordinary snap switches or push button switches as used in safety panels.

Main Switches—The main switches, when used, are of the standard Krantz brush-type construction with galvanized steel toggle mechanism, as used in the Krantz safety **auto-lock** enclosed switches. They are quick-break and double-break, and are provided with arcing tips at each end. They are of ample capacity to stand much heavier than the current for which they are rated. These switches are removable as a unit, and interchangeable. They may be placed under a separate door on special order; for prices see pages on "Through-Feeds and Mains of Larger Capacity."

Fuse Connections—The branch fuse connections are provided either for N. E. C. enclosed fuses or standard plug fuses.

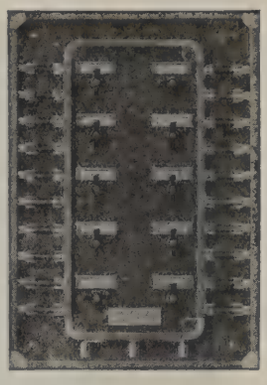
Fuses in Mains—Standard Krantz panel boards are not made with fuses in mains, as fuses for the same purpose are required by the N. E. Code at the origin of the line feeding the panel, and they are, therefore, unnecessary and undesirable at the panel board. Fuses in mains will be supplied on special order; for prices see pages on "Through-Feeds and Mains of Larger Capacity."



SECTION OF KRANTZ SAFETY PANEL BOARD WITH SAFETY BRUSH TYPE MAIN SWITCH

Mains—With terminal lugs only.

Branches—Two-wire with special 30-ampere snap switches arranged for N. E. C. enclosed fuses.



CABINETS

Style FS—Flush steel box and steel trim.

Style SS—Surface steel box and steel trim.

Style FW—Flush steel box and wood trim.

For inside dimensions of box add 6½ inches to panel size for 3¼-inch gutter.

Through-feed panels and mains of larger capacity are listed on a following page.

Style number and list price do not include fuses.

Boxes will be drilled for conduit without extra charge provided complete drilling information accompanies order. Boxes will be shipped undrilled unless templates are sent with order showing location and size of holes wanted

Knockouts for one half of the total number of circuits will be furnished without additional charge when requested on the initial order. Extra knockouts will be furnished at **10c** each, list.

For panels with fuses in the mains add 8 per cent to list price of panel.

For panels with three-way switches see table of parts and accessories on a following page.

TYPE S PANEL BOARDS COMPLETE WITH CABINET

Amps. Capacity of Mains	Outside Dimensions of Panels in Inches Height	Width	Depth	Number of Circuits	STYLE NUMBERS N. E. C. Fuses Style FS	Style SS	List Price	STYLE NUMBERS N.E.C. Fuses Style FW	List Price
	2-Wire Mains				**125 Volts**			**Double Branch**	
30	11½	14½	4½	4	K-38254	K-38270	$ 42 00	K-38302	$ 46 00
60	14½	14½	4½	6	K-38255	K-38271	49 00	K-38303	54 00
60	17½	14½	4½	[illegible]	K-38256	K-38372	59 00	K-38304	65 00
60	20½	14½	4½	10	K-38257	K-38273	68 00	K-38305	75 00
100	23½	14½	4½	12	K-38258	K-38274	77 00	K-38306	85 00
100	26½	14½	4½	14	K-38259	K-38275	87 00	K-38307	96 00
100	29½	14½	4½	16	K-38260	K-38276	94 00	K-38308	104 00
200	32½	14½	4½	18	K-38261	K-38277	104 00	K-38309	115 00
200	35½	14½	4½	20	K-38262	K-38278	115 00	K-38310	126 00
200	38½	14½	4½	22	K-38263	K-38279	123 00	K-38311	136 00
200	41½	14½	4½	24	K-38264	K-38280	135 00	K-38312	148 00
200	44½	14½	4½	26	K-38265	K-38281	144 00	K-38313	158 00
200	47½	14½	4½	28	K-38266	K-38282	155 00	K-38314	171 00
200	50½	14½	4½	30	K-38267	K-38283	167 00	K-38315	183 00
200	53½	14½	4½	32	K-38268	K-38284	178 00	K-38316	195 00
	3-Wire Mains				**125 Volts**			**Double Branch**	
30	11½	14½	4½	4	K-38350	K-38366	42 00	K-38398	46 00
30	14½	14½	4½	6	K-38351	K-38367	49 00	K-38399	54 00
30	17½	14½	4½	[illegible]	K-38352	K-38368	59 00	K-38400	65 00
30	20½	14½	4½	10	K-38353	K-38369	68 00	K-38401	75 00
60	23½	14½	4½	12	K-38354	K-38370	77 00	K-38402	85 00
60	26½	14½	4½	14	K-38355	K-38371	87 00	K-38403	96 00
60	29½	14½	4½	16	K-38356	K-38372	94 00	K-38404	104 00
60	32½	14½	4½	18	K-38357	K-38373	104 00	K-38405	115 00
60	35½	14½	4½	20	K-38358	K-38374	115 00	K-38406	126 00
100	38½	14½	4½	22	K-38359	K-38375	123 00	K-38407	136 00
100	41½	14½	4½	24	K-38360	K-38376	135 00	K-38408	148 00
100	44½	14½	4½	26	K-38361	K-38377	144 00	K-38409	158 00
100	47½	14½	4½	28	K-38362	K-38378	155 00	K-38410	171 00
100	50½	14½	4½	30	K-38363	K-38379	167 00	K-38411	183 00
100	53½	14½	4½	32	K-38364	K-38380	178 00	K-38412	195 00
	2-Wire Mains				**250 Volts**			**Double Branch**	
30	11½	14½	4½	[illegible]	K-38446	K-38462	46 00	K-38494	51 00
30	14½	14½	4½	6	K-38447	K-38463	54 00	K-38495	60 00
30	17½	14½	4½	[illegible]	K-38448	K-38464	65 00	K-38496	72 00
30	20½	14½	4½	10	K-38449	K-38465	75 00	K-38497	82 00
60	23½	14½	4½	12	K-38450	K-38466	85 00	K-38498	94 00
60	26½	14½	4½	14	K-38451	K-38467	96 00	K-38499	106 00
60	29½	14½	4½	16	K-38452	K-38468	104 00	K-38500	116 00
60	32½	14½	4½	18	K-38453	K-38469	115 00	K-38501	127 00
60	35½	14½	4½	20	K-38454	K-38470	126 00	K-38502	138 00
100	38½	14½	4½	22	K-38455	K-38471	136 00	K-38503	150 00
100	41½	14½	4½	24	K-38456	K-38372	148 00	K-38504	163 00
100	44½	14½	4½	26	K-38457	K-38473	158 00	K-38505	174 00
100	47½	14½	4½	28	K-38458	K-38474	171 00	K-38506	188 00
100	50½	14½	4½	30	K-38459	K-38475	183 00	K-38507	201 00
100	53½	14½	4½	32	K-38460	K-38476	195 00	K-38508	215 00

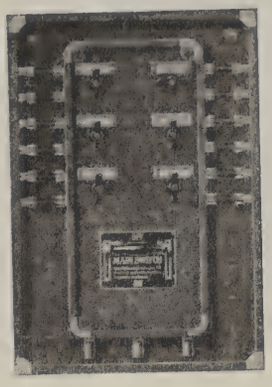
For shipping weights see fourth page following.

Order by Style Number

KRANTZ TYPE S DEAD-FRONT SAFETY PANEL BOARDS—Continued

Mains—With unfused safety brush switch.

Branches—Two-wire with special 30-ampere snap switch arranged for N. E. C. enclosed fuses.



CABINETS

Style FS—Flush steel box and steel trim.

Style SS—Surface steel box and steel trim.

Style FW—Flush steel box and wood trim.

For inside dimensions of box add 6½ inches to panel size for 3¼-inch gutter.

Through-feed panels and mains of larger capacity are listed on a following page.

Style number and list price do not include fuses.

Boxes will be drilled for conduit without extra charge provided complete drilling information accompanies order. Boxes will be shipped undrilled unless templates are sent with order showing location and size of holes wanted.

Knockouts for one half of the total number of circuits will be furnished without additional charge when requested on the initial order. Extra knockouts will be furnished at **10c** each, list.

For panels with fuses in the mains add 4 per cent to list price of panel.

For panels with three-way switches see table of parts and accessories on a following page.

TYPE S PANEL BOARDS COMPLETE WITH CABINET

Amps. Capacity of Mains	Outside Dimensions of Panels in Inches Height	Width	Depth	Number of Circuits	STYLE NUMBERS N. E. C. Fuses Style FS	Style SS	List Price	STYLE NUMBERS N. E. C. Fuses Style FW	List Price
	2-Wire Mains				**125 Volts**			**Double Branch**	
30	17½	14½	4½	4	K-38542	K-38558	$ 67 00	K-38590	$ 74 00
60	22	14½	4½	6	K-38543	K-38559	74 00	K-38591	82 00
60	25	14½	4½	8	K-38544	K-38560	84 00	K-38592	93 00
60	28	14½	4½	10	K-38545	K-38561	93 00	K-38593	102 00
100	31	14½	4½	12	K-38546	K-38562	102 00	K-38594	112 00
100	34	14½	4½	14	K-38547	K-38563	112 00	K-38595	123 00
100	37	14½	4½	16	K-38548	K-38564	122 00	K-38596	134 00
200	41½	16	5½	18	K-38549	K-38565	133 00	K-38597	147 00
200	44½	16	5½	20	K-38550	K-38566	141 00	K-38598	155 00
200	47½	16	5½	22	K-38551	K-38567	154 00	K-38599	169 00
200	50½	16	5½	24	K-38552	K-38568	161 00	K-38600	177 00
200	53½	16	5½	26	K-38553	K-38569	168 00	K-38601	185 00
200	56½	16	5½	28	K-38554	K-38570	181 00	K-38602	200 00
200	59½	16	5½	30	K-38555	K-38571	190 00	K-38603	209 00
200	62½	16	5½	32	K-38556	K-38572	200 00	K-38604	220 00
	3-Wire Mains				**125 Volts**			**Double Branch**	
30	17½	14½	4½	4	K-38638	K-38654	67 00	K-38686	74 00
30	20½	14½	4½	6	K-38639	K-38655	74 00	K-38687	82 00
30	23½	14½	4½	8	K-38640	K-38656	84 00	K-38688	93 00
30	26½	14½	4½	10	K-38641	K-38657	93 00	K-38689	102 00
60	31	14½	4½	12	K-38642	K-38658	102 00	K-38690	112 00
60	34	14½	4½	14	K-38643	K-38659	112 00	K-38691	123 00
60	37	14½	4½	16	K-38644	K-38660	122 00	K-38692	134 00
60	40	14½	4½	18	K-38645	K-38661	133 00	K-38693	147 00
60	43	14½	4½	20	K-38646	K-38662	141 00	K-38694	155 00
100	46	14½	4½	22	K-38647	K-38663	154 00	K-38695	169 00
100	49	14½	4½	24	K-38648	K-38664	161 00	K-38696	177 00
100	52	14½	4½	26	K-38649	K-38665	168 00	K-38697	185 00
100	55	14½	4½	28	K-38650	K-38666	181 00	K-38698	200 00
100	58	14½	4½	30	K-38651	K-38667	190 00	K-38699	209 00
100	61	14½	4½	32	K-38652	K-38668	200 00	K-38700	220 00
	2-Wire Mains				**250 Volts**			**Double Branch**	
30	17½	14½	4½	4	K-38734	K-38750	74 00	K-38782	81 00
30	20½	14½	4½	6	K-38735	K-38751	82 00	K-38783	91 00
30	23½	14½	4½	8	K-38736	K-38752	93 00	K-38784	102 00
30	26½	14½	4½	10	K-38737	K-38753	102 00	K-38785	113 00
60	31	14½	4½	12	K-38738	K-38754	112 00	K-38786	124 00
60	34	14½	4½	14	K-38739	K-38755	123 00	K-38787	136 00
60	37	14½	4½	16	K-38740	K-38756	134 00	K-38788	147 00
60	40	14½	4½	18	K-38741	K-38757	147 00	K-38789	163 00
60	43	14½	4½	20	K-38742	K-38758	155 00	K-38790	172 00
100	46	14½	4½	22	K-38743	K-38759	169 00	K-38791	186 00
100	49	14½	4½	24	K-38744	K-38760	177 00	K-38792	195 00
100	52	14½	4½	26	K-38745	K-38761	185 00	K-38793	204 00
100	55	14½	4½	28	K-38746	K-38762	200 00	K-38794	220 00
100	58	14½	4½	30	K-38747	K-38763	209 00	K-38795	230 00
100	61	14½	4½	32	K-38748	K-38764	220 00	K-38796	242 00

For weights see third page following.

KRANTZ TYPE S DEAD-FRONT PANEL BOARDS—Continued

Mains—With terminal lugs only.

Branches—Two-wire with special 30-ampere snap switches arranged for plug fuses.

CABINETS

Style FS—Flush steel box and steel trim.

Style SS—Surface steel box and steel trim.

Style FW—Flush steel box and wood trim.

For inside dimensions of box add 6½ inches to panel size for 3¼-inch gutter.

Through-feed panels and mains of larger capacity are listed on a following page.

Style number and list price do not include fuses.

Boxes will be drilled for conduit without extra charge provided complete drilling information accompanies order. Boxes will be shipped undrilled unless templates are sent with order showing location and size of holes wanted.

Knockouts for one half of the total number of circuits will be furnished without additional charge when requested on the initial order. Extra knockouts will be furnished at **10c** each, list.

For panels with fuses in the mains add 8 per cent to list price of panel.

For panels with three-way switches see table of parts and accessories on a following page.

For shipping weights see second page following.

TYPE S PANEL BOARDS COMPLETE WITH CABINET

Amps. Capacity of Mains	Outside Dimensions of Panels in Inches Height	Width	Depth	Number of Circuits	STYLE NUMBERS Plug Fuses Style FS	Style SS	List Price	STYLE NUMBERS Plug Fuses Style FW	List Price
	2-Wire Mains				**125 Volts**			**Double Branch**	
30	11½	14½	4½	4	K-38222	K-38238	$ 39 00	K-38286	$ 43 00
60	14½	14½	4½	6	K-38223	K-38239	47 00	K-38287	51 00
60	17½	14½	4½	8	K-38224	K-38240	57 00	K-38288	62 00
60	20½	14½	4½	10	K-38225	K-38241	65 00	K-38289	72 00
100	23½	14½	4½	12	K-38226	K-38242	74 00	K-38290	81 00
100	26½	14½	4½	14	K-38227	K-38243	84 00	K-38291	92 00
100	29½	14½	4½	16	K-38228	K-38244	91 00	K-38292	101 00
200	32½	14½	4½	18	K-38229	K-38245	102 00	K-38293	112 00
200	35½	14½	4½	20	K-38230	K-38246	112 00	K-38294	123 00
200	38½	14½	4½	22	K-38231	K-38247	120 00	K-38295	132 00
200	41½	14½	4½	24	K-38232	K-38248	132 00	K-38296	145 00
200	44½	14½	4½	26	K-38233	K-38249	142 00	K-38297	156 00
200	47½	14½	4½	28	K-38234	K-38250	153 00	K-38298	169 00
200	50½	14½	4½	30	K-38235	K-38251	164 00	K-38299	180 00
200	53½	14½	4½	32	K-38236	K-38252	175 00	K-38300	192 00
	3-Wire Mains				**125 Volts**			**Double Branch**	
30	11½	14½	4½	4	K-38318	K-38334	39 00	K-38382	43 00
30	14½	14½	4½	6	K-38319	K-38335	47 00	K-38383	51 00
30	17½	14½	4½	8	K-38320	K-38336	57 00	K-38384	62 00
30	20½	14½	4½	10	K-38321	K-38337	65 00	K-38385	72 00
60	23½	14½	4½	12	K-38322	K-38338	74 00	K-38386	81 00
60	26½	14½	4½	14	K-38323	K-38339	84 00	K-38387	92 00
60	29½	14½	4½	16	K-38324	K-38340	91 00	K-38388	101 00
60	32½	14½	4½	18	K-38325	K-38341	102 00	K-38389	112 00
60	35½	14½	4½	20	K-38326	K-38342	112 00	K-38390	123 00
100	38½	14½	4½	22	K-38327	K-38343	120 00	K-38391	132 00
100	41½	14½	4½	24	K-38328	K-38344	132 00	K-38392	145 00
100	44½	14½	4½	26	K-38329	K-38345	142 00	K-38393	156 00
100	47½	14½	4½	28	K-38330	K-38346	153 00	K-38394	169 00
100	50½	14½	4½	30	K-38331	K-38347	164 00	K-38395	180 00
100	53½	14½	4½	32	K-38332	K-38348	175 00	K-38396	192 00

Order by Style Number

KRANTZ TYPE S DEAD-FRONT SAFETY PANEL BOARDS—Continued

Mains—With unfused safety brush switch.

Branches—Two-wire with special 30-ampere snap switch arranged for plug fuses.

CABINETS

Style FS—Flush steel box and steel trim.

Style SS—Surface steel box and steel trim.

Style FW—Flush steel box and wood trim.

For inside dimensions of box add 6½ inches to panel size for 3¼-inch gutter.

Through-feed panels and mains of larger capacity are listed on a following page.

Style number and list price do not include fuses.

Boxes will be drilled for conduit without extra charge provided complete drilling information accompanies order. Boxes will be shipped undrilled unless templates are sent with order showing location and size of holes wanted.

Knockouts for one half of the total number of circuits will be furnished without additional charge when requested on the initial order. Extra knockouts will be furnished at **10c** each, list.

For panels with fuses in the mains add 4 per cent to list price of panel.

For panels with three-way switches see table of parts and accessories on a following page.

TYPE S PANEL BOARDS COMPLETE WITH CABINET

Amps. Capacity of Mains	Outside Dimensions of Panels in Inches Height	Width	Depth	Number of Circuits	STYLE NUMBERS Plug Fuses Style FS	Style SS	List Price	STYLE NUMBERS Plug Fuses Style FW	List Price
	2-Wire Mains				**125 Volts**			**Double Branch**	
30	17½	14½	4½	4	K-38510	K-38526	$ 61 00	K-38574	$ 67 00
60	22	14½	4½	6	K-38511	K-38527	70 00	K-38575	77 00
60	25	14½	4½	8	K-38512	K-38528	80 00	K-38576	88 00
60	28	14½	4½	10	K-38513	K-38529	90 00	K-38577	99 00
100	31	14½	4½	12	K-38514	K-38530	99 00	K-38578	109 00
100	34	14½	4½	14	K-38515	K-38531	109 00	K-38579	120 00
100	37	14½	4½	16	K-38516	K-38532	118 00	K-38580	130 00
200	41½	16	5½	18	K-38517	K-38533	128 00	K-38581	140 00
200	44½	16	5½	20	K-38518	K-38534	138 00	K-38582	152 00
200	47½	16	5½	22	K-38519	K-38535	151 00	K-38583	168 00
200	50½	16	5½	24	K-38520	K-38536	158 00	K-38584	174 00
200	53½	16	5½	26	K-38521	K-38537	165 00	K-38585	182 00
200	56½	16	5½	28	K-38522	K-38538	178 00	K-38586	196 00
200	59½	16	5½	30	K-38523	K-38539	187 00	K-38587	206 00
200	62½	16	5½	32	K-38524	K-38540	196 00	K-38588	215 00
	3-Wire Mains				**125 Volts**			**Double Branch**	
30	17½	14½	4½	4	K-38606	K-38622	61 00	K-38670	67 00
30	20½	14½	4½	6	K-38607	K-38623	70 00	K-38671	77 00
30	23½	14½	4½	8	K-38608	K-38624	80 00	K-38672	88 00
30	26½	14½	4½	10	K-38609	K-38625	90 00	K-38673	99 00
60	31	14½	4½	12	K-38610	K-38626	99 00	K-38674	109 00
60	34	14½	4½	14	K-38611	K-38627	109 00	K-38675	120 00
60	37	14½	4½	16	K-38612	K-38628	118 00	K-38676	130 00
60	40	14½	4½	18	K-38613	K-38629	128 00	K-38677	140 00
60	43	14½	4½	20	K-38614	K-38630	138 00	K-38678	152 00
100	46	14½	4½	22	K-38615	K-38631	151 00	K-38679	168 00
100	49	14½	4½	24	K-38616	K-38632	158 00	K-38680	174 00
100	52	14½	4½	26	K-38617	K-38633	165 00	K-38681	182 00
100	55	14½	4½	28	K-38618	K-38634	178 00	K-38682	196 00
100	58	14½	4½	30	K-38619	K-38635	187 00	K-38683	206 00
100	61	14½	4½	32	K-38620	K-38636	196 00	K-38684	215 00

For shipping weights see the following page.

Order by Style Number

KRANTZ TYPE S DEAD-FRONT SAFETY PANEL BOARDS—Continued

SUPPLY PARTS FOR KRANTZ TYPE S SAFETY PANEL BOARDS

Description	Style No.	List Price Each
Snap switch, 2-pole, double-break, 30 amperes, 250 volts, complete mounted on individual steel bases (standard)	K-2999	$2 75
Stationary branch high-contact blade	K-2952	35
Stationary branch low-contact blade	K-2951	30
Stationary main straight-bar contact blade	K-2955	10
Stationary main U-shaped contact blade	K-2956	10
Handle for snap switch	K-2988	20
Music wire spring for snap switch	K-2992	10
Lock nut for handle	K-2940	10
Snap switch,2-pole, 3-way 30 amp., 250 volts,complete,mounted on individual steel bases	K-52366	4 25

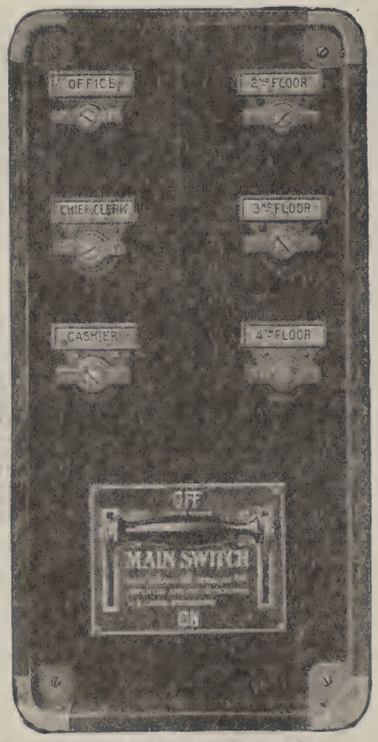
EXTRAS AND ACCESSORIES

For lamp socket add **$1.00 net** each to price of panel. (Types S. and B.).
For test lamp and receptacle add **$2.00 net** each to price of panel. (Types S. and B.).
For meter loop below 100 amperes add 5 per cent to list of panel board. (Types C. B. and S.)
For fused sub-feeds add the following prices to list of type B panels:

	Two-Pole	Three-Pole
30-ampere	$ 8 25	$10 00
60-ampere	13 65	16 75
100-ampere	23 40	30 00
200-ampere	37 40	.....

For sub-feed to safety type panels, prices will be supplied on request.

Type S safety panels may be furnished with three-way (not three-pole) snap switches. Using these switches however, increases size of panel. Add, for each three-way circuit **$8.00** to list price of standard panel.



Switch Compartment of Krantz Safety Panel Board with Brush-Type Main Switch

APPROXIMATE SHIPPING WEIGHTS

Krantz Panel Boards with Terminal Lugs Complete in Steel Cabinets

Number of Circuits	Approximate Shipping Weight—Lbs. Type S Safety	Type C Safety	Type F Safety	Types B and BP Straight Line
4	125	100	65	115
6	140	110	75	125
8	155	125	85	140
10	170	135	90	150
12	185	150	100	165
14	200	160	105	175
16	210	170	115	185
18	225	185	120	195
20	235	190	125	205
22	250	200	135	215
24	265	210	140	225
26	280	225	150	240
28	310	250	165	265
30	325	260	175	275
32	340	270	180	285

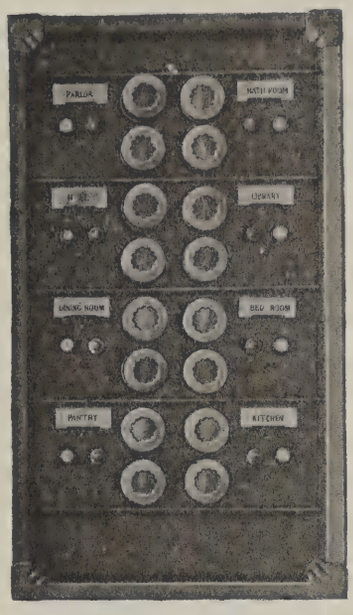
For shipping weights of panels with unfused main switches add 20 per cent to above figures for panels of 4 to 20 circuits and 15 per cent to panels 22 to 32 circuits.

Order by Style Number

KRANTZ TYPE C 10-AMPERE SAFETY PANELS

DEAD-FRONT PUSH-BUTTON SWITCH

For Capacities up to 200-Amperes, 125 Volts



These panels are principally used in apartment houses, residences and for similar light service. They are the *narrowest safety switch panels on the market*, and the *only* 10-ampere panels that may be furnished with a safety main switch.

Construction

These panels are made up with 10-ampere 125-volt Perkins push-button switches of special design and are provided for plug fuses.

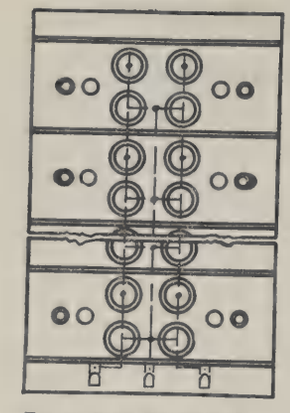
The base is of 1-inch slate with a ½-inch slate gutter frame. There is a metal sectional cover for each pair of switches, enclosing switches and bus-bars; this gives ready access only to the switch buttons and plug fuses.

Should there be an occasion to replace a damaged switch, it is simply necessary to take off the switch cover-section and remove the defective part. This is done without disconnecting wires, without exposing other switches, and without having to remove the panel from box.

The Safety main switch, if required, is similar in design to that used on the type S safety panels. See previous pages. If fuses are wanted in the mains, they can be supplied on special order. See following page for prices.

All exposed parts are finished in dull black and a card holder is provided for each circuit.

KRANTZ TYPE C DEAD-FRONT SAFETY PANEL BOARDS—Continued



THREE-WIRE MAINS WITH TERMINAL LUGS

Mains—Three-wire with terminal lugs or with unfused switch.

Branches—Two-wire with 10-ampere push button switches arranged for plug fuses.

CABINETS

Style FS—Flush steel box and steel trim.

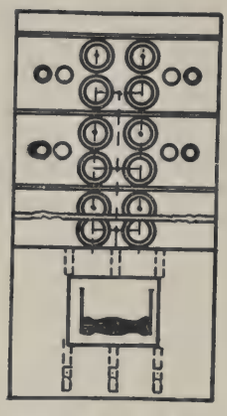
Style SS—Surface steel box and steel trim.

Style FW—Flush steel box and wood trim.

For inside dimensions of box add 6½ inches to panel size for 3¼-inch gutter.

Through-feed panels and mains of larger capacity are listed on a following page.

Style number and list price do not include fuses.



THREE-WIRE MAINS WITH UNFUSED SWITCH

Boxes will be drilled for conduit without extra charge provided complete drilling information accompanies the order. Boxes will be shipped undrilled unless templates are sent with the order showing location and size of holes wanted.

Knockouts for one half of the total number of circuits will be furnished without additional charge when requested on the initial order. Extra knockouts will be furnished at **10c** each, list.

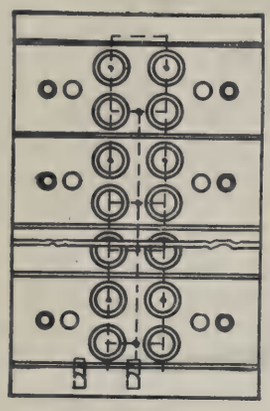
For panels with fuses in the mains add 8 per cent to list price of panel.

For panels with fused main switches add 4 per cent to list price of panel.

Amp. Capacity of Mains	Outside Dimensions of Panels in Inches Height	Width	Depth	Number of Circuits	PANELS COMPLETE WITH CABINET — Style Numbers Style FS	Style SS	List Price In Steel Cabinet	Style Number Style FW	List Price Style FW With Wood Trim
		125 Volts			**With Terminal Lugs Only**		**Double Branch**		
30	11½	10	4	4	K43627	K43643	$ 34 00	K43659	$ 38 00
30	14½	10	4	6	K43628	K43644	42 00	K43660	46 00
30	17½	10	4	8	K43629	K43645	51 00	K43661	56 00
30	20½	10	4	10	K43630	K43646	60 00	K43662	66 00
60	25	10	4	12	K43631	K43647	68 00	K43663	75 00
60	28	10	4	14	K43632	K43648	77 00	K43664	85 00
60	32½	10	4	16	K43633	K43649	83 00	K43665	92 00
60	35½	10	4	18	K43634	K43650	93 00	K43666	102 00
60	38½	10	4	20	K43635	K43651	100 00	K43667	110 00
100	43	10	4	22	K43636	K43652	110 00	K43668	122 00
100	46	10	4	24	K43637	K43653	123 00	K43669	135 00
100	49	10	4	26	K43638	K43654	133 00	K43670	147 00
100	53½	10	4	28	K43639	K43655	142 00	K43671	157 00
100	56½	10	4	30	K43640	K43656	149 00	K43672	164 00
100	59½	10	4	32	K43641	K43657	158 00	K43673	174 00
		125 Volts			**With Unfused Switch**		**Double Branch**		
30	19	10	4½	4	K43499	K43515	54 00	K43531	60 00
30	22	10	4½	6	K43500	K43516	62 00	K43532	69 00
30	25	10	4½	8	K43501	K43517	71 00	K43533	78 00
30	28	10	4½	10	K43502	K43518	80 00	K43534	88 00
60	32½	10	4½	12	K43503	K43519	88 00	K43535	97 00
60	35½	10	4½	14	K43504	K43520	97 00	K43536	107 00
60	40	10	4½	16	K43505	K43521	103 00	K43537	114 00
60	43	10	4½	18	K43506	K43522	113 00	K43538	124 00
60	46	10	4½	20	K43507	K43523	120 00	K43539	132 00
100	50½	10	4½	22	K43508	K43524	132 00	K43540	145 00
100	53½	10	4½	24	K43509	K43525	145 00	K43541	160 00
100	56½	10	4½	26	K43510	K43526	155 00	K43542	170 00
100	61	10	4½	28	K43511	K43527	164 00	K43543	180 00
100	64	10	4½	30	K43512	K43528	171 00	K43544	188 00
100	67	10	4½	32	K43513	K43529	180 00	K43545	198 00

Shipping weights of panels are shown on the fourth page before this.

KRANTZ TYPE C DEAD-FRONT SAFETY PANEL BOARDS—Continued



TWO-WIRE MAINS WITH TERMINAL LUGS

Mains—Two-wire with terminal lugs, or with unfused switch (see table).

Branches—Two-wire with 10-ampere push button switches arranged for plug fuses.

CABINETS

Style FS—Flush steel box and steel trim.

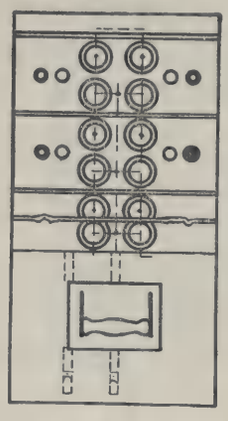
Style SS—Surface steel box and steel trim.

Style FW—Flush steel box and wood trim.

For inside dimensions of box add 6½ inches to panel size for 3¼-inch gutter.

Through-feed panels and mains of larger capacity are listed on a following page.

Style number and list price do not include fuses.



TWO-WIRE MAINS WITH UNFUSED SWITCH

Boxes will be drilled for conduit without extra charge provided complete drilling information accompanies the order. Boxes will be shipped undrilled unless templates are sent with the order showing location and size of holes wanted.

Knockouts for one half of the total number of circuits will be furnished without additional charge when requested on the initial order. Extra knockouts will be furnished at **10c** each, list

For panels with fuses in the mains add 8 per cent to list price of panel.

For panels with fused main switches add 4 per cent to list price of panel.

Amp. Capacity of Mains	Outside Dimensions of Panels in Inches Height	Width	Depth	Number of Circuits	PANELS COMPLETE WITH CABINET — Style Numbers Style FS	Style SS	List Price In Steel Cabinet	Style Number Style FW	List Price Style FW With Wood Trim
		125 Volts			**With Terminal Lugs Only**		**Double Branch**		
30	11½	10	4	4	K43563	K43579	$ 34 00	K43595	$ 38 00
60	14½	10	4	6	K43564	K43580	42 00	K43596	46 00
60	17½	10	4	8	K43565	K43581	51 00	K43597	56 00
60	20½	10	4	10	K43566	K43582	60 00	R43598	66 00
100	25	10	4	12	K43567	K43583	68 00	K43599	75 00
100	28	10	4	14	K43568	K43584	77 00	K43600	85 00
100	32½	10	4	16	K43569	K43585	83 00	K43601	92 00
200	35½	10	4	18	K43570	K43586	93 00	K43602	102 00
200	38½	10	4	20	K43571	K43587	100 00	K43603	110 00
200	43	10	4	22	K43572	K43588	110 00	K43604	122 00
200	46	10	4	24	K43573	K43589	123 00	K43605	135 00
200	49	10	4	26	K43574	K43590	133 00	K43606	147 00
200	53½	10	4	28	K43575	K43591	142 00	K43607	157 00
200	56½	10	4	30	K43576	K43592	149 00	K43608	164 00
200	59½	10	4	32	K43577	K43593	158 00	K43609	174 00
		125 Volts			**With Unfused Switch**		**Double Branch**		
30	19	10	4½	4	K43435	K43451	54 00	K43467	60 00
60	22	10	4½	6	K43436	K43452	62 00	K43468	69 00
60	25	10	4½	8	K43437	K43453	71 00	K43469	78 00
60	28	10	4½	10	K43438	K43454	80 00	K43470	88 00
100	32½	10	4½	12	K43439	K43455	88 00	K43471	97 00
100	35½	10	4½	14	K43440	K43456	97 00	K43472	107 00
100	40	10	4½	16	K43441	K43457	103 00	K43473	114 00
200	43	10	4½	18	K43442	K43458	113 00	K43474	124 00
200	46	10	4½	20	K43443	K43459	120 00	K43475	132 00
200	50⅛	10	4½	22	K43444	K43460	132 00	K43476	145 00
200	53½	10	4½	24	K43445	K43461	145 00	K43477	160 00
200	56½	10	4½	26	K43446	K43462	155 00	K43478	170 00
200	61	10	4½	28	K43447	K43463	164 00	K43479	180 00
200	64	10	4½	30	K43448	K43464	171 00	K43480	188 00
200	67	10	4½	32	K43449	K43465	180 00	K43481	198 00

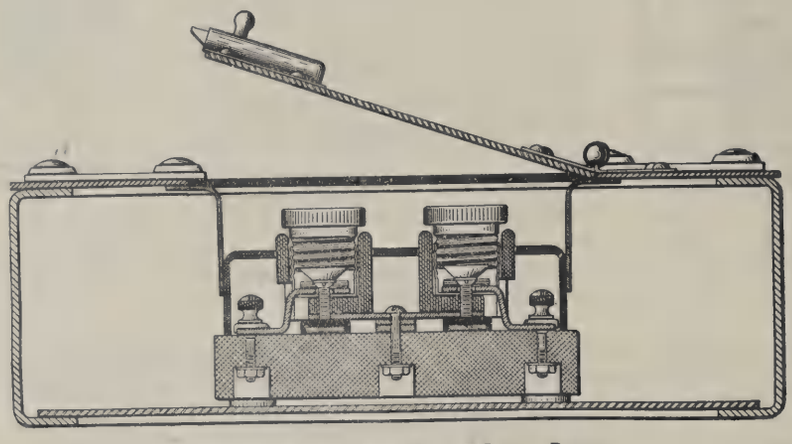
Shipping weights of panels are shown on the fifth page before this.

Order by Style Number

KRANTZ TYPE F SAFETY FUSE PANELS

DEAD-FRONT—WITHOUT SWITCHES IN BRANCHES

For Capacities up to 200 Amperes, 125 Volts



CROSS-SECTIONAL VIEW OF TYPE F SAFETY PANEL

For apartment or residential use, where panels *without switches* in the branches are required, the Krantz type F safety fuse panel is recommended.

Distinctive Features

These panels embody the following distinctive features of design:

1. These panels are the narrowest safety panels on the market.
2. All parts accessible by removing the insulating cover.
3. Necessary parts are removable without injury to insulation.
4. Plug fuse caps project through micarta cover.
5. They are easily installed.

Construction

The base of the panel is made of 1-inch black-marine-finish slate and instead of using a slate gutter frame, a *moulded micarta cover* encloses all metal parts. The porcelain fuse holders project through this cover, which is slotted for the branch circuit wires. By removing this cover all terminals are exposed, making installation extremely simple. As soon as the wires have been connected, the enclosing cover is replaced and no metal parts are exposed.

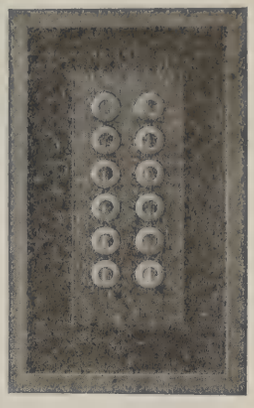
It has been possible to reduce the width of these panels by mounting the fuses directly to the cross bars and covering the main bus bars with the highest grade of channel fibre.

The type F panels are furnished for either two or three-wire systems, both of these taking the same width base. If main fuses or main switches are required for these panels, they can be furnished on special order. It is necessary, however, to enclose these in separate compartments and the depth of the box is increased.

KRANTZ TYPE F DEAD-FRONT SAFETY FUSE PANELS

Mains—With terminal lugs only.

Branches—Two-wire arranged only for plug fuses.



CABINETS

Style FS—Flush steel box and steel trim.

Style SS—Surface steel box and steel trim.

Style FW—Flush steel box and wood trim.

Style number and list price do not include fuses.

Boxes will be drilled for conduit without extra charge provided complete drilling information accompanies the order. Boxes will be shipped undrilled unless templates are sent with the order showing location and size of holes wanted.

Knockouts for one half of the total number of circuits will be furnished without additional charge when requested on the initial order. Extra knockouts will be furnished at **10c** each, list.

TYPE F PANEL BOARDS COMPLETE WITH CABINET

Amps. Cap. of Mains	Outside Dimensions of Panels in Inches Height	Width	Depth	Number of Circuits	Style Numbers Plug Fuses Style FS	Style SS	Size of Box Height	Width	Depth	List Price	Style Numbers Plug Fuses Style FW	List Price
2-Wire Mains						**125 Volts**					**Double Branch**	
30	10½	6	3¼	4	K-52231	K-52246	18 9/32	13 19/32	3 3/8	$23 00	K-52261	$26 00
60	13½	6	3¼	6	K-52232	K-52247	21 9/32	13 19/32	3 3/8	26 00	K-52262	29 00
60	16½	6	3¼	8	K-52233	K-52248	24 1/16	13 9/16	3 3/8	30 00	K-52263	33 00
60	19½	6	3¼	10	K-52234	K-52249	27 1/16	13 9/16	3 3/8	33 00	K-52264	37 00
100	24	6	3¼	12	K-52235	K-52250	31 1/16	13 9/16	3 3/8	38 00	K-52265	42 00
100	27	6	3¼	14	K-52236	K-52251	34 1/16	13 9/16	3 3/8	41 00	K-52266	46 00
100	31½	6	3¼	16	K-52237	K-52252	39 1/16	13 9/16	3 3/8	45 00	K-52267	50 00
200	34½	6	3¼	18	K-52238	K-52253	42	13½	3 3/8	48 00	K-52268	53 00
200	37½	6	3¼	20	K-52239	K-52254	45	13½	3 3/8	52 00	K-52269	57 00
200	40½	6	3¼	22	K-52240	K-52255	48	13½	3 3/8	59 00	K-52270	64 00
200	45	6	3¼	24	K-52241	K-52256	52½	13½	3 3/8	63 00	K-52271	70 00
200	48	6	3¼	26	K-52242	K-52257	55½	13½	3 3/8	68 00	K-52272	75 00
200	51	6	3¼	28	K-52243	K-52258	58½	13½	3 3/8	71 00	K-52273	78 00
200	55½	6	3¼	30	K-52244	K-52259	62 13/16	13 1/16	3 3/8	76 00	K-52274	84 00
200	58½	6	3¼	32	K-52245	K-52260	65 13/16	13 1/16	3 3/8	81 00	K-52275	90 00
3-Wire Mains						**125 Volts**					**Double Branch**	
30	10½	6	3¼	4	K-52276	K-52291	18 9/32	13 19/32	3 3/8	23 00	K-52306	26 00
30	13½	6	3¼	6	K-52277	K-52292	21 9/32	13 19/32	3 3/8	26 00	K-52307	29 00
30	16½	6	3¼	8	K-52278	K-52293	24 1/16	13 9/16	3 3/8	30 00	K-52308	33 00
30	19½	6	3¼	10	K-52279	K-52294	27 1/16	13 9/16	3 3/8	33 00	K-52309	37 00
60	24	6	3¼	12	K-52280	K-52295	31 1/16	13 9/16	3 3/8	38 00	K-52310	42 00
60	27	6	3¼	14	K-52281	K-52296	34 1/16	13 9/16	3 3/8	41 00	K-52311	46 00
60	31½	6	3¼	16	K-52282	K-52297	39 1/16	13 9/16	3 3/8	45 00	K-52312	50 00
60	34½	6	3¼	18	K-52283	K-52298	42	13½	3 3/8	48 00	K-52313	53 00
60	37½	6	3¼	20	K-52284	K-52299	45	13½	3 3/8	52 00	K-52314	57 00
100	40½	6	3¼	22	K-52285	K-52300	48	13½	3 3/8	59 00	K-52315	64 00
100	45	6	3¼	24	K-52286	K-52301	52½	13½	3 3/8	63 00	K-52316	70 00
100	48	6	3¼	26	K-52287	K-52302	55½	13½	3 3/8	68 00	K-52317	75 00
100	51	6	3¼	28	K-52288	K-52303	58½	13½	3 3/8	71 00	K-52318	78 00
100	55½	6	3¼	30	K-52289	K-52304	62 13/16	13 1/16	3 3/8	76 00	K-52319	84 00
100	58½	6	3¼	32	K-52290	K-52305	65 13/16	13 1/16	3 3/8	81 00	K-52320	90 00

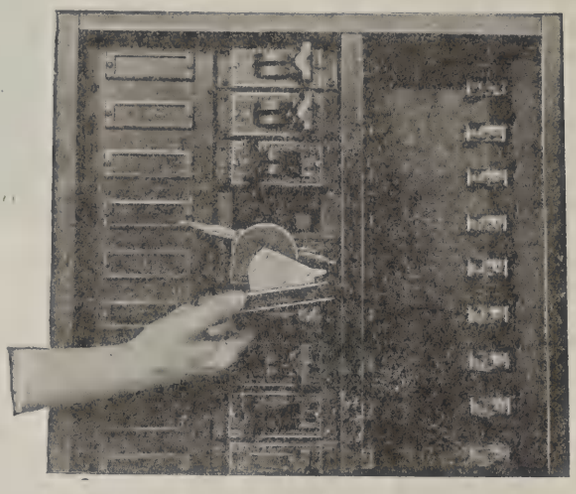
Shipping weights of panels are shown on the seventh page before this.

Order by Style Number

KRANTZ RAILWAY-TYPE SAFETY PANEL BOARDS

(DEAD-FRONT)

For Use on 600-Volt Circuits



600-Volt, Single-Pole, Krantz Safety Brush Switch Panel for Lighting and Small Heaters

Application

The Krantz railway type safety panel boards are applied for the control of 600-volt lighting and heating circuits in electric railway stations or for the control of circuits for any purpose up to 30 amperes operated from railway feeders.

Safety to the operator is not only desirable but essential in the operation of such circuits at railway line voltages owing to the fact that the operation of these circuits is frequently by individuals not connected with car operation and not familiar with the very real life hazards from contact with 600-volt live circuits.

The Krantz safety panel boards have been used in large quantities by some of the largest subway and elevated railways in the country.

Distinctive Features

The Krantz 600-volt safety panel boards provide complete safety as all live parts are fully covered in the ordinary operation of the switches and when the switches are removed no live parts are exposed. Individual circuit switches can be removed for inspection without interfering with other circuits and without danger of coming in contact with the live parts of other circuits. Circuit switches are of the standard brush-type construction.

Operating Characteristics and Construction

The Krantz 600-volt safety panel board is mounted in a steel cabinet with steel doors. All switches are single pole of the double-end, double-break, quick-break, brush-type with brushes protected by arcing contacts at each end. Each switch is mounted in a separate compartment insulated from each adjacent switch. The compartment walls also act as arcing shields to prevent the arc formed upon opening a switch from communicating with an adjacent circuit. Fuse connections for N. E. C. fuses are provided in a compartment separate from the circuit switch compartments thus preventing any other than authorized persons from having access to the fuses.

These panel boards can be provided with circuit switches of any capacity up to 30 amperes and for any number of circuits. Blow out coils are required where the capacity of the circuit is over 6 amperes

Higher capacities can be developed; prices on application.

KRANTZ RAILWAY-TYPE DEAD-FRONT SAFETY PANEL BOARDS—Continued

SWITCHES ARE REMOVED WITHOUT EXPOSING OPERATOR TO DANGER

INDIVIDUAL CIRCUIT SWITCH IN COMPARTMENT

Prices

Circuit	Approximate Outside Dimensions of Panel—Inches: Height	Width	Depth	Approximate Shipping Wt., Lbs.	Style No.	List Price for Panel and Cabinet
For 600-Volt Circuits						
3	12	18	5½	95	K-52327	77 00
4	13½	18	5½	110	K-52328	84 00
5	15	18	5½	120	K-52329	92 00
6	16½	18	5½	135	K-52330	100 00
7	19½	18	5½	150	K-52331	110 00
8	21	18	5½	163	K-52332	118 00
9	22½	18	5½	180	K-52333	126 00
10	24	18	5½	195	K-52334	135 00
11	27	18	5½	210	K-52335	143 00
12	28½	18	5½	225	K-52336	152 00
13	30	18	5½	240	K-52337	160 00
14	31½	18	5½	255	K-52338	168 00
15	34½	18	5½	270	K-52339	176 00
16	36	18	5½	285	K-52340	185 00
17	37½	18	5½	300	K-52341	194 00
18	39	18	5½	315	K-52342	202 00
19	42	18	5½	330	K-52343	210 00
20	43½	18	5½	345	K-52344	218 00
21	45	18	5½	360	K-52345	228 00
22	46½	18	5½	375	K-52346	238 00
23	49½	18	5½	390	K-52347	250 00
24	51	18	5½	405	K-52348	260 00
25	52½	18	5½	420	K-52349	273 00

List prices do not include fuses.

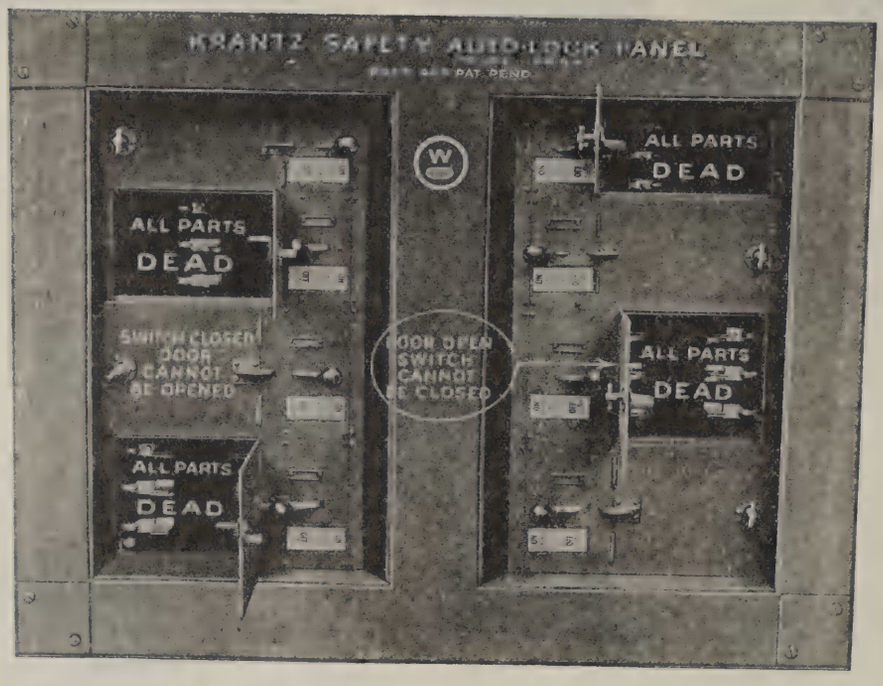
1-inch base, ¾-inch frame. For box sizes add 7½ inches to width and height of panel for a 3¾-inch gutter. Depth of box is 5 11/16 inches.

Order by Style Number

KRANTZ SAFETY AUTO-LOCK CONTROL PANELS

DEAD FRONT FOR LIGHT AND POWER DISTRIBUTION

125-250 Volts D. C. and 500 Volts A. C.


KRANTZ SAFETY AUTO-LOCK PANEL
ALL PARTS DEAD
SWITCH CLOSED DOOR CANNOT BE OPENED
DOOR OPEN SWITCH CANNOT BE CLOSED
ALL PARTS DEAD
ALL PARTS DEAD
ALL PARTS DEAD

The Krantz safety auto-lock panels are used in light or power distribution for 125-250-volt direct-current or 500-volt alternating-current service. They are made up of switches of the standard auto-lock type, all their safety features being maintained.

Construction

These panels are mounted on a common base of slate and all switches make direct contact to a common set of bus bars. Each switch is separated from its neighbor by means of a slate barrier and since each switch is provided with an individual cover it is possible to work with perfect safety on any one switch without throwing off current of neighboring switches. The panels may be made up single branch; with all circuits on one side of the main bus bar, or double branch with switches mounted on both sides of main bus. The main switch may also be mounted either fused or unfused.

Each switch has a provision for a padlock to lock it in the open position, and all parts are removable from the front without disturbing wire connections or removing the panel from wall. Repairs may therefore be made with least possible delay and expense.

The panel is enclosed in an iron cabinet with a door which opens over the switches, but at no time are the bus or cross bars exposed. The entire outfit is compact, neat in appearance and practically dust-proof.

Any number of circuits can be furnished ranging from 30 to 800 Amp. for 125-250 volts, direct current, or 500 volts. alternating current.

KRANTZ SAFETY AUTO-LOCK CONTROL PANELS—Continued

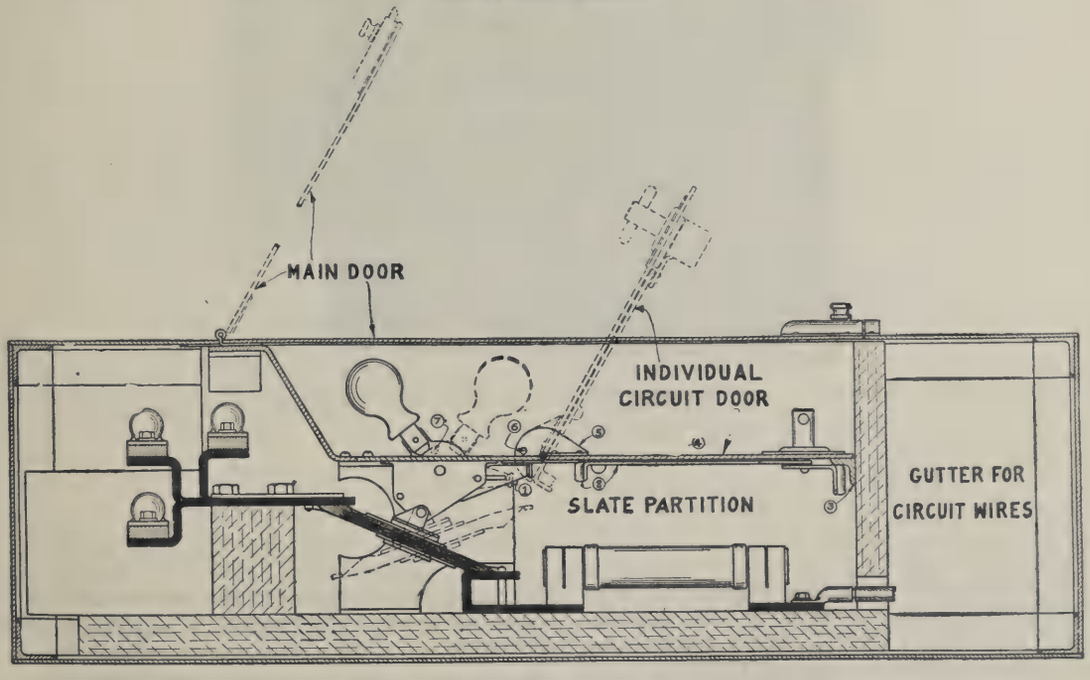
Largest Switch Capacity, Amperes	Base Price Including Largest Switch	Additional to Base Price For Each Additional Switch 30 A.	60 A.	100 A.	A.
250 Volts for Two-Wire Mains and Two-Wire Branches					
200	$61 00	$17 00	$20 00	$26 00	$36 00
100	48 00	16 00	19 50	25 00	.....
60	40 00	15 50	18 50	.....	.....
30	36 00	15 00	.....	.....	.....
250 Volts for Three-Wire Mains and Three-Wire Branches					
200	62 00	17 50	20 50	27 00	38 00
100	49 00	16 50	20 00	26 00	.....
60	41 00	16 00	19 00	.....	.....
30	36 50	15 50	.....	.....	.....
250 Volts for Three-Wire Mains and Three-Wire Branches					
200	72 00	19 00	23 00	32 00	46 00
100	55 00	18 00	22 00	31 00	.....
60	44 00	17 00	21 00	.....	.....
30	39 00	16 00	.....	.....	.....
500 Volts for Three-Wire Mains and Three-Wire Branches					
200	83 00	22 00	26 00	37 00	55 00
100	63 00	21 00	25 00	36 00	.....
60	50 00	20 00	24 00	.....	.....
30	45 00	19 00	.....	.....	.....

To figure the price of an auto-lock control panel take, for example, a board of the following specifications:
One three-wire main, three-wire branch, 500-volt safety panel with one 200, three 60, one 100, and one 30 ampere switches.
Always allow the largest sized switch to govern the size of **all** switches: Therefore take base price of a three-wire main, three-wire branch 500-volt panel for a 400-ampere switch (this being the largest switch on the panel)..... $83.00
Add to this the price for each other switch when used with a 200-ampere switch:

3– 60 ampere switches	78 00
1–100 ampere switch	37 00
1– 30 ampere switch	22 00
	$220 00

From this deduct the standard discount.
For panels with larger switches than listed above, prices will be furnished on request.
Weights and dimensions furnished upon receipt of specifications.

Order by Style Number



KRANTZ SAFETY AUTO-LOCK PANEL
SECTIONAL VIEW

Auto-lock Features:

SWITCH ON (Full Lines):- Slide 1 moves link 2 under angle 3 so that door 4 cannot be opened exposing live parts.
SWITCH OFF (Dotted Lines):- Slide 1 allows link 2 to clear angle 3 permitting door 4 to be opened, but all live parts are inaccessible.

Additional Safety Features:

SWITCH ON (Full Lines):- If link 2 is forcibly released from angle 3, same moves slide 1 throwing switch off.
SWITCH ON (Dotted Lines):- With door 4 opened, attempts to close switch are obstructed by slide 1 hitting cam 5. Hole 6 provides locking arrangement for door 4. Hole 7 provides locking arrangement for switch in off position.

KRANTZ SAFETY THEATRE SWITCHBOARDS

DEAD-FRONT

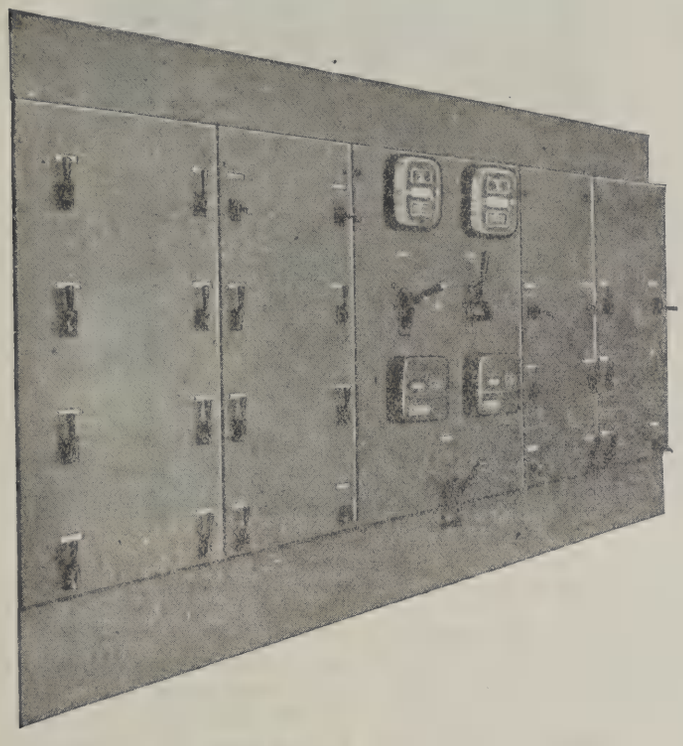
KRANTZ SAFETY THEATRE SWITCHBOARD WITH DIMMER MOUNTED ABOVE

For theatre work safety switchboards are now a requirement in order to reduce fire and accident hazard. The Krantz Theatre boards are dead-front and occupy the minimum amount of space, making them especially desirable for this work. Dimmer banks are mounted conveniently above the boards. These can be furnished with the switchboard if desired. Handles of the switches are enameled the same color as the lights they control, so that the operator can work without delay or hesitation.

Prices upon request and receipt of specifications.

KRANTZ SAFETY SWITCHBOARDS

DEAD-FRONT AND DEAD-REAR



FRONT VIEW OF SWITCHBOARD

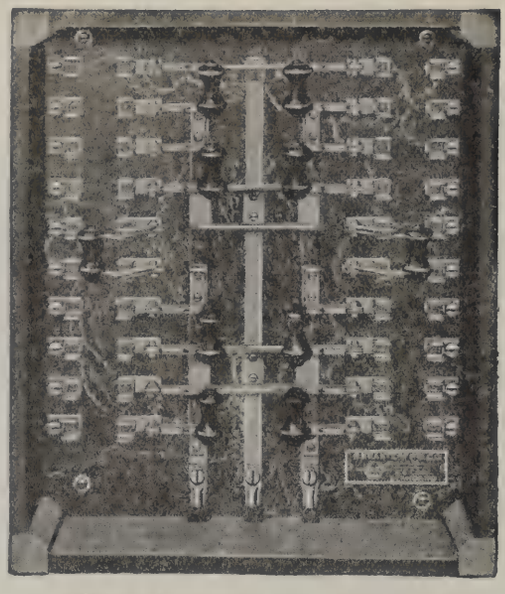
The Krantz Co. is in a position to furnish safety switchboards to meet any specification and for various installations including theatres, industrial plants, hotels and heavy marine work.

A safety dead-front and dead-rear switchboard, particularly suited for industrial use, is now ready for the market. These have already been installed in large plants where they have met with entire satisfaction and approval. These boards are not only dead front but dead in the rear as well. No switches, fuses, busbars or wires are exposed; consequently they may be installed in the centre of a room should it be more convenient. The switches are each in a separate compartment and fastened individually to the board. They make direct contact to the busbars so that all cross bars are eliminated. Wires are brought through the pull boxes and wiring ducts directly to the fuse terminals thus doing away with all unnecessary splicings in the circuit, and giving as direct a connection as is possible to get. Any number of switches may be used and for any capacity up to 1000 Amp. 250 V.D.C. and 500 V. A. C. Meters and Circuit Breakers are mounted when specified.

Prices upon application and receipt of specification.

KRANTZ TYPES B AND BP STRAIGHT-LINE PANEL BOARDS

For Capacities up to 200 Amperes, and for Voltages up to 250.



TYPE B STRAIGHT-LINE PANEL BOARD

Application

The Krantz types B and BP straight-line panel boards are intended to meet the demand for panel boards of standard construction and arrangement where the safety features represented by the Krantz safety panel boards are not required.

The aim has been to standardize a line of these panels sufficiently complete to meet all ordinary conditions for application in large or small private houses, apartment houses, stores, office buildings and factories for the control of lighting circuits up to a total capacity in the mains of 200 amperes at 125 volts or 100 amperes at 250 volts.

The type B panel boards have branches fused with N. E. C. fuses.

The type BP panel boards have branches fused with plug fuses.

All Krantz types B and BP straight-line panel boards have been approved by the Underwriters' Laboratories.

Distinctive Features

Types B and BP straight-line panel boards have the following distinctive features:

Straight-line mains requiring fewer contact joints and allowing narrower panels than ordinary construction; base and frame of slate with black-marine finish; frame held together at corners by patented clamp and all joints covered by metal corners.

Operating Characteristics

The **straight-line** panel boards are made up of knife-blade switches and either N. E. C. enclosed fuses or plug fuses. In the panel boards containing a main switch a high grade milled-jaw knife-blade switch is used. Both the branch switches and the main switch, when used, have moulded spool handles so offset that the switches may be operated with the least possible danger of coming into contact with the live parts.

Construction

The Krantz types B and BP **straight-line** panel boards of standard design are furnished under the following specifications:

Specifications for Panels

Base—1-inch black-marine slate free from metalic veins and imperfections.

Frame—½-inch black marine slate slotted for mains and branches. Held together by dull black finished metal corners, which conceal all joints of frame.

Cover—⅜-inch black marine slate.

Corner Iron—Clamping slate frame and metal corners by one screw.

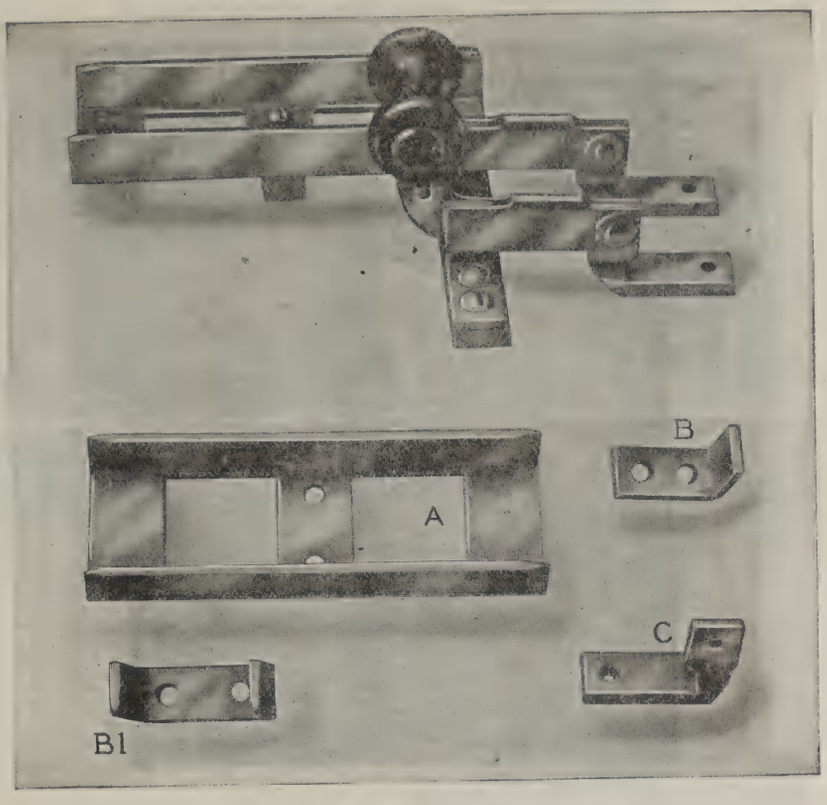
Gutter—3¼-inch. Add 6½ inches to size of panel to get size of box.

Bus-bars—98% conductivity drawn copper.

Hinges—98% conductivity drawn copper forged in one piece.

Cross Bars—98% conductivity drawn copper.

KRANTZ TYPES B AND BP STRAIGHT-LINE PANEL BOARDS—Continued



DETAILS OF STRAIGHT-LINE CONSTRUCTION
Note the Long Double Spring Contact Blades and Single Solid $\frac{3}{32}$-inch Copper Cross Bar

Terminal Lugs—98% conductivity drawn copper. (No castings used).

Current Density—750 amperes per square inch cross section.

Finish—Exposed parts polished and lacquered.

Spacings—As per rules and regulations of the National Board of Fire Underwriters.

Capacity—Mains are figured:

3 amperes per circuit for 3-2 wire, 125 volts.
6 amperes per circuit for 2-2 wire, 125 volts.
3 amperes per circuit for 3-2 and 2-2 wire, 250 volts.
Mains of larger capacities are listed on a following page.

Through Feed Panel Boards—Listed on a following page.

Branch Circuit Switches—30-ampere double-blade knife switches with blades moulded in substantial composition handle. Branch-circuit terminals provided with horseshoe washers confining and retaining the wires.

Fuse Arrangement (Removable from front of board)—N. E. C. with phosphor bronze clips. Edison plug with black enameled porcelain shell. Enclosed plug with black enameled porcelain shell.

ADJUSTABLE CORNER IRON

Specifications for Boxes and Cabinets

Boxes—No. 12 U. S. gauge steel, rigid channel construction, riveted at corners. Panels are held in position by four adjustable clamps held to the box by two screws each. Finished dull black marine.

Trims—Steel No. 10 U. S. gauge dull black marine finish with Yale lock.

Wood—$\frac{7}{8}$-inch white, plain oak, filled and rubbed to a smooth, even finish. Equipped with lock or catch. Lined with $\frac{1}{16}$" sheet iron over panel and gutter.

Gutter—3¼-inch wiring gutter all around frame of panel.

Special Boxes—Steel trims or wood trims can be furnished at a slight advance over the list price.

Straight-Line Construction

The reason why **straight-line** construction is used in types B and BP panel boards is shown in the above illustration. Referring to this Fig., a summary of pieces needed to make an eight-circuit Krantz **straight-line** panel is as follows:

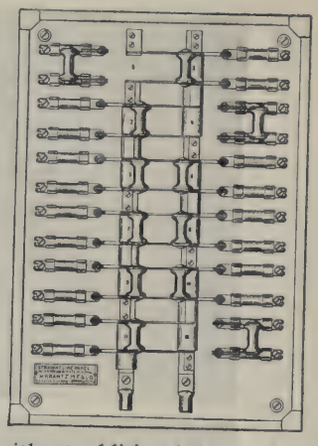
(A) Cross Bar.....2, each with 1 contact surface = 2 contact surfaces.
(B) Single Clip....4, each with 1 contact surface = 4 contact surfaces.
(B1) Double Clip...2, each with 1 contact surface = 2 contact surfaces.
(C) Hinge.....16
Totals.....24 pieces = 8 contact surfaces
1 large two-screw contact for each circuit.

Compared with the above construction the

KRANTZ TYPES B AND BP STRAIGHT-LINE PANEL BOARDS—Continued

Mains—Two-wire with terminal lugs.

Branches—Two-wire with 30-ampere switches arranged for N. E. C. enclosed fuses.



CABINETS

Style FS—Flush steel box and steel trim.

Style SS—Surface steel box and steel trim.

Style FW—Flush steel box and wood trim.

For inside dimensions of box add 6½ inches to panel size for 3¼-inch gutter.

Through-feed panels and mains of larger capacity are listed on a following page.

Style number and list price do not include fuses.

Boxes will be drilled for conduit without extra charge provided drilling information accompanies the order. Boxes will be shipped undrilled unless templates are sent with order showing location and size of holes wanted.

Knockouts for one half of the total number of circuits will be furnished without additional charge when requested on the initial order. Extra knockouts will be furnished at **10c** each, list.

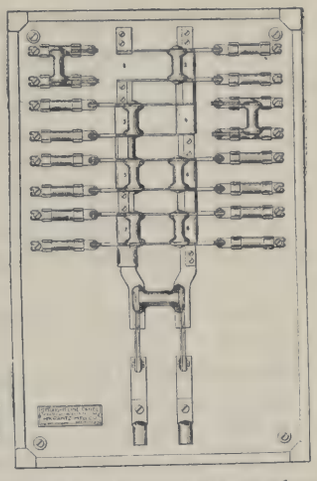
Shipping weights of panels are shown on the last page of "Type S Safety Panel Boards."

Amp. Capacity of Mains	Outside Dimensions of Panels in Inches			Number of Circuits	Panel Only Without Slate Frame or Cabinet		Slate Frame Only List Price	Panels Complete with Cabinet				
								Style Numbers		List Price	Style Number Style FW	List Price Style FW
	Height	Width	Depth		Style No.	List Price		Style FS	Style SS			
125 Volts								**Double Branch**				
30	10	13½	4½	4	K-38798	9 70	$ 4 10	K-38814	K-38830	$30 00	K-38846	$33 00
60	13	13½	4½	6	K-38799	13 10	4 50	K-38815	K-38831	34 60	K-38847	38 00
60	16	13½	4½	8	K-38800	16 60	4 80	K-38816	K-38832	39 60	K-38848	43 50
60	19	13½	4½	10	K-38801	20 00	5 20	K-38817	K-38833	43 80	K-38849	48 20
100	22	13½	4½	12	K-38802	24 00	5 50	K-38818	K-38834	49 50	K-38850	54 50
100	25	13½	4½	14	K-38803	28 00	5 90	K-38819	K-38835	54 50	K-38851	60 00
100	26½	13½	4½	16	K-38804	31 60	6 10	K-38820	K-38836	59 00	K-38852	65 00
200	29½	13½	4½	18	K-38805	36 70	6 40	K-38821	K-38837	65 50	K-38853	72 00
200	32½	13½	4½	20	K-38806	40 40	6 80	K-38822	K-38838	70 60	K-38854	77 60
200	35½	13½	4½	22	K-38807	43 70	7 10	K-38823	K-38839	75 30	K-38855	82 80
200	38½	13½	4½	24	K-38808	47 50	7 50	K-38824	K-38840	80 70	K-38856	88 80
200	41½	13½	4½	26	K-38809	51 00	7 80	K-38825	K-38841	86 00	K-38857	94 60
200	43	13½	4½	28	K-38810	54 70	8 00	K-38826	K-38842	90 00	K-38858	99 00
200	46	13½	4½	30	K-38811	58 00	8 30	K-38827	K-38843	96 00	K-38859	105 60
200	49	13½	4½	32	K-38812	62 00	8 60	K-38828	K-38844	102 00	K-38860	112 20
250 Volts								**Double Branch**				
30	11½	14½	5½	4	K-38862	10 00	4 70	K-38878	K-38894	31 60	K-38910	34 80
30	14½	14½	5½	6	K-38863	13 70	5 10	K-38879	K-38895	36 70	K-38911	40 40
30	17½	14½	5½	8	K-38864	17 50	5 40	K-38880	K-38896	41 60	K-38912	45 80
30	22	14½	5½	10	K-38865	20 50	5 90	K-38881	K-38897	46 70	K-38913	51 40
60	25	14½	5½	12	K-38866	25 00	6 20	K-38882	K-38898	52 50	K-38914	57 80
60	29½	14½	5½	14	K-38867	28 60	6 80	K-38883	K-38899	58 20	K-38915	64 00
60	32½	14½	5½	16	K-38868	32 40	7 10	K-38884	K-38900	63 50	K-38916	70 00
60	35½	14½	5½	18	K-38869	36 30	7 50	K-38885	K-38901	68 50	K-38917	75 40
60	40	14½	5½	20	K-38870	40 00	8 00	K-38886	K-38902	75 50	K-38918	83 00
100	43	14½	5½	22	K-38871	45 80	8 40	K-38887	K-38903	81 20	K-38919	89 30
100	46	14½	5½	24	K-38872	48 50	8 90	K-38888	K-38904	87 00	K-38920	95 70
100	50½	14½	5½	26	K-38873	52 50	9 40	K-38889	K-38905	93 20	K-38921	102 50
100	53½	14½	5½	28	K-38874	56 00	9 80	K-38890	K-38906	98 50	K-38922	108 30
100	56½	14½	5½	30	K-38875	60 00	10 10	K-38891	K-38907	104 00	K-38923	114 40
100	61	14½	5½	32	K-38876	64 00	10 70	K-38892	K-38908	110 00	K-38924	121 00

For panels with fuses in mains add 8 per cent to above prices.

Order by Style Number

KRANTZ TYPES B AND BF STRAIGHT-LINE PANEL BOARDS—Continued



Mains—Two-wire with unfused switch.

Branches—Two-wire with 30-ampere switches arranged for N. E. C. enclosed fuses.

CABINETS

Style FS—Flush steel box and steel trim.

Style SS—Surface steel box and steel trim.

Style FW—Flush steel box and wood trim.

For inside dimensions of box add 6½ inches to panel size for 3¼-inch gutter.

Through-feed panels and mains of larger capacity are listed on a following page.

Style number and list price do not include fuses.

Boxes will be drilled for conduit without extra charge provided drilling information accompanies the order. Boxes will be shipped undrilled unless templates are sent with the order showing location and size of holes wanted.

Knockouts for one half of the total number of circuits will be furnished without additional charge when requested on the initial order. Extra knockouts will be furnished at **10c** each, list.

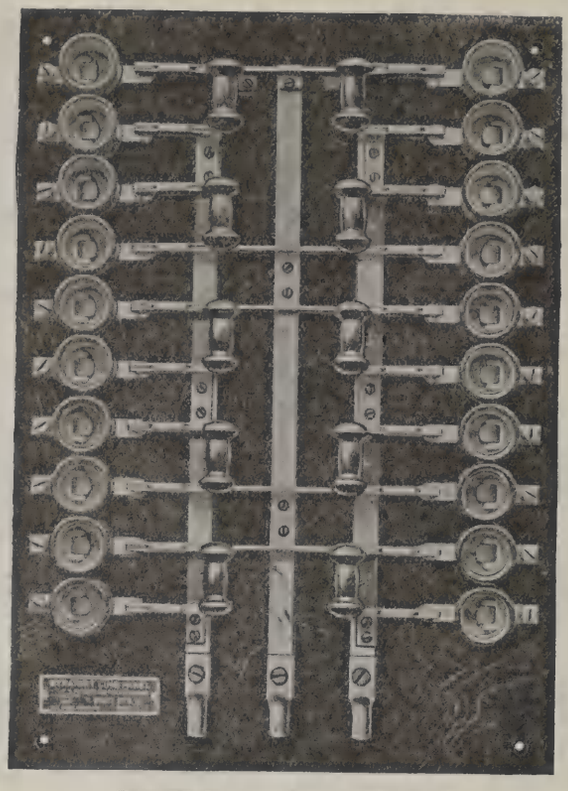
Shipping weights of panels are shown on the last page of "Type S Safety Panel Boards."

Amp. Capacity of Mains	Outside Dimensions of Panels in Inches			Number of Circuits	Panel Only Without Slate Frame or Cabinet		Slate Frame Only List Price	Panels Complete with Cabinet				
								Style Numbers		List Price	Style Number Style FW	List Price Style FW
	Height	Width	Depth		Style No.	List Price		Style FS	Style SS			
125 Volts								**Double Branch**				
30	13	13½	4½	4	K-38942	$14 60	4 50	K-38958	K-38974	$ 36 20	K-38990	$ 40 00
60	19	13½	4½	6	K-38943	19 00	5 20	K-38959	K-38975	43 00	K-38991	47 30
60	22	13½	4½	8	K-38944	22 50	5 50	K-38960	K-38976	48 00	K-38992	52 80
60	25	13½	4½	10	K-38945	26 00	5 90	K-38961	K-38977	52 50	K-38993	57 80
100	28	13½	4½	12	K-38946	33 00	6 20	K-38962	K-38978	61 40	K-38994	67 50
100	31	13½	4½	14	K-38947	37 00	6 60	K-38963	K-38979	66 50	K-38995	73 20
100	34	13½	4½	16	K-38948	41 00	6 90	K-38964	K-38980	72 00	K-38996	79 20
200	46	14½	5½	18	K-38949	49 50	8 80	K-38965	K-38981	88 20	K-38997	97 00
200	49	14½	5½	20	K-38950	53 20	9 20	K-38966	K-38982	93 00	K-38998	102 30
200	52	14½	5½	22	K-38951	56 60	9 60	K-38967	K-38983	98 50	K-38999	108 30
200	53½	14½	5½	24	K-38952	60 50	80	K-38968	K-38984	103 00	K-39000	113 30
200	56½	14½	5½	26	K-38953	64 00	10 20	K-38969	K-38985	108 00	K-39101	118 80
200	59½	14½	5½	28	K-38954	67 80	10 50	K-38970	K-38986	113 00	K-39102	124 30
200	62½	14½	5½	30	K-38955	71 00	10 80	K-38971	K-38987	118 00	K-39103	130 00
200	64	14½	5½	32	K-38956	75 00	11 20	K-38972	K-38988	123 00	K-39104	136 00
250 Volts								**Double Branch**				
30	19	14½	5½	4	K-39106	15 00	5 50	K-39122	K-39138	39 70	K-39154	43 70
30	23½	14½	5½	6	K-39107	18 60	6 10	K-39123	K-39139	45 50	K-39155	50 00
30	26½	14½	5½	8	K-39108	22 40	6 40	K-39124	K-39140	50 70	K-39156	55 80
30	29½	14½	5½	10	K-39109	25 50	6 80	K-39125	K-39141	55 00	K-39157	60 50
60	35½	14½	5½	12	K-39110	31 00	7 50	K-39126	K-39142	63 50	K-39158	70 00
60	40	14½	5½	14	K-39111	34 50	8 00	K-39127	K-39143	70 00	K-39159	77 00
60	43	14½	5½	16	K-39112	38 40	8 40	K-39128	K-39144	75 00	K-39160	82 50
60	46	14½	5½	18	K-39113	42 20	80	K-39129	K-39145	81 00	K-39161	89 00
60	49	14½	5½	20	K-39114	46 00	9 20	K-39130	K-39146	85 70	K-39162	94 00
100	56½	14½	5½	22	K-39115	53 80	10 00	K-39131	K-39147	98 00	K-39163	108 00
100	59½	14½	5½	24	K-39116	57 80	10 50	K-39132	K-39148	103 00	K-39164	113 00
100	62½	14½	5½	26	K-39117	61 70	10 80	K-39133	K-39149	109 00	K-39165	120 00
100	65½	14½	5½	28	K-39118	65 20	11 30	K-39134	K-39150	114 50	K-39166	126 00
100	70	14½	5½	30	K-39119	69 20	12 00	K-39135	K-39151	122 00	K-39167	134 00
100	73	14½	5½	32	K-39120	73 20	12 30	K-39136	K-39152	128 00	K-39168	141 00

For panels with fuses in mains add 4 per cent to above prices.

Order by Style Number

KRANTZ TYPES B AND BP STRAIGHT-LINE PANEL BOARDS—Continued



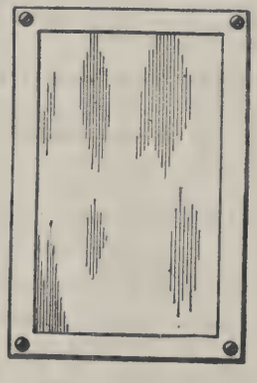
TYPE BP STRAIGHT-LINE PANEL BOARD

summary of similar pieces needed to make a panel of ordinary construction shows the use of 100 pieces and 88 contact surfaces or a total of 76 pieces and 80 contact surfaces more than in a similar Krantz panel.

Adjustable Corner Irons

Panels are shipped with corner irons fastened to the base and are held to the box by means of clamps which allow adjustment in all directions.

Corner irons and corners as shown on the preceding page are furnished with all Krantz panels finished in dull black.



DIRECTORY FRAME

Fuses in Mains

Standard Krantz panel boards are not made with fuses in mains as fuses for the same purpose are required by the N. E. Code at the origin of the line feeding the panel and are therefore unnecessary and undesirable at the panel board.

Fuses in mains will be supplied on special order. For prices see footnotes on following pages.

Directory Frames

Standard frames are made of sheet steel in one piece and are finished in dull black marine.

Price includes glass, screws, and drilling of trims for frames, if trims are ordered.

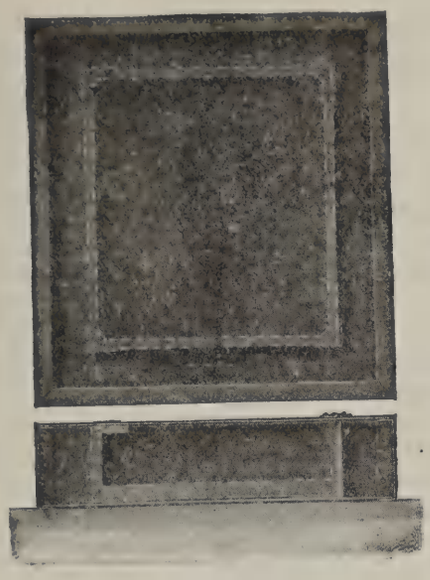
Style No.	Size Inside	List Price Each
K-1807	14 x7	$3 00
K-1808	12¾x5⅞	2 20
K-1809	7¾x4¾	1 80
K-1810	6⅝x3¼	1 40
K-1811	4¾x3 11/16	1 00

Special—For directory frames of other than standard material and finish use the following prices:

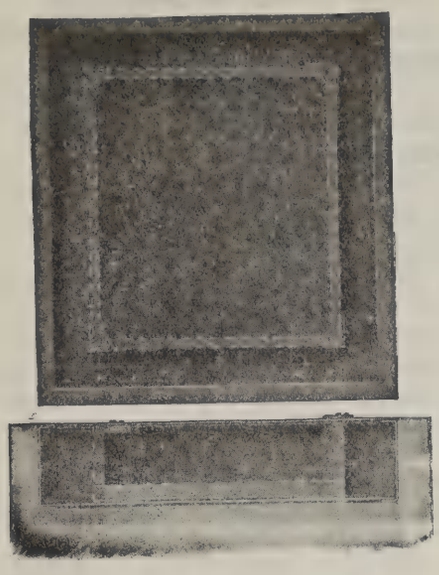
Style No. Copper Finished Polished	Style No. Brass Finished Polished	Inside Dimensions	List Price Each
K-2795	K-2815	12½x9½	$4 00
K-2796	K-2816	14 x7	4 00
K-2797	K-2817	12¾x5⅞	2 70
K-2798	K-2818	7¾x4¾	2 20
K-2799	K-2819	6⅝x3¼	1 80
K-2800	K-2820	4¾x3 11/16	1 40

Order by Style Number

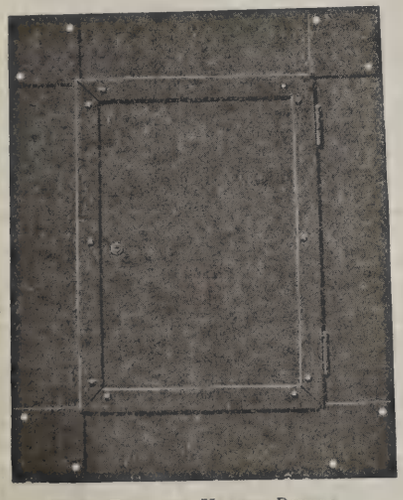
KRANTZ TYPES B AND BP STRAIGHT-LINE PANEL BOARDS—Continued



SURFACE BOX



FLUSH BOX



STEEL TRIM FOR KRANTZ PANELS

WOOD TRIM FOR KRANTZ PANELS

Marble Panels

Types B and BP panel boards can be furnished in white Italian, gray Tennessee, pink Tennessee, or blue Vermont marble at the following advance over prices for standard slate panels.

25% over price on panel.

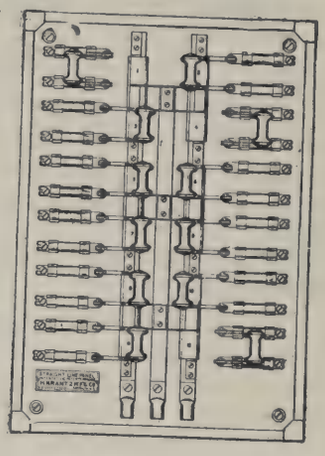
100% over price on frame.

For marble panel boards complete with cabinets obtain the additions indicated above for panel and frame and add these to price of standard panel with cabinet.

KRANTZ TYPES B AND BP STRAIGHT-LINE PANEL BOARDS—Continued

Mains—Three-wire with terminal lugs.

Branches—Two-wire with 30-ampere switches arranged for N. E. C. enclosed fuses.



CABINETS

Style FS—Flush steel box and steel trim.

Style SS—Surface steel box and steel trim.

Style FW—Flush steel box and wood trim.

For inside dimensions of box add 6½ inches to panel size for 3¼-inch gutter.

Through-feed panels and mains of larger capacity are listed on a following page.

Style number and list price do not include fuses.

Boxes will be drilled for conduit without extra charge provided drilling information accompanies the order. Boxes will be shipped undrilled unless templates are sent with the order showing location and size of holes wanted,

Knockouts for one half of the total number of circuits will be furnished without additional charge when requested on the initial order. Extra knockouts will be furnished at **10c** each, list.

Shipping weights of panels are shown on the last page of "Type S Safety Panel Boards."

Amp. Capacity of Mains	Outside Dimensions of Panels in Inches			Number of Circuits	Panel Only Without Slate Frame or Cabinet		Slate Frame Only List Price	Panels Complete With Cabinet				
								Style Numbers		List Price	Style Number Style FW	List Price Style FW
	Height	Width	Depth		Style No.	List Price		Style FS	Style SS			
125 Volts								**Double Branch**				
30	10	13½	4½	4	K-39170	$10 70	▮ 4 10	K-39186	K-39202	$ 31 00	K-39218	$ 34 20
30	13	13½	4½	6	K-39171	14 10	4 50	K-39187	K-39203	35 60	K-39219	39 20
30	16	13½	4½	8	K-39172	17 60	4 80	K-39188	K-39204	40 60	K-39220	44 70
30	17½	13½	4½	10	K-39173	21 20	5 10	K-39189	K-39205	44 60	K-39221	49 00
60	20½	13½	4½	12	K-39174	25 40	5 40	K-39190	K-39206	50 20	K-39222	55 20
60	23½	13½	4½	14	K-39175	29 10	5 70	K-39191	K-39207	55 20	K-39223	60 70
60	26½	13½	4½	16	K-39176	32 50	6 10	K-39192	K-39208	60 00	K-39224	66 00
60	29½	13½	4½	18	K-39177	36 00	6 40	K-39193	K-39209	65 00	K-39225	71 50
60	32½	13½	4½	20	K-39178	40 00	6 80	K-39194	K-39210	70 40	K-39226	77 50
100	35½	13½	4½	22	K-39179	45 00	7 10	K-39195	K-39211	76 70	K-39227	84 40
100	37	13½	4½	24	K-39180	49 00	7 30	K-39196	K-39212	81 20	K-39228	89 30
100	40	13½	4½	26	K-39181	52 70	7 60	K-39197	K-39213	87 30	K-39229	96 00
100	43	13½	4½	28	K-39182	56 50	7 90	K-39198	K-39214	91 80	K-39230	101 00
100	46	13½	4½	30	K-39183	60 00	8 30	K-39199	K-39215	97 50	K-39231	107 30
100	49	13½	4½	32	K-39184	64 00	8 60	K-39200	K-39216	102 80	K-39232	113 00
250 Volts								**Double Branch**				
30	11½	16	5½	4	K-39234	10 90	4 80	K-39250	K-39266	33 30	K-39282	36 60
30	14½	16	5½	6	K-39235	14 80	5 20	K-39251	K-39267	38 50	K-39283	42 30
30	19	16	5½	8	K-39236	18 90	5 60	K-39252	K-39268	44 40	K-39284	48 80
30	22	16	5½	10	K-39237	22 60	6 00	K-39253	K-39269	49 70	K-39285	54 60
60	25	16	5½	12	K-39238	27 00	6 30	K-39254	K-39270	55 20	K-39286	60 70
60	29½	16	5½	14	K-39239	30 70	6 90	K-39255	K-39271	61 20	K-39287	67 30
60	32½	16	5½	16	K-39240	34 90	7 20	K-39256	K-39272	67 00	K-39288	73 70
60	35½	16	5½	18	K-39241	39 00	7 60	K-39257	K-39273	72 70	K-39289	80 00
60	40	16	5½	20	K-39242	42 60	8 00	K-39258	K-39274	79 00	K-39290	86 80
100	43	16	5½	22	K-39243	48 80	8 50	K-39259	K-39275	86 40	K-39291	95 00
100	46	16	5½	24	K-39244	53 20	8 80	K-39260	K-39276	93 00	K-39292	102 00
100	50½	16	5½	26	K-39245	57 50	9 60	K-39261	K-39277	100 00	K-39293	110 00
100	53½	16	5½	28	K-39246	61 50	10 00	K-39262	K-39278	105 80	K-39294	116 30
100	56½	16	5½	30	K-39247	65 80	10 30	K-39263	K-39279	112 00	K-39295	123 00
100	61	16	5½	32	K-39248	70 00	11 00	K-39264	K-39280	119 00	K-39296	130 00

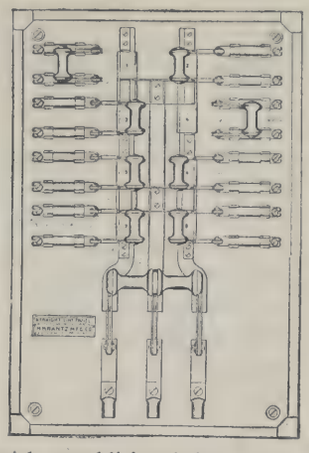
For panels with fuses in mains add ▮ per cent to above prices.

Order by Style Number

KRANTZ TYPES B AND BP STRAIGHT-LINE PANEL BOARDS—Continued

Mains—Three-wire with unfused switch.

Branches—Two-wire with 30-ampere switches arranged for N. E. C. enclosed fuses.



CABINETS

Style FS—Flush steel box and steel trim.

Style SS—Surface steel box and steel trim.

Style FW—Flush steel box and wood trim.

For inside dimensions of box add 6½ inches to panel size for 3¼-inch gutter.

Through-feed panels and mains of larger capacity are listed on a following page.

Style number and list price do not include fuses.

Boxes will be drilled for conduit without extra charge provided drilling information accompanies the order. Boxes will be shipped undrilled unless templates are sent with order showing location and size of holes wanted.

Knockouts for one half of the total number of circuits will be furnished without additional charge when requested on the initial order. Extra knockouts will be furnished at **10c** each, list.

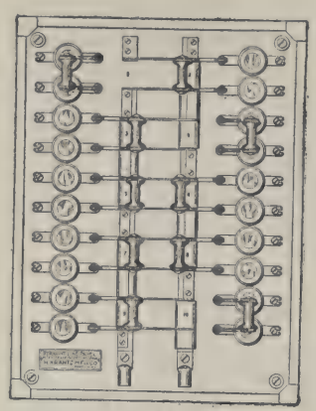
Shipping weights of panels are shown on the last page of "Type S Safety Panel Boards."

Amp. Capacity of Mains	Outside Dimensions of Panels in Inches			Number of Circuits	Panel Only Without Slate Frame or Cabinet		Slate Frame Only List Price	Panels Complete with Cabinet				
								Style Numbers		List Price	Style Number Style FW	List Price Style FW
	Height	Width	Depth		Style No.	List Price		Style FS	Style SS			
125 Volts								**Double Branch**				
30	13	13½	4½	4	K-39298	$18 20	$ 4 50	K-39314	K-39330	$ 39 70	K-39346	$ 43 70
30	16	13½	4½	6	K-39299	21 60	4 80	K-39315	K-39331	44 60	K-39347	49 00
30	19	13½	4½	8	K-39300	25 00	5 20	K-39316	K-39332	49 00	K-39348	54 00
30	22	13½	4½	10	K-39301	28 70	5 50	K-39317	K-39333	54 20	K-39349	59 60
60	28	14½	4½	12	K-39302	34 40	6 20	K-39318	K-39334	62 60	K-39350	69 00
60	31	14½	4½	14	K-39303	38 00	6 60	K-39319	K-39335	67 50	K-39351	74 20
60	32½	14½	4½	16	K-39304	41 60	6 80	K-39320	K-39336	71 80	K-39352	79 00
60	35½	14½	4½	18	K-39305	45 00	7 10	K-39321	K-39337	76 70	K-39353	84 40
60	38½	14½	4½	20	K-39306	49 00	7 50	K-39322	K-39338	82 00	K-39354	90 00
100	41½	14½	4½	22	K-39307	58 80	7 80	K-39323	K-39339	94 00	K-39355	103 40
100	44½	14½	4½	24	K-39308	63 00	8 20	K-39324	K-39340	99 50	K-39356	109 40
100	47½	14½	4½	26	K-39309	66 60	8 40	K-39325	K-39341	104 40	K-39357	115 00
100	49	14½	4½	28	K-39310	70 20	8 60	K-39326	K-39342	109 00	K-39358	120 00
100	52	14½	4½	30	K-39311	73 80	9 00	K-39327	K-39343	114 00	K-39359	125 00
100	55	14½	4½	32	K-39312	77 80	9 30	K-39328	K-39344	119 00	K-39360	130 00
250 Volts								**Double Branch**				
30	19	16	5½	4	K-39362	18 40	5 60	K-39378	K-39394	44 00	K-39410	48 40
30	23½	16	5½	6	K-39363	22 30	6 20	K-39379	K-39395	50 00	K-39411	55 00
30	26½	16	5½	8	K-39364	26 30	6 50	K-39380	K-39396	55 40	K-39412	60 50
30	29½	16	5½	10	K-39365	30 00	6 90	K-39381	K-39397	60 50	K-39413	66 50
60	35½	16	5½	12	K-39366	36 00	7 60	K-39382	K-39398	69 60	K-39414	76 50
60	40	16	5½	14	K-39367	39 60	8 00	K-39383	K-39399	76 00	K-39415	83 60
60	43	16	5½	16	K-39368	43 80	8 50	K-39384	K-39400	81 50	K-39416	89 60
60	46	16	5½	18	K-39369	48 00	8 90	K-39385	K-39401	87 80	K-39417	96 50
60	49	16	5½	20	K-39370	51 50	9 20	K-39386	K-39402	92 80	K-39418	102 00
100	56½	16	5½	22	K-39371	52 60	10 30	K-39387	K-39403	108 60	K-39419	119 00
100	59½	16	5½	24	K-39372	66 80	10 70	K-39388	K-39404	114 40	K-39420	126 00
100	62½	16	5½	26	K-39373	71 20	11 00	K-39389	K-39405	121 00	K-39421	133 00
100	65½	16	5½	28	K-39374	75 20	11 40	K-39390	K-39406	127 00	K-39422	139 00
100	70	16	5½	30	K-39375	79 50	12 00	K-39391	K-39407	134 00	K-39423	147 00
100	73	16	5½	32	K-39376	83 70	12 30	K-39392	K-39408	140 00	K-39424	154 00

For panels with fuses in mains add 4 per cent to above prices.

Order by Style Number

KRANTZ TYPES B AND BP STRAIGHT-LINE PANEL BOARDS—Continued



TWO-WIRE MAINS WITH TERMINAL LUGS

Mains — Two-wire with terminal lugs, or with unfused switch.

Branches — Two-wire with 30-ampere switches arranged for plug fuses.

CABINETS

Style FS—Flush steel box and steel trim.

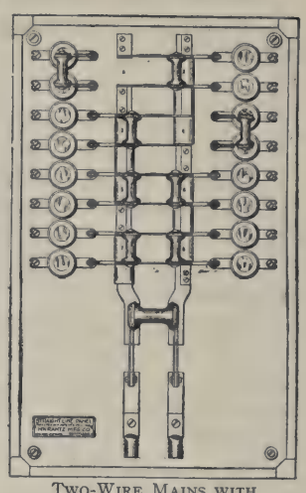
Style SS—Surface steel box and steel trim.

Style FW—Flush steel box and wood trim.

For inside dimensions of box add 6½ inches to panel size for 3¼-inch gutter.

Through-feed panels and mains of larger capacity are listed on a following page.

Style number and list price do not include fuses.



TWO-WIRE MAINS WITH UNFUSED SWITCH

Boxes will be drilled for conduit without extra charge provided drilling information accompanies the order. Boxes will be shipped undrilled unless templates are sent with order showing location and size of holes wanted.

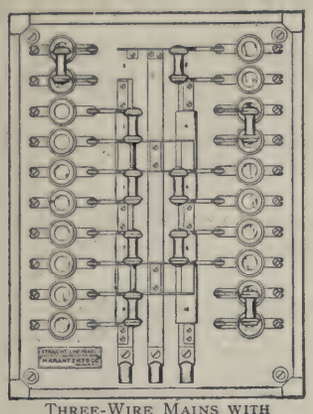
Knockouts for one half of the total number of circuits will be furnished without additional charge when requested on the initial order. Extra knockouts will be furnished at **10c** each, list.

Amp. Capacity of Mains	Outside Dimensions of Panels in Inches			Number of Circuits	Panel Only Without Slate Frame or Cabinet		Slate Frame Only List Price	Panels Complete with Cabinet				
								Style Numbers		List Price	Style Number Style FW	List Price Style FW
	Height	Width	Depth		Style No.	List Price		Style FS	Style SS			
	125 Volts				**With Terminal Lugs Only**			**Double Branch**				
30	10	13½	4½	4	K-39426	9 80	4 10	K-39442	K-39458	$ 30 00	K-39474	$ 33 00
60	13	13½	4½	6	K-39427	13 30	4 50	K-39443	K-39459	35 00	K-39475	38 50
60	16	13½	4½	8	K-39428	17 00	4 80	K-39444	K-39460	40 00	K-39476	44 00
60	19	13½	4½	10	K-39429	20 40	5 20	K-39445	K-39461	45 50	K-39477	50 00
100	23½	13½	4½	12	K-39430	24 50	5 70	K-39446	K-39462	50 60	K-39478	55 70
100	26½	13½	4½	14	K-39431	28 60	6 10	K-39447	K-39463	56 20	K-39479	61 80
100	29½	13½	4½	16	K-39432	32 00	6 40	K-39448	K-39464	61 00	K-39480	67 00
200	32½	13½	4½	18	K-39433	37 50	6 80	K-39449	K-39465	68 00	K-39481	74 80
200	35½	13½	4½	20	K-39434	41 20	7 10	K-39450	K-39466	72 80	K-39482	80 00
200	38½	13½	4½	22	K-39435	45 00	7 50	K-39451	K-39467	78 00	K-39483	85 80
200	41½	13½	4½	24	K-39436	48 50	7 80	K-39452	K-39468	83 50	K-39484	91 80
200	44½	13½	4½	26	K-39437	52 30	20	K-39453	K-39469	89 00	K-39485	98 00
200	47½	13½	4½	28	K-39438	56 00	8 40	K-39454	K-39470	94 00	K-39486	103 40
200	50½	13½	4½	30	K-39439	60 70	8 70	K-39455	K-39471	99 00	K-39487	109 00
200	53½	13½	4½	32	K-39440	63 20	20	K-39456	K-39472	104 50	K-39488	115 00
	125 Volts				**With Unfused Switch**			**Double Branch**				
30	13	13½	4½	4	K-39490	14 70	4 50	K-39506	K-39522	36 20	K-39538	39 80
60	20½	13½	4½	6	K-39491	19 30	5 40	K-39507	K-39523	44 00	K-39539	48 40
60	23½	13½	4½	8	K-39492	23 00	5 80	K-39508	K-39524	49 00	K-39540	54 00
60	26½	13½	4½	10	K-39493	26 30	6 10	K-39509	K-39525	53 70	K-39541	59 00
100	29½	13½	4½	12	K-39494	33 70	6 40	K-39510	K-39526	62 50	K-39542	68 70
100	32½	13½	4½	14	K-39495	37 80	6 80	K-39511	K-39527	68 20	K-39543	75 00
100	35½	13½	4½	16	K-39496	41 30	7 10	K-39512	K-39528	72 80	K-39544	80 00
200	49	14½	5½	18	K-39497	50 30	20	K-39513	K-39529	90 00	K-39545	99 00
200	52	14½	5½	20	K-39498	54 00	9 60	K-39514	K-39530	95 80	K-39546	105 30
200	55	14½	5½	22	K-39499	57 80	10 00	K-39515	K-39531	101 00	K-39547	111 00
200	58	14½	5½	24	K-39500	61 30	10 30	K-39516	K-39532	106 20	K-39548	117 80
200	61	14½	5½	26	K-39501	65 00	10 70	K-39517	K-39533	111 50	K-39549	122 70
200	64	14½	5½	28	K-39502	68 80	11 20	K-39518	K-39534	117 50	K-39550	129 00
200	67	14½	5½	30	K-39503	72 50	11 60	K-39519	K-39535	123 50	K-39551	136 00
200	70	14½	5½	32	K-39504	76 00	12 00	K-39520	K-39536	129 00	K-39552	142 00

For panels with main fuses add 8 per cent to above prices for lugs only in mains—for fused main switches add 4 per cent. Shipping weights of panels are shown on the last page on "Type S Safety Panel Boards."

Order by Style Number

KRANTZ TYPES B AND BP STRAIGHT-LINE PANEL BOARDS—Continued



THREE-WIRE MAINS WITH TERMINAL LUGS

Mains—Three-wire with terminal lugs, or with unfused switch.
Branches—Two-wire with 30-ampere switches arranged for plug fuses.

CABINETS

Style FS—Flush steel box and steel trim.

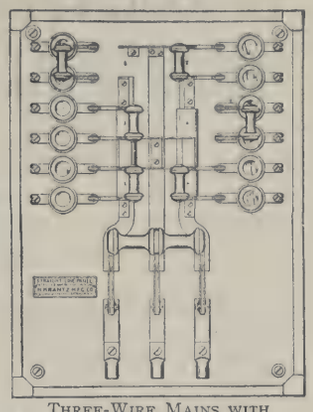
Style SS—Surface steel box and steel trim.

Style FW—Flush steel box and wood trim.

For inside dimensions of box add 6½ inches to panel size for 3¼ inch gutter.

Through-feed panels and mains of larger capacity are listed on a following page.

Style number and list price do not include fuses.



THREE-WIRE MAINS WITH UNFUSED SWITCH

Boxes will be drilled for conduit without extra charge provided drilling information accompanies the order. Boxes will be shipped undrilled unless templates are sent with the order showing location and size of holes wanted.

Knockouts for one half of the total number of circuits will be furnished without additional charge when requested on the initial order. Extra knockouts will be furnished at **10c** each, list.

Amp. Capacity of Mains	Outside Dimensions of Panels in Inches			Number of Circuits	Panel Only Without Slate Frame or Cabinet		Slate Frame Only List Price	PANELS COMPLETE WITH CABINET				
								Style Numbers		List Price	Style Number Style FW	List Price Style FW
	Height	Width	Depth		Style No.	List Price		Style FS	Style SS			
	125 Volts				**With Terminal Lugs Only**			**Double Branch**				
30	10	13½	4½	4	K-39554	$11 00	$ 4 10	K-39570	K-39586	$ 31 50	K-39602	$ 34 70
30	13	13½	4½	6	K-39555	14 50	4 50	K-39571	K-39587	36 00	K-39603	39 60
30	16	13½	4½	8	K-39556	18 00	4 80	K-39572	K-39588	41 00	K-39604	45 00
30	19	13½	4½	10	K-39557	21 90	5 20	K-39573	K-39589	45 70	K-39605	50 00
60	22	13½	4½	12	K-39558	26 20	5 50	K-39574	K-39590	51 60	K-39606	56 80
60	25	13½	4½	14	K-39559	29 80	5 90	K-39575	K-39591	56 50	K-39607	62 20
60	28	13½	4½	16	K-39560	33 70	6 20	K-39576	K-39592	62 00	K-39608	68 20
60	31	13½	4½	18	K-39561	37 40	6 60	K-39577	K-39593	67 00	K-39609	73 70
60	34	13½	4½	20	K-39562	41 30	6 90	K-39578	K-39594	72 50	K-39610	79 80
100	38½	13½	4½	22	K-39563	46 70	7 50	K-39579	K-39595	80 00	K-39611	88 00
100	41½	13½	4½	24	K-39564	49 50	7 80	K-39580	K-39596	85 50	K-39612	94 00
100	44½	13½	4½	26	K-39565	54 50	8 20	K-39581	K-39597	91 00	K-39613	100 00
100	47½	13½	4½	28	K-39566	58 00	8 40	K-39582	K-39598	96 00	K-39614	105 60
100	50½	13½	4½	30	K-39567	61 80	8 80	K-39583	K-39599	102 00	K-39615	112 00
100	53½	13½	4½	32	K-39568	65 70	9 20	K-39584	K-39600	107 00	K-39616	118 00
	125 Volts				**With Unfused Switch**			**Double Branch**				
30	13	13½	4½	4	K-39618	18 50	4 50	K-39634	K-39650	40 00	K-39666	44 00
30	16	13½	4½	6	K-39619	22 00	4 80	K-39635	K-39651	45 00	K-39667	49 50
30	19	13½	4½	8	K-39620	25 50	5 20	K-39636	K-39652	49 50	K-39668	54 50
30	22	13½	4½	10	K-39621	29 50	5 50	K-39637	K-39653	54 80	K-39669	60 30
60	29½	14½	4½	12	K-39622	35 00	6 40	K-39638	K-39654	64 00	K-39670	70 40
60	32½	14½	4½	14	K-39623	38 60	6 80	K-39639	K-39655	69 00	K-39671	76 00
60	35½	14½	4½	16	K-39624	42 70	7 10	K-39640	K-39656	74 20	K-39672	81 60
60	38½	14½	4½	18	K-39625	46 50	7 50	K-39641	K-39657	79 50	K-39673	87 50
60	41½	14½	4½	20	K-39626	50 00	7 80	K-39642	K-39658	85 00	K-39674	93 50
100	44½	14½	4½	22	K-39627	60 50	8 10	K-39643	K-39659	97 00	K-39675	106 70
100	47½	14½	4½	24	K-39628	64 50	8 40	K-39644	K-39660	103 00	K-39676	113 30
100	50½	14½	4½	26	K-39629	68 30	8 80	K-39645	K-39661	108 00	K-39677	118 00
100	53½	14½	4½	28	K-39630	72 00	9 20	K-39646	K-39662	113 00	K-39678	124 00
100	56½	14½	4½	30	K-39631	75 50	9 50	K-39647	K-39663	118 00	K-39679	130 00
100	59½	14½	4½	32	K-39632	79 50	9 80	K-39648	K-39664	124 00	K-39680	137 00

For panels with main fuses add 8 per cent to above prices; for fused main switches add 4 per cent.
Shipping weights of panels are shown on the last page on "Types S Safety Panel Boards."

Order by Style Number

THROUGH-FEED AND MAINS OF LARGER CAPACITY

KRANTZ TYPE B OR TYPE BP STRAIGHT LINE AND TYPE S SNAP SWITCH OR TYPE C PUSHBUTTON SWITCH SAFETY PANEL BOARDS

Any listed Krantz type B or BP straight-line or type S snap-switch or type C pushbutton switch safety panel board can be supplied with mains of larger capacity with or without through-feed at an additional price obtained by adding the additional list price shown in the following table to the list price of the standard panel.

In this table the ampere capacity of mains is the total capacity and not the added capacity.

TWO-WIRE

Total Ampere Capacity of Mains	ADDITIONAL LIST PRICES			
	Terminal Lugs Only on Mains		Main Switch Unfused	
	Panel Only	Panel in Cabinet	Panel Only	Panel in Cabinet
4 Circuit				
60	$ 1 00	$ 1 30	$ 3 10	$ 3 80
100	1 70	2 10	8 00	9 40
200	3 80	4 40	14 00	16 70
400	10 50	11 60	31 50	36 50
6 Circuit				
100	80	90	5 20	5 80
200	3 00	3 30	11 00	13 00
400	9 50	10 40	29 00	33 70
8 Circuit				
100	1 10	1 20	5 40	6 10
200	3 40	3 60	11 40	13 50
400	10 40	11 00	30 00	34 00
10 Circuit				
100	1 20	1 30	5 60	6 30
200	3 80	4 10	11 80	13 80
400	11 00	11 70	30 40	35 40
12 Circuit				
200	2 80	3 00	6 60	9 00
400	11 40	12 00	27 00	39 00
14 Circuit				
200	3 00	3 20	6 90	10 00
400	12 00	12 50	27 00	40 00

Total Ampere Capacity of Mains	ADDITIONAL LIST PRICES			
	Terminal Lugs Only on Mains		Main Switch Unfused	
	Panel Only	Panel in Cabinet	Panel Only	Panel in Cabinet
16 Circuit				
200	$ 3 20	$ 3 60	$ 7 10	$10 50
400	12 50	13 10	27 40	40 00
18 Circuit				
400	11 80	12 40	23 00	30 00
20 Circuit				
400	12 40	13 00	24 50	30 00
22 Circuit				
400	12 80	13 50	24 50	31 00
24 Circuit				
400	13 40	16 70	25 00	31 00
26 Circuit				
400	14 00	18 50	25 80	31 50
28 Circuit				
400	14 60	15 50	26 20	32 00
30 Circuit				
400	15 00	16 00	26 80	32 80
32 Circuit				
400	15 60	16 50	27 30	33 00

(Continued on next page)

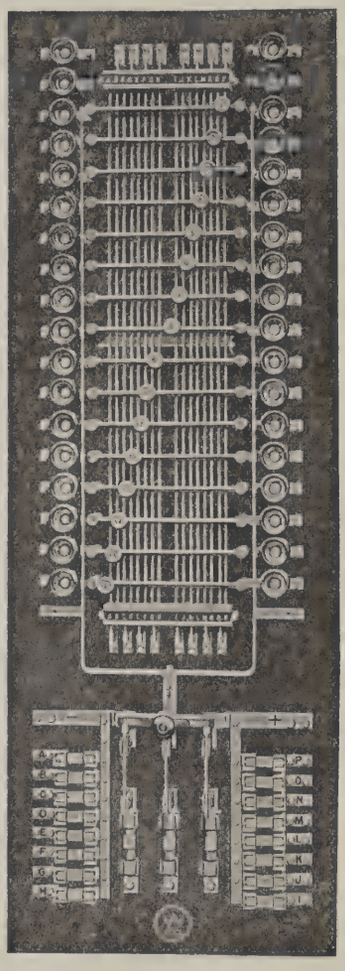
THROUGH-FEEDS AND MAINS OF LARGER CAPACITY Continued

THREE-WIRE

Total Ampere Capacity of Mains	ADDITIONAL LIST PRICES			
	Terminal Lugs Only on Mains		Main Switch Unfused	
	Panel Only	Panel in Cabinet	Panel Only	Panel in Cabinet
4 Circuit				
60	$ 1 30	$ 1 50	$ 4 00	$ 5 00
100	2 50	2 80	11 00	12 40
200	5 30	5 80	19 00	21 80
6 Circuit				
60	1 40	1 70	4 10	5 10
100	2 80	3 00	11 20	12 40
200	5 70	6 30	19 40	22 20
8 Circuit				
60	1 50	1 70	4 20	5 10
100	2 90	3 20	11 40	12 80
200	6 30	6 90	20 00	22 60
10 Circuit				
60	1 60	1 90	4 30	5 20
100	3 10	3 50	11 70	13 10
200	6 60	7 20	20 40	23 20
12 Circuit				
100	1 60	1 70	8 00	8 60
200	5 60	5 90	16 50	19 00
14 Circuit				
100	1 90	2 00	8 20	8 80
200	6 20	6 40	17 20	23 00
16 Circuit				
100	$ 2 10	$ 2 30	$ 8 10	8 80
200	6 20	6 50	17 60	23 60
18 Circuit				
100	2 30	2 50	8 40	9 50
200	7 10	7 40	18 80	24 00
20 Circuit				
100	2 50	2 60	8 60	10 20
200	7 60	7 80	18 80	24 40
22 Circuit				
200	5 50	5 80	10 70	15 60
24 Circuit				
200	5 90	6 30	10 90	16 00
26 Circuit				
200	6 10	6 70	11 30	16 30
28 Circuit				
200	6 50	7 10	11 60	16 70
30 Circuit				
200	6 80	7 40	11 90	16 90
32 Circuit				
200	7 00	7 60	12 20	17 20

KRANTZ METERING PANEL BOARDS

(Manufactured under the McWilliams and other Patents)



Application

Krantz metering panel boards are particularly applicable to office buildings, apartment buildings, warehouses, factories, lofts, stores, etc. They are used wherever it is desirable to connect a circuit, or combination of circuits, through any one of a number of meters by simply changing the location of the metering connectors on the face of the board.

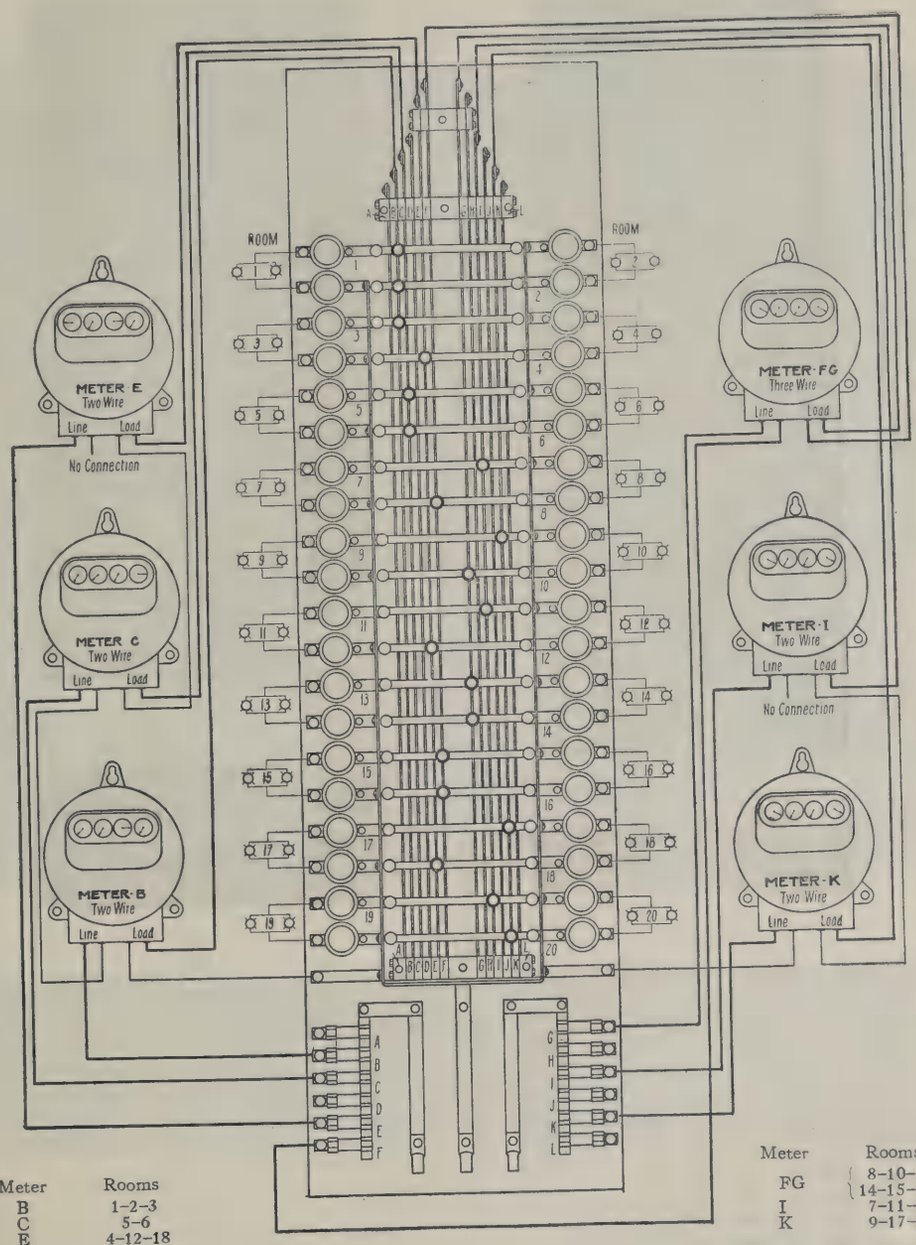
When this panel board is used in an office building, it is only necessary to supply a meter for each tenant. Formerly a meter was required for each room. Any room or combination of rooms can be metered through one meter by changing the location of the meter connector on the face of the board. Changes in or additions to tenants' space can be provided for quickly at no expense. The meter equipment and cost of meter readings are greatly reduced. Mistakes and fire risks are eliminated.

Modern apartment buildings furnish laundry, vacuum cleaning, storage rooms and servants' quarters for tenants use. With this panel board the current used for operating these devices can be metered through any tenants' meter as desired.

In warehouses, factories, lofts, etc., tenants' current can be metered to care for changes or additions to space without changing the wiring in the building.

In factories, apartments and stores it is often necessary to charge the current used to departments or work in progress. The Krantz metering panel board offers an easy, accurate and safe means for doing this.

KRANTZ METERING PANEL BOARDS—Continued



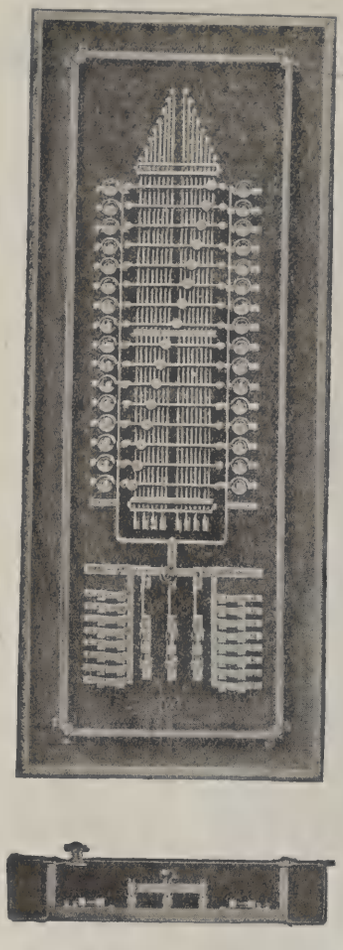
Meter	Rooms
B	1–2–3
C	5–6
E	4–12–18

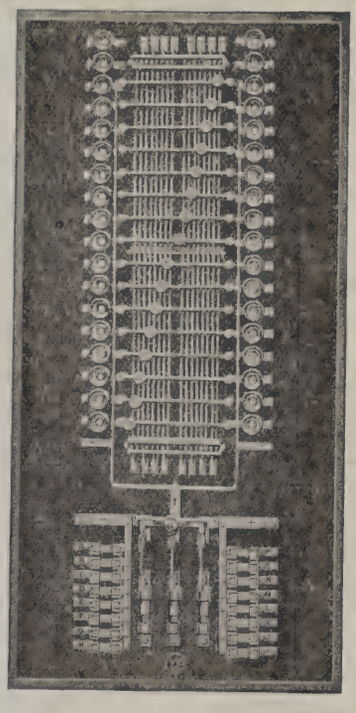
Meter	Rooms
FG	8–10–13 14–15–16
I	7–11–19
K	9–17–20

Distinctive Features

Krantz metering panel boards have a series of parallel meter bars lying all in the same plane, extending lengthwise on the panel board. Crossing these meter bars and supported above them are round consumption circuit bars. The ends of these consumption bars are connected through fuses to the circuits to be metered. On these bars are placed sliding and rotating switch contactors. The operator can easily move the contactor from one meter bar to another and clamp the contactor in the selected location. The meter fuses are arranged so that they can be easily placed in multiple, to the end that additional fuse capacity can be obtained for any desired meter. All bus-bars and wire terminals are arranged to show clearly every connection; in fact, the panel board itself might be considered a full scale wiring diagram. This feature prevents improper meter and wire connections.

KRANTZ METERING PANEL BOARDS ENCLOSED IN STEEL CABINETS





PRICES

List prices include metering panel boards enclosed in cabinets with terminals only in mains.

No. Cir.	Number of Meter Loops 4	6	8	10	12	14	16	18	20	22	24	26
4	$45 00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
6	61 00	69 00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
8	76 00	84 00	92 00	.....	.....	.....	.....	.....	.....	.....	.....	.....
10	91 00	99 00	107 00	115 00	.....	.....	.....	.....	.....	.....	.....	.....
12	106 00	114 00	122 00	130 00	137 00	.....	.....	.....	.....	.....	.....	.....
14	121 00	129 00	137 00	145 00	152 00	160 00	.....	.....	.....	.....	.....	.....
16	136 00	144 00	152 00	160 00	167 00	175 00	183 00	.....	.....	.....	.....	.....
18	151 00	159 00	167 00	175 00	183 00	191 00	199 00	217 00	.....	.....	.....	.....
20	167 00	174 00	182 00	190 00	198 00	205 00	213 00	221 00	229 00	.....	.....	.....
22	182 00	190 00	198 00	206 00	214 00	223 00	231 00	239 00	247 00	256 00	.....	.....
24	197 00	206 00	214 00	222 00	230 00	238 00	246 00	254 00	263 00	271 00	279 00	.....
26	212 00	220 00	229 00	237 00	245 00	253 00	261 00	269 00	278 00	286 00	294 00	302 00
28	228 00	236 00	244 00	252 00	260 00	268 00	276 00	284 00	293 00	301 00	309 00	317 00
30	244 00	252 00	259 00	267 00	275 00	283 00	291 00	299 00	308 00	316 00	324 00	332 00

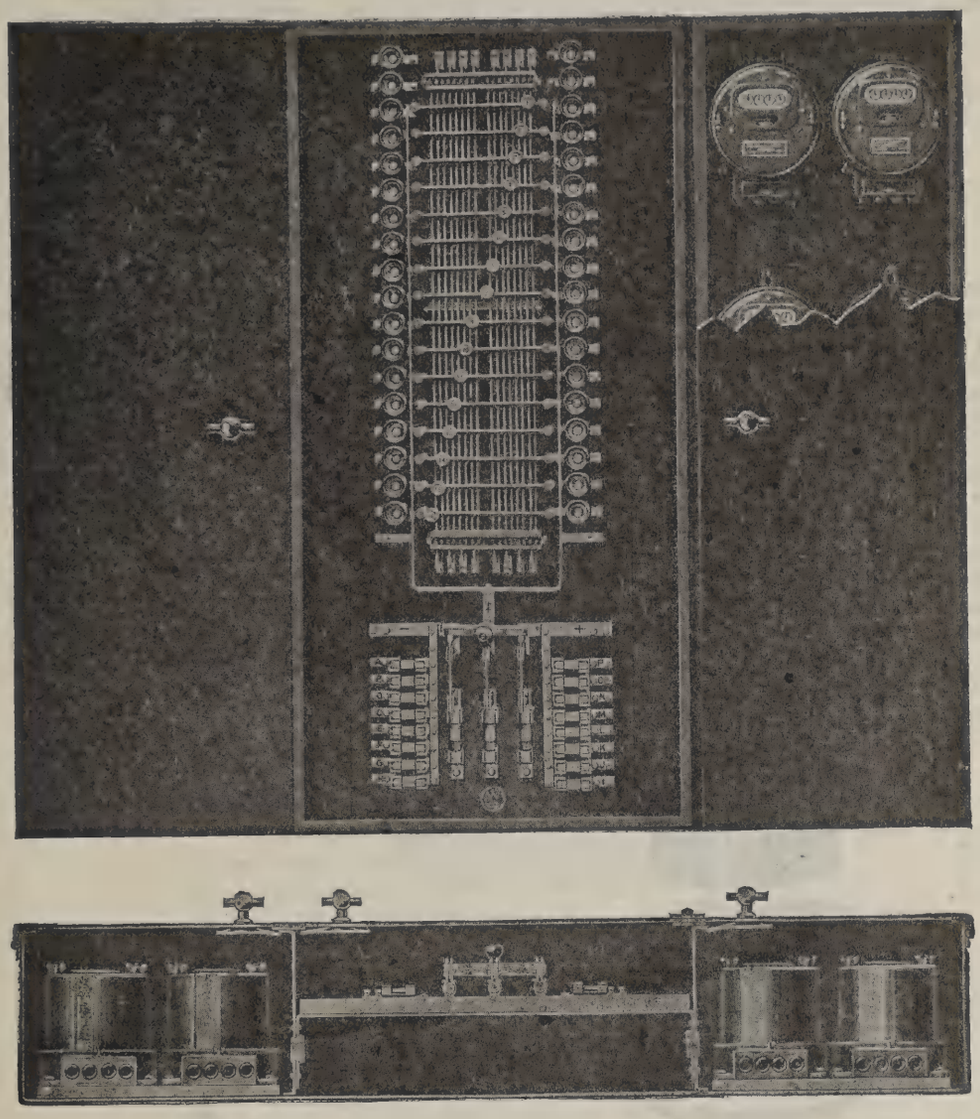
Above list prices apply for either Edison plug fuses or N. E. C. enclosed cartridge fuses.

Additional List Prices

Description	Ampere Capacity 0–30	35–60	65–100	105–200
Main fuse extensions	$ 2 50	$ 3 00	$ 4 25	$ 5 00
Unfused main switch	10 00	12 00	18 00	22 00
Fused main switch	12 00	15 00	24 00	30 00
Circuit knife switch	1 00	.....	.....	.....

Dimensions of these panel boards and cabinets will be furnished upon application.

KRANTZ METERING PANEL BOARDS ENCLOSED IN TYPICAL METER CLOSETS



PRICES

Prices on metering panel boards, enclosed in meter closets will be quoted upon application. In asking for quotation on such boards, specify the number and make of the meters to be enclosed.

KRANTZ FLOOR BOXES

The Krantz floor boxes are applied as floor, wall, or ceiling conduit outlet boxes. They are especially designed with a view to their convenient adaptation to this purpose under all conditions of mounting.

The boxes are regularly drilled and tapped for four ½-inch conduit holes in the side walls, three of which are provided with screw plugs. Boxes can be provided with openings tapped for ¾ and 1-inch conduit on special order.

All boxes are guaranteed not to infringe patents held by others.

KRANTZ ACME FLOOR BOXES

The Acme patented floor box is adjustable—*horizontally and vertically*—and water tight. The cover can be turned ½-inch in any direction, and raised or lowered more than ½ inch. All adjustments are made on the inside.

The electrical connections can be made in the box without breaking joints at the floor flange.

The box body is of galvanized cast iron. The cover plate and parts for same are of brass.

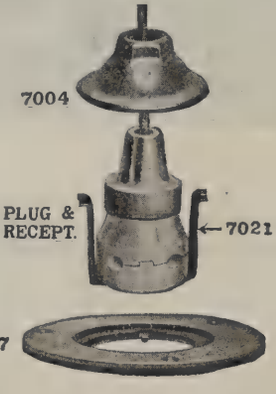
This box is listed complete with or without a standard Bryant porcelain plug and receptacle and additional parts are listed for adapting the box to General Electric or Hubbell plugs and receptacles.

Additional cover parts are also supplied for temporarily covering the box flush with the floor and for bringing standard size of conduit into the cover.

Complete Acme Floor Box

Outside Dimensions:

Diameter of cover flange 4⅜ inches.
Maximum height 4⅞ inches.
Minimum height 4¼ inches.



Details of Acme Floor Box

KRANTZ ACME FLOOR BOXES

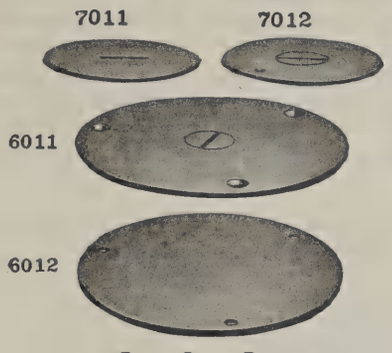
Style No.	Description	List Price
K-6561	Complete Acme box consisting of box body No. 6061, gasket No. 6062, adjusting ring No. 6063, cover ring No. 6065, gasket No. 6017, cover plate No. 6011	$4 75
K-6562	Complete Acme box consisting of box body No. 6061, gasket No. 6062, adjusting ring No. 6063, cover ring No. 6065, nozzle cover No. 6007, brass center disc No. 7011	5 50
K-6565	Complete Acme box consisting of box body No. 6061, gasket No. 6062, adjusting ring No. 6063, cover ring No. 6065, nozzle cover No. 6007, brass center No. 7011, Bryant receptacle and plug No. 7057, nozzle No. 7004 and Steel Bridge No. 7021	7 00

Parts and Accessories

K-6061	Galvanized cast iron box body	1 15
K-6062	Rubber gasket	15
K-6063	Adjusting ring with inside fastening ring No. 6064	1 00
K-6065	Adjustable cover ring with brass floor flange No. 6005	1 35
K-6007	Brass nozzle cover with rubber gasket and receptacle bridge support	1 60
K-7011	Flat brass disc for cover No. 6007	35
K-7012	Flat brass disc for cover No. 6007, with ½-inch plug	60
K-7013	Flat brass disc for cover No. 6007, with ¾-inch plug	70
K-7014	Flat brass disc for cover No. 6007, with 1-inch plug	80
K-6012	Brass cover plate	90
K-6011	Brass cover plate with ½-inch plug	1 08
K-6013	Brass cover plate with ¾-inch plug	1 16
K-6014	Brass cover plate with 1-inch plug	1 26
K-6017	Rubber gasket for cover plate	07
K-7021	Steel bridge for Bryant, General Electric, or Hubbell receptacle	17
*K-7057	*Bryant plug and receptacle	1 00
K-7004	Brass nozzle for Bryant receptacle	1 00
K-7001	Brass nozzle for Hubbell receptacle	1 00
K-7002	Brass nozzle with insulating bushing for General Electric receptacle	1 15

*This plug and receptacle is Bryant Electric Company standard "Spartan" List No. KD112.

Order by Style Number



BRASS COVER PLATES

KRANTZ TYPE CT FLOOR BOXES

(Fullman)

STYLE NO. K-52352
Floor Box with Bell Nozzle

STYLE NO. K-52353
Floor Box with Drip Nozzle

These boxes are so designed that they are readily adjusted both horizontally and vertically to make them level with the finished floor. This is accomplished automatically by raising or lowering the adjusting ring in the groove of the box body. When the adjusting ring is properly set it is sealed to the Box Body by means of a cement with which the groove in the box body is filled. This cement is an electrical conductor uniting the two parts electrically and mechanically. When the cement in the groove of the box body hardens, the two parts are united just like a solid casting. This method of adjustment and uniting the two parts insures even distribution of stresses and a watertight joint. The necessary cement is furnished with each box.

These boxes are regularly furnished with four openings tapped for ½-inch conduit, three of which are provided with screw plugs. Floor boxes can be furnished on special order without additional charge for conduits up to and including 1½ inches with room for bushings.

Note—Porcelain Receptacles and Plugs for this type of Floor Boxes are not furnished by us and are not included in list prices. See list of suitable Receptacles and Plugs on following page.

Style No.	Description	List Price Each
K-52351	Complete floor box consisting of box body, sealing cement, adjusting ring, rubber gasket and brass cover plate with 2 inch flush brass plug for No. K-52357 nozzle	$4 50
K-52352	Same as K-52351 except with brass bell nozzle	5 50
K-52353	Complete floor box consisting of box body, sealing cement, adjusting ring, rubber gasket and brass cover plate with ½-inch flush brass plug and drip nozzle for telephone service	5 00

STYLE NO. K-52351
Floor Box with Flat Top

Order by Style Number

KRANTZ FLOOR BOXES—Continued

Accessories for Type CT Boxes

Adjusting Ring
Style No. K-52355

Box Body Style No. K-52354

Style No. K-52360 Brass Flange Ring
Used to Prevent Chipping of Granolithic, Cement, Marble or Similar Flooring when Cover-Plate is Removed Frequently

Style No.	Description	List Price
K-52354	Box body	$2 27
K-52355	Adjusting ring	50
K-52356	Brass cover plate with 2-inch flush brass plug	1 56
K-52357	Brass bell nozzle	1 00
K-52358	Brass cover plate with ½-inch flush brass plug	1 06
K-52359	Brass drip nozzle for telephone service	1 00
K-52360	Brass flange ring including rubber gasket	75
K-52361	2 inch flush brass plug	35
K-52362	Rubber gasket	07
K-52363	Sealing cement for one floor box	10
K-52364	Template for setting covers (no charge)	....

Brass Cover-Plate with Flush Brass Plug, Style No. K-52356

Order by Style Number

RECEPTACLES AND PLUGS

The following Receptacles and Plugs are suitable for use with type CT Adjustable box, but are not furnished and are not included in list prices. The receptacle lugs fit the supporting lugs of outlets, eliminating the use of receptacle straps or bridges.

Brass Bell Nozzle
Style No. K-52357

Arrow Electric Co., Hartford, Conn., Catalog No. 17.
Receptacles Nos. 1363, 1708 and 8219.
Plugs Nos. 1110, 1065, RA-RE-RB-RG-8300, 1948, 925.

Benjamin Electric Mfg. Co., Chicago, Ill.
Receptacles No. 7664 and 7675.
Plug No. 903.

Bryant Electric Co., Bridgeport, Conn., 1916 Catalog.
Receptacles Nos. 120, 1363, 1708, 475, 411.
Plugs KA, KB, KC, Nos. 1110, 476, 376.

Chelten Electric Co., Philadelphia, Pa., 1918 Catalog.
Receptacles Nos. 3002, 3007, 3502, 5560 and 6020.
Plugs Nos. 3003, 3004, 3008, 3503, 5561 and 5561-A.

Connecticut El c. & Mfg. Co., Bridgeport, Conn., Catalog No. 5.
Receptacle No. 8010 and Plug No. 8001. Receptacle No. 3010.
Receptacle and Plug No. 3020 without Plate.

Brass Cover-Plate with ½-Inch Flush Brass Plug, Style No. K-52358

Cutler-Hammer Mfg. Co., Milwaukee, Wis., Catalog No. 8, Oct. 1916.
Receptacles Nos. 7611, 7642, 7700, 7710, 7711, 7712.
Plugs Nos. 7604, 7607, 7700, 7702, 7703, 7704, 7706, 7600, 7601, 7602.
Note—No. 7702 Duplex Receptacle may be used with special cover plates and nozzles. Further details upon request.

E. H. Freeman Electric Co., Trenton, N. J., Catalog No. 6.
Receptacles Nos. 4354 and 105.
Plugs Nos. 115, 116, 117, 108, 109, 118 and 119.

General Electric Co., Schenectady, N. Y., Catalog No. Y-849.
Receptacles Nos. 36817, GE287, GE996, GE658, GE990, GE711.
Plugs Nos. GE288, 59197, 59200, GE625, GE662, GE663, GE704, GE693.
Note—G. E. Receptacle and Plug No. 59199 or No. 45395 may be used in No. 421 Outlet but special Cover Plate and Nozzle must be furnished. Receptacles must be fitted at our factory and extra charge is made for special parts.

Brass Drip Nozzle for Telephone Service, Style No. K-52359

Hart & Hegeman Mfg. Co., Hartford, Conn., Catalog No. 20.
Receptacles Nos. 1430, 1440, 1708 and 3001.
Plugs Nos. 1400, 1401, 1403, 1404, 1412, 1430 and 3002.

Harvey Hubbell, Inc., Bridgeport, Conn., Catalog No. 16.
Receptacles Nos. 5547, 5566, 5579 and 6051.
Plugs Nos. 5816, 5831, 5419, 5420, 5421, 5523, 5524, 5525, 5526, 5527, 6043, 6044, 6149 6150, 6918, 5567 and 6919.

H. T. Paiste Co., Hartford, Conn., Catalog No. 20.
Receptacles Nos. 530, 540, 1430, 1440, 1708, 2034 and 2934.
Plugs Nos. 400, 402, 403, 404, and 430.

KRANTZ GEM FLOOR BOXES

The Gem floor box is the only small water-tight non-adjustable floor box in which the receptacle can be installed after the floor is laid, without breaking the floor joints. The floor flange need never be removed. No screws are needed to install receptacles.

The boxes are drilled and tapped for two ½-inch pipes at opposite points in the side walls, one of which is provided with a plug, and two ½-inch pipes in the bottom provided with plugs.

COMPLETE GEM FLOOR BOX

The box body is of galvanized cast iron. The cover parts are of brass.

This box is listed complete with or without a standard Bryant porcelain plug and receptacle and additional parts are listed for adapting the box to General Electric or Hubbell plugs and receptacles.

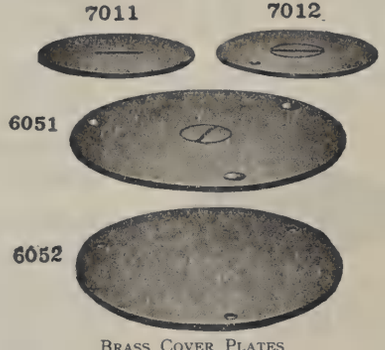
Additional cover parts are also supplied for temporarily covering the box flush with the floor and for bringing standard size of conduit into the cover.

Outside Dimensions:

Diameter of cover flange 3 11/16 inches.

Diameter of box body 2 7/8 inches.

DETAILS OF GEM FLOOR BOX



BRASS COVER PLATES

PRICES
GEM FLOOR BOX

Style No.	Description	List Price
K-6545	Gem box complete as per cut, consisting of box body No. 6041, gasket No. 6057, nozzle cover No. 6047, nozzle No. 7004, receptacle No. 7057, brass center disc No. 7011 and steel bridge No. 7021	$4 00
	Parts and Accessories	
K-6041	Galvanized cast iron box body	85
K-6057	Rubber gasket	20
K-6047	Brass nozzle cover	1 50
K-6052	Brass cover plate	1 75
K-6051	Brass cover plate with ½-inch removable plug	2 25
K-7011	Flat brass disc for cover No. 6007	35
K-7012	Flat brass disc for cover No. 6007, with ½-inch plug	60
K-7021	Steel bridge for Bryant, General Electric, or Hubbell receptacle	17
*K-7057	*Bryant plug and receptacle	1 00
K-7004	Brass nozzle for Bryant receptacle	1 00
K-7001	Brass nozzle for Hubbell receptacle	1 10
K-7002	Brass nozzle with insulating bushing for General Electric receptacle	1 15

*This plug and receptacle is Bryant Electric Company standard "Spartan" List No. KD112.

KRANTZ NO. 1945 FLOOR BOXES

The No. 1945 floor box is of heavy cast iron *vertically adjustable* and absolutely water-tight.

The box is of black enamel finish and can be drilled and tapped for pipe up to 1 inch as specified on order.

Covers are of brass.

This box is listed complete with or without a standard Bryant plug and receptacle, but additional parts are listed for adapting the box to General Electric or Hubbell plugs and receptacles.

Additional cover parts are also supplied for temporarily covering the box flush with the floor and for bringing standard size of conduit into the cover.

The boxes are drilled and tapped with four ½-inch conduit holes in side walls, three of which are provided with plugs. Boxes can be provided with openings tapped for ¾-inch and 1-inch conduit on special order.

Outside Dimensions:

Diameter 4¼ inches.

Minimum height 4 inches.

Maximum height 4⅝ inches.

COMPLETE NO.1945 FLOOR BOX

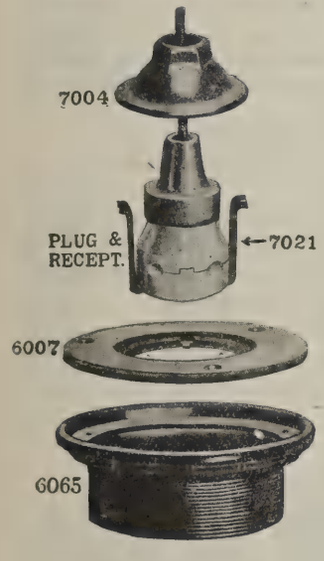
PRICES
NO. 1945 FLOOR BOX

Style No.	Description	List Price
K-6641	Complete No. 1945 box consisting of box body No. 6141, cover ring No. 6065, gasket No. 6017, cover No. 6011	$3 60
K-6642	Complete No. 1945 box consisting of box body No. 6141, cover ring No. 6065, nozzle cover No. 6007, nozzle No. 7004 and brass center disc No. 7011	5 00
K-6643	Complete No. 1945 box consisting of box body No. 6141, cover ring No. 6065, nozzle cover No. 6007, nozzle No. 7004, Bryant plug and receptacle K7057 and, brass center disc 7011 and Steel bridge No. 7021	6 00

Parts and Accessories

K-6141	Cast iron box body	1 15
K-6065	Adjustable cover ring with brass floor flange No. 6005	1 35
K-6017	Rubber gasket for cover plate	07
K-6007	Brass nozzle cover with rubber gasket and receptacle bridge support	1 60
K-7011	Flat brass disc for cover No. 6007	35
K-7012	Flat brass disc for cover No. 6007, with ½-inch plug	60
K-7013	Flat brass disc for cover No. 6007, with ¾-inch plug	70
K-7014	Flat brass disc for cover No. 6007, with 1-inch plug	80
K-6012	Brass cover plate	90
K-6011	Brass cover plate with ½-inch plug	1 06
K-6013	Brass cover plate with ¾-inch plug	1 16
K-6014	Brass cover plate with 1-inch plug	1 26
K-7021	Steel bridge for Bryant, General Electric or Hubbell receptacle.	17
*K-7057	*Bryant plug and receptacle	1 00
K-7004	Brass nozzle for Bryant receptacle	1 00
K-7001	Brass nozzle for Hubbell receptacle	1 00
K-7002	Brass nozzle with insulating bushing for General Electric receptacle	1 15

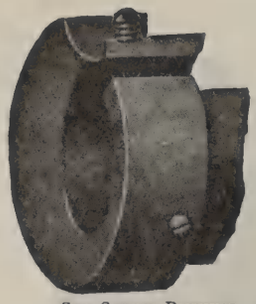
*This plug and receptacle is Bryant Electric Company standard "Spartan" List No. KD112.



DETAILS OF NO. 1945 FLOOR BOX

BRASS COVER PLATES

KRANTZ PORCELAIN-LINED CONDUIT BUSHINGS



SET SCREW BUSHING

SPLIT BUSHING

THREADED BUSHING

Krantz bushings are made of annealed cast iron and are designed to provide a durable, hard, and smooth surface for conduit outlets.

Porcelain lining is a very high insulator and the best and surest rust preventative known. It forms an insulating coating which is absolutely moisture-proof, is not affected by chemicals and acids, and withstands exceedingly high temperature without any harm. After carefully testing the lining, the Underwriters say: "The enamel is smooth and hard and adheres to the iron well, quite a sharp blow being required to chip it off. The enamel cannot be cracked by screwing pipe into the fitting unless enough force is used to split the fitting entirely."

Krantz porcelain lined set screw bushings are a great convenience where it is found difficult to place a thread on the conduit. In many cases it is impossible to do so; for instance, where elbows are used as terminating points it is impossible to thread the elbows. Here the set screw bushings come in handy; all that is necessary is to countersink the conduit for the point of the set screw, place the bushing over the pipe, and then tighten the screws.

Krantz porcelain lined split bushings are designed to be used on conduits where it is impractical to thread the conduits or use set screw bushings. For instance, in rewiring buildings using existing conduits, the split bushing makes it unnecessary to disconnect the wire.

Standard Package	Size of Conduit, In.	Set Screw — Style No.	Set Screw — List Price per 100	Split Bushing — Style No.	Split Bushing — List Price Per 100	Threaded — Style No.	Threaded — List Price Per 100
100	½	K-2681	$18 00	K-2741	$30 00	K-2751	$30 00
100	¾	K-2682	20 00	K-2742	30 00	K-2752	30 00
60	1	K-2683	25 00	K-2743	38 00	K-2753	38 00
60	1¼	K-2684	28 00	K-2744	44 00	K-2754	44 00
50	1½	K-2685	33 00	K-2745	48 00	K-2755	48 00
20	2	K-2686	38 00	K-2746	55 00	K-2756	55 00
20	2½	K-2687	54 00	K-2747	75 00	K-2757	75 00
20	3	K-2688	66 00	K-2748	90 00	K-2758	90 00
10	3½	K-2689	80 00	K-2749	110 00	K-2759	110 00
10	4	K-2690	98 00	.....	.....	K-2760	125 00

ENCLOSED-FUSE BLOCKS FOR INSTRUMENT CIRCUITS

For Indoor Mounting Only

The fuse blocks described and listed on this page are supplied for protection of electrical measuring instruments; they can, however, be used for protection on any circuits within their rated capacity.

Two forms are listed; one using small glass-tube fuses of small capacity, and the other using standard enclosed cartridge fuses.

FUSE BLOCKS FOR GLASS CARTRIDGE FUSES

For Capacities up to 2 Amperes, 250 Volts—Single-, Two- and Three-Pole

These fuse blocks use a small glass-tube fuse of 2 amperes capacity. They are used principally for the protection of instruments connected directly to the line without transformers and in the secondary circuit of instrument transformers.

The complete block consists of fuse clips of the ferrule type mounted on porcelain blocks with barriers on the outside edges and, with the two and three-pole blocks, between poles. They are made for mounting on the wall or in the rear of panels and are front connected.

FOR GLASS CARTRIDGE FUSES
(Shown with fuses in place)

Style number and list price include block as described, complete, but do not include fuses which must be ordered separately.

Description	Poles	Maximum Volts	Maximum Amperes	Standard Package Quantity	Shipping Wt. Per Std. Pkg. Lb.	Style No.	List Price
Fuse block	1	250	0–2	100	15	235888	$0 12
Fuse block	2	250	0–2	100	20	235889	25
Fuse block	3	250	0–2	100	30	235890	36
Glass tube fuse	..	250	1	100	½	156096	06

FUSE BLOCKS FOR STANDARD CARTRIDGE FUSES

For Capacities up to 30 Amperes at 600 Volts and 15 Amperes at 2500 Volts Two-Pole Only

These blocks are especially adapted to the protection of instrument transformers and of other transformers of small capacity. The base can be bolted to the fuse-block supports on standard Westinghouse voltage transformers, thus economizing space and making a compact equipment.

They consist of ferrule-type fuse clips mounted on porcelain blocks and are front connected. The 2500-volt block has a porcelain barrier between poles.

The 600-volt fuse block, Style No. 56359, is adapted to direct mounting on all standard dry-type Westinghouse transformers within its voltage limit, except 25-cycle transformers, Style No. 10352, 10333 and 30902, for mounting on which auxiliary mounting strap, Style No. 229104, as listed is required.

The 2500-volt fuse block, Style No. 117375, is adapted to direct mounting on the 1000 and 2000-volt dry-type 60-cycle standard Westinghouse transformers, but requires auxiliary mounting-strap, Style No. 168041, as listed, for mounting on the 1000 and 2000-volt 25-cycle dry-type transformers, Style Nos. 30055 and 30056.

STYLE NO. 56359

STYLE NO. 117375

Style number and list price of fuse block include the double-pole block complete as shown in the above illustrations. Fuses are not included and should be ordered separately. See pages on "Enclosed Cartridge Fuses." Fuse blocks, Style No. 117375, will take fuses Style Nos. 32304 to 32313, inclusive.

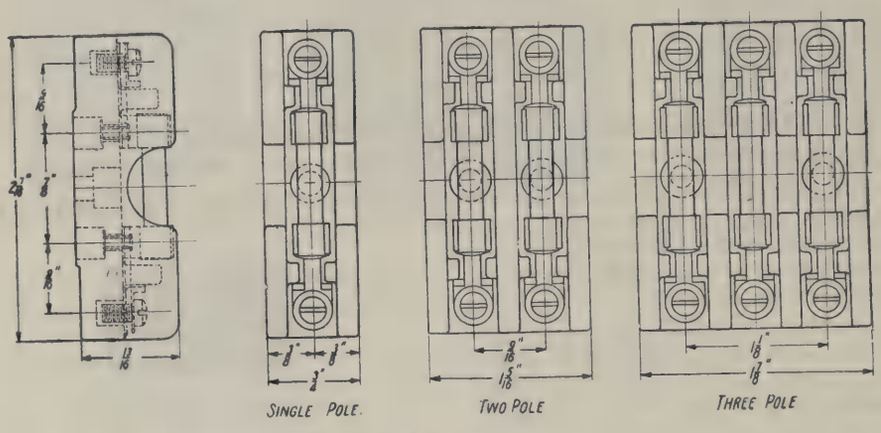
The style number of the mounting-strap includes strap complete with necessary stove bolts for mounting strap on transformer.

Description	Maximum Volts	For Enclosed Fuses Amperes	Standard Package Quantity	*Net Weight Each Lb.	Style No.	List Price
Fuse block	600	1–30	25	3	56359	[illegible] 50
Fuse block	2500	1–15	10	4½	117375	4 00
Mounting-Strap	600	....	..	1	229104	†
Mounting-Strap	2500	....	..	1	168041	†

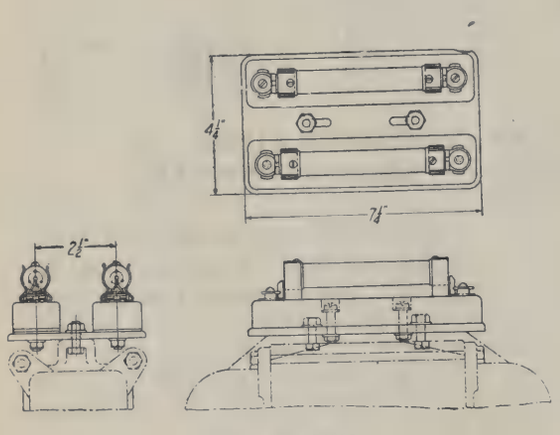
*For shipping weight add 10 per cent. when shipped in quantities.
†This strap will be supplied without extra charge when ordered with fuse blocks listed above.

Order by Style Number

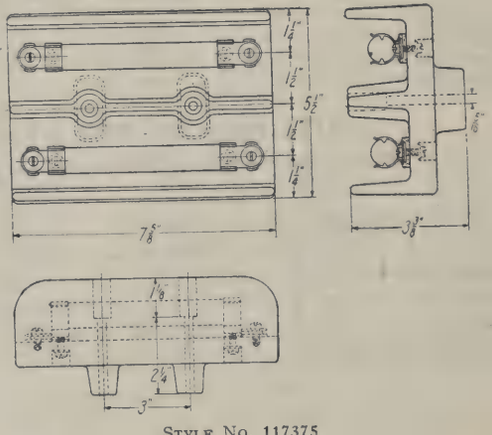
OUTLINE DIMENSIONS



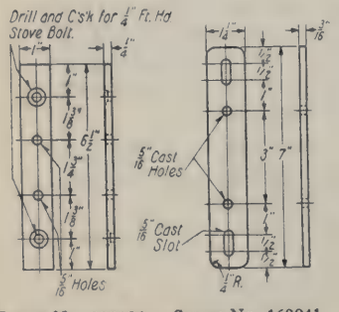
FUSE BLOCKS FOR GLASS CARTRIDGE FUSES



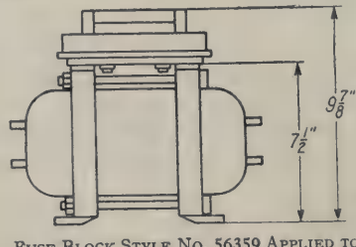
STYLE NO. 56359



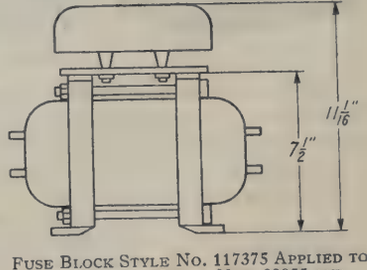
STYLE NO. 117375



STYLE NO. 229104 STYLE NO. 168041



FUSE BLOCK STYLE NO. 56359 APPLIED TO TRANSFORMERS STYLE NOS. 10352, 10333, AND 30902 BY STRAP STYLE NO. 229104



FUSE BLOCK STYLE NO. 117375 APPLIED TO TRANSFORMERS STYLE NOS. 30055 AND 30056 BY STRAP STYLE NO. 168041

These dimensions are for reference only. For official dimensions apply to the nearest district office.

FUSE BLOCKS WITH CAST IRON BASES

Wall-Mounting Type

These fuse blocks are used for the protection of switchboard-mounting and other voltage transformers of small capacity for voltages up to 25,000 maximum. They can, however, be used on any circuit up to their rated capacity.

Bases—The finish of the cast iron bases is dull black. Ample insulation is provided by porcelain insulators, supported by the base.

Contacts—These fuse blocks have a combination ferrule and knife-blade contact securely fastened to the insulator.

Connections to these fuse blocks are made by means of a screw and washer.

FIG. 7—WALL-MOUNTING TYPE

Single-Pole—Front-Connected
For Voltages up to 7500, 15,000 and 25,000

Style number and list price include fuse block complete without fuses, which must be ordered separately.

Capacity Range Amperes	Maximum Voltage	Approx. Net* Weight, Lb.	Standard Package	Style No.	List Price Each
¾–30	7500	19	6	55382	$ 6 00
¾–15	15000	31	6	55383	8 50
¾– 5	25000	40	6	58070	11 00

Fuse blocks should be ordered in standard package quantities whenever possible. Standard package quantities cannot be made up by combining different capacities.

*For shipping weight add 10 per cent. for boxing.

SWITCHBOARD-TYPE FUSE BLOCKS

This fuse block is made for switchboard use where it is desired to replace the fuse from the front of the panel. The standard enclosed fuse is inserted in the clip in the plug and the plug is then screwed into the receptacle until the fuse enters the inner contacts. These fuse blocks are for one and one-quarter-inch, one and one-half-inch and two-inch panels.

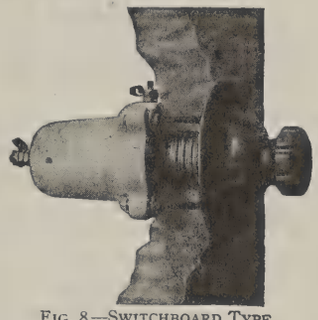


FIG. 8—SWITCHBOARD TYPE

Single-Pole—Rear-Connected
For Voltages up to 2500

Style number and list price of complete blocks, plugs, or receptacles do not include fuses, which must be ordered separately.

Capacity Range, Amperes	Panel Thickness Inches	Complete: Approx. Net Wt. Lb.	Complete: Style No.	Complete: List Price Each	Receptacle Only: Approx. Net Wt. Lb.	Receptacle Only: Style No.	Receptacle Only: List Price Each	Plug Only: Approx. Net Wt. Lb.	Plug Only: Style No.	Plug Only: List Price Each
1½–15	1¼	2	81133	$12 50	1	81552	$7 50	1	81545	$5 00
1½–15	1½	2	81134	12 50	1	81553	7 50			
1½–15	2	2	38759	12 50	1	81554	7 50			
20 –30	1¼	3	81135	13 50	1½	81555	8 00	1½	81548	5 50
20 –30	1½	3	81136	13 50	1½	81556	8 00			
20 –30	2	3	38760	13 50	1½	81557	8 00			
40 –60	1¼	5	81137	15 00	3	81558	9 00	2	81551	6 00
40 –60	1½	5	81138	15 00	3	81559	9 00			
40 –60	2	5	38761	15 00	3	81560	9 00			

Order by Style Number

OUTLINE DIMENSIONS

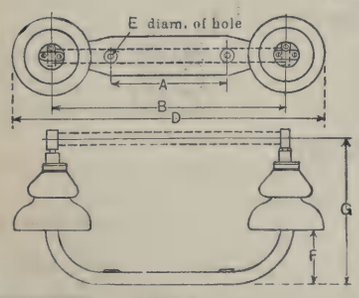


FIG. 9

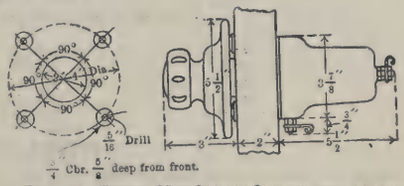


FIG. 10—STYLE NOS. 38759, 38760 AND 38761

Style Nos. 81133 to 81138 have the dimensions given above with the exception of the length back of the panels. The length back of the panel is six inches for a one and one-half inch panel and six and one-quarter inches for a one and one-quarter inch panel.

Style No.	Fig.	Dimensions in Inches: A	B	D	E	F	G
55382	9	6	13	16½	7/16	3¾	9
55383	9	9	18	24	7/16	4⅛	9⅞
	9	9	20	26¾	½	4	10⅝

The above dimensions are for reference only. For official dimensions apply to the nearest district office of this Company.

LIMITING RESISTORS FOR POTENTIAL TRANSFORMER FUSES

The resistors listed herein are designed to be placed in series with potential transformer fuses of not more than 1½ amperes capacity rated at 600 to 3500 volts, or not more than ¾ ampere capacity rated at 6600 to 25000 volts, only, (that is one per wire) when the kva. rating of the station or power source exceeds the interrupting capacity of the fuses (see pages of this catalog on "Enclosed Cartridge Fuses With Indicators"). These limiting resistors restrict the power that the fuses may be called upon to interrupt in the case of a short-circuit or overload to such a value that the fuses will safely interrupt the circuit. They are so selected that they will not materially increase errors in meter reading.

The resistors are in rod form and have sprayed copper terminals on each end for connecting in the mounting clips. They should preferably be mounted just ahead of the fuse, between the fuse and the bus.

Two types of mounting are listed. One type (Fig. 1) is intended for mounting directly on the bus, and the other type (Fig. 2) is intended for use when the resistor is supported on a standard Westinghouse pillar-type insulator. In either case, the resistor is enclosed within a micarta insulating tube.

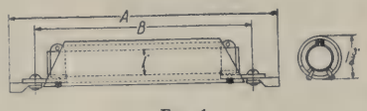


FIG. 1

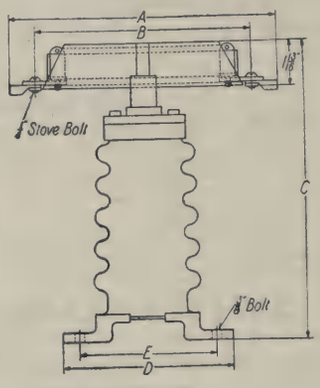


FIG. 2

PRICES

Resistors Without Mounting

Style number and list price include resistor only. One resistor is required for each fuse.

Voltage Over	Voltage To	Resistance Ohms	Approx. Shipping Wt., Lbs.	Style No.	List Price
		18–22	2	266565	$1 00
600	2500	45–55	2	266426	1 20
2500	3500	90–110	2	266412	1 60
3500	7000	180–220	3	266413	1 85
7000	15000	360–440	3	266414	2 10
15000	25000				

Resistors With Mountings

Style number and list price include resistor with mounting as shown.

Voltage Over	Voltage To	Resistance Ohms	Approx. Shipping Wt., Lbs.	Style No.	List Price
		For Mounting Directly on Bus, Fig. 1			
		18–22	8	267778	$3 80
600	2500	45–55	8	267779	3 80
2500	3500	90–110	8	267780	3 80
3500	7000	180–220	10	267781	3 80
7000	15000	360–440	10	267782	3 80
15000	25000				
		For mounting on Pillar-Type Insulator, Fig. 2			
		18–22	15	267034	8 40
600	2500	45–55	15	267035	8 40
2500	3500	90–110	15	267036	8 40
3500	7000	180–220	17	267037	8 75
7000	15000	360–440	17	267038	11 25
15000	25000				

OUTLINE DIMENSIONS

Style No.			Dimensions in Inches, Figs. 1 and 2.				
Resistor	Unit Complete for Mounting on Bus-Bar	Unit Complete with Insulator	A	B	C	D	E
266565	267778	267034	6 1/16	4 7/8	6 3/4	5 11/32	4 3/4
266426	267779	267035	7 1/16	5 7/8	6 3/4	5 11/32	4 3/4
266412	267780	267036	9 1/16	7 7/8	6 3/4	5 11/32	4 3/4
266413	267781	267037	10 1/16	8 7/8	8 1/8	5 11/32	4 3/4
266414	267782	267038	14 1/16	12 7/8	11 1/32	6 11/32	5 3/4

EXPULSION-TYPE FUSE BLOCKS

Front-Connected

For Capacities up to 100 Amperes—For Voltages 3500 to 25,000

FIG. 1—7500 VOLTS

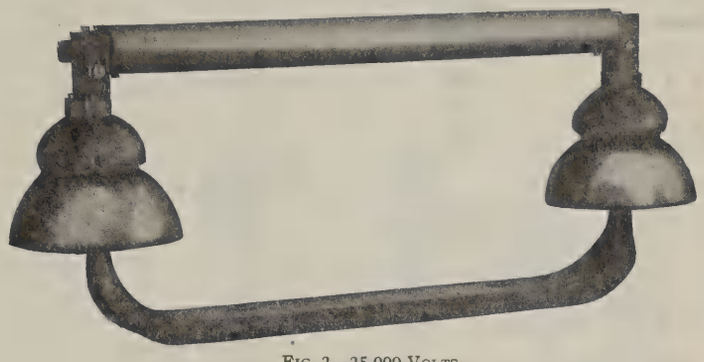


FIG. 2—25,000 VOLTS

APPLICATION

These fuse blocks are made especially for opening the circuit in the event of sudden and severe overloads or short-circuits, but they are also entirely suitable for the protection of circuits in the case of gradually increasing overloads if the fuse wire is inserted in asbestos sleeving.

The fuse tube is readily removable from the contact clips and the fuse wire easily inserted therein, making the re-fusing a very simple matter. These fuse blocks are easily installed, neat in appearance, light in weight, but substantially built, and will operate satisfactorily on any circuits within their interrupting capacity, which is approximately 1000 amperes at 7500 volts when used one per wire and proportionately greater or less at other lower or higher voltages.

CAUTION—In order that these fuse blocks can be "cut dead" before the operator handles them, it is recommended that disconnecting switches be used in series with them when operated on a power circuit. Fuse tongs should be used only where the power capacity back of the fuses is known to be limited by such apparatus as voltage transformers.

Distinctive Features—The distinctive features of these expulsion-type fuse blocks are: cast iron yoke; petticoat-type insulators; double tube, insuring rigidity of contacts; knife-blade jaws.

OPERATION

The fuse tube is hollow and one end is left open, so that when the fuse blows, the metallic vapors are expelled from the tube through the open end and successfully extinguish any arc incident to the blowing of the fuse. Before being inserted in the fuse tube the fuse wire should be enclosed in asbestos sleeving. The asbestos sleeving prevents the gradual charring of the inside of the fuse tube by the overheated fuse and thereby eventually lengthens the life of or prevents burning out of the fuse tube. The open end of the fuse tube extends beyond the contact jaw so that all danger of the expelled vapors coming in contact with the metallic portion of the block is eliminated.

CONSTRUCTION

The fuse wire, enclosed in asbestos sleeving, is placed within a micarta tube which is enclosed by another micarta tube having brass contact clips on each end. Except in the 3500-volt blocks, the fuse tube is supported by copper contact jaws mounted on two porcelain insulators which are mounted on a cast-iron yoke or base. Two holes are provided in the base for mounting screws.

The 3500-volt fuse block is designed for panel use and is furnished with two studs for mounting directly on a marble panel.

The fuse wire is secured by a screw and washer, at one end to a terminal in the expulsion chamber and at the other end to a terminal on the contact block.

EXPULSION-TYPE FUSE BLOCKS—Continued

Style number and list price include the fuse block complete including the fuse tube, ready for mounting. Fuse wire (see pages of this catalogue on "Fuse Wire") and asbestos sleeving (see Catalogue on "Insulating Materials and Supplies") are not included and must be ordered separately. The length of fuse wire required for each block is 11 inches for 3500-volt size, 14 inches for 7500-volt, 19 inches for 15000-volt, and 28 inches for 25,000-volt. Aluminum or Nickle Silver fuse wire should be used.

RATINGS AND PRICES

Amperes	Maximum Voltage	Mounting	Approx. Net Weight Lbs.	Style No	List Price
		Fuse Blocks			
Up to 100	3500	Switchboard	8	**124414**	**$17 50**
Up to 100	7500	Wall	13	**124401**	**21 00**
Up to 100	15000	Wall	24	**124402**	**25 00**
Up to 100	25000	Wall	28	**124413**	**28 75**
		Fuse Tubes			
.....	3500	.....	4	**185312**	**$ 25**
.....	7500	.....	6	**185313**	**10 00**
.....	15000	.....	9	**185314**	**10 50**
.....	25000	.....	12	**185315**	**12 25**

Fuse Tongs

See pages of this catalogue on "Enclosed Cartridge Fuses with Indicators."

Order by Style Number

OUTLINE DIMENSIONS

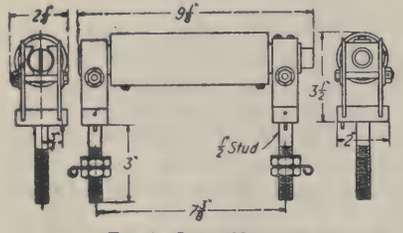


FIG. 3—STYLE NO. 124414

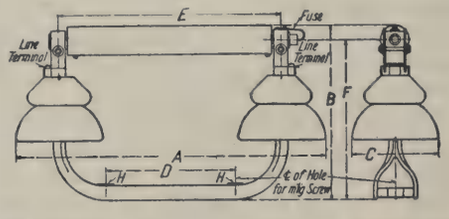


FIG. 4—STYLE NOS. 124401, 124402 AND 124413

Style No.	Dimensions in Inches—Fig. 4 A	B	C	D	E	F	H	Approx. Net Weight Lb.
124401	13⅞	10	3½	4	10⅜	9	7/16	13
124402	21⅜	12⅛	6	9	15⅜	11⅛	7/16	24
124413	31⅛	12⅝	6¾	12	24⅜	11⅝	½	28

These dimensions are for reference only. For official dimensions apply to the nearest district office.

Any user will endorse Westinghouse apparatus—It is built to give service —And it does

HIGH-VOLTAGE FUSE BLOCKS

Disconnecting-Switch Type—For Outdoor and Indoor Mounting
Single-Pole—For Voltages Up To 66,000.

APPLICATION

The high-voltage fuse blocks here listed are made for the protection of high-voltage branch lines, step-down transformers, or small substation equipments. They are entirely weatherproof and designed for mounting on the transmission-line pole, thus eliminating the necessity of any enclosing structure.

In addition to affording automatic protection, this fuse block may also be used as a disconnecting switch, thus performing the combined functions of a fuse and line switch. When used as a disconnecting switch, however, it should under no circumstances be opened when current is flowing in the line.

Fuses of this type depend for their successful operation on a current considerably higher than that necessary to slowly melt the fusible element. For this reason they should not be applied as a protection to installations where the maximum overload current will not reach values at least three times the normal rating of the fusible element, which capacity should be selected to allow such overload as may be suitable for the apparatus.

This type of fuse block is primarily designed to protect the system against short-circuit conditions and not for small overloads on the apparatus. The interrupting capacity is approximately 1000 amperes at 6600 volts, and proportionally less at higher voltages.

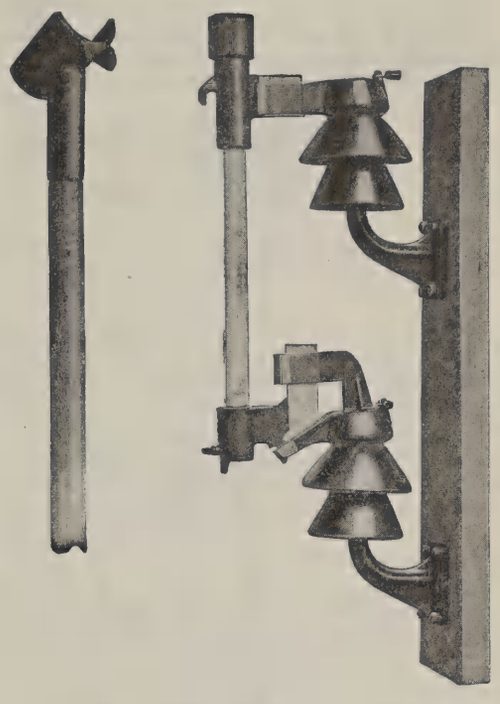
CONSTRUCTION

The fuse block consists of two porcelain petticoat insulators on iron brackets securely bolted to a base of well-seasoned timber. Each insulator is provided with a cast-iron cap, having mounted thereon a brass jaw into which is inserted one of the knife-blade contacts of the fuse holder.

This fuse holder consists of an inner micarta tube and an outer tube of porcelain, with a cast-iron cap and expulsion chamber at the upper end and a casting for supporting the knife blade contact at the lower end. The lower end of the tube is open so that when the fuse blows, the gases are expelled downwards and out of the tube.

Terminals are provided on the insulator caps for the line wires, making connection thereto a very simple matter.

Fuses used with this type of block should be of standard aluminum or Nickel silver wire. The wire is inserted in the inner tube after removing the cap, and secured to each end by thumb screws provided for that purpose. Before being inserted in the fuse tube, the fuse wire should be enclosed in asbestos sleeving (see catalogue on "Insulating Material and Supplies."). The asbestos sleeving prevents the gradual charring of the inside of the fuse tube by the overheated fuse and thereby eventually lengthens the life of or prevents the burning out of the fuse tube.



STYLE NO. 149139 FUSE BLOCK AND
STYLE NO. 149141 FUSE POLE

For data and prices on fuse wire see pages of this catalogue on "Fuse Wire". The length of fuse wire required for each fuse is:

For Volts	Length of Wire, Inches
7500	25
15000	30
25000	36
44000	44
66000	44

The fuse tube is operated by a fuse pole shown in illustration above. One of these poles should be ordered for each installation.

The style number and list price include the fuse block complete ready for installation but do not include fuse wire or fuse pole which must be ordered.

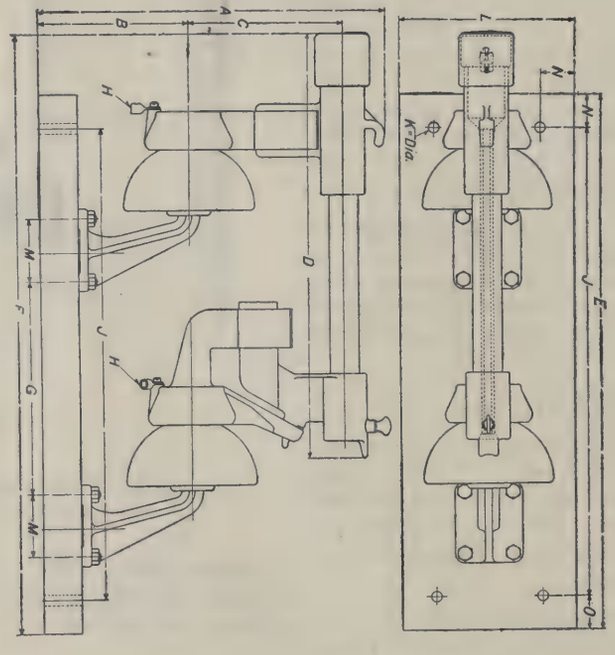
HIGH-VOLTAGE FUSE BLOCKS—Continued

PRICES

Normal Voltages	Maximum Voltages	Maximum Capacity Amperes	Mounting	Description	Approx. Net Wt., Lbs.	Style No.	List Price
.....	7500	50	Outdoor	Fuse block complete	50	151072	$ 38 50
.....	15000	50	Outdoor	Fuse block complete	74	166071	41 00
.....	25000	50	Outdoor	Fuse block complete	74	149139	48 50
44000*	.....	50	Outdoor	Fuse block complete	160	163446*	87 00
66000*	.....	50	Indoor	Fuse block complete	175	260586*	140 00
.....	7500	50	Outdoor	Fuse tube, only	9	151073	18 40
.....	15000	50	Outdoor	Fuse tube, only	12	160672	20 00
.....	25000	50	Outdoor	Fuse tube, only	14	149140	25 00
44000*	.....	50	Outdoor	Fuse tube, only	28	163447*	42 00
66000*	.....	50	Indoor	Fuse tube, only	32	260587*	50 00
.....	7500 to 25000	50	Outdoor	Fuse pole, only	3	149141	7 50
44000-66000*	.....	50	Indoor and Outdoor	Fuse pole, only	5	260588*	20 00

*Style Nos. 163446 and 163447 listed at normal voltage of 44000 are 50000-volt maximum-rated devices; Style Nos. 260586 and 260587 listed at normal voltage of 66000 are 73000-volt maximum-rated devices; and Style No. 260588 rated at normal voltage of 44000 to 66000 is a 73000-volt maximum-rated fuse pole. These devices may be applied up to maximum rating.

OUTLINE DIMENSIONS



DIMENSIONS IN INCHES CORRESPONDING TO LETTERS IN ABOVE VIEW

Style No.	A	B	C	D	E	F	G	H	J	K	L	M	N	O
151072	17 11/16	7½	8	22 1/16	27¾	30¼	10 13/16	.334	24¼	5/16	9	3¼	1¾	1¾
149139	19 7/16	9¼	8	29 5/8	40¼	43¼	17½	.334	36¾	5/16	9	4¼	1¾	1¾
160671	19	8¾	8	26	31¾	36	14 13/16	.334	28¼	½	9	3¼	1¾	1¾
163446	31 3/8	19 1/16	10	38 5/16	48 3/8	63 5/8	...	.334	31¾	11/16	10	...	2	14 5/8
260586	33 3/8	21¼	10	42 5/16	51 11/16	67 7/8	29 5/16	.186	36⅛	11/16	8	7¾	2	13 5/16

HIGH-VOLTAGE FUSED CIRCUIT-BREAKERS

For Voltages up to 66,000

APPLICATION

Westinghouse fused-type circuit-breakers meet the demand for a low-priced breaker for use on high-voltage circuits.

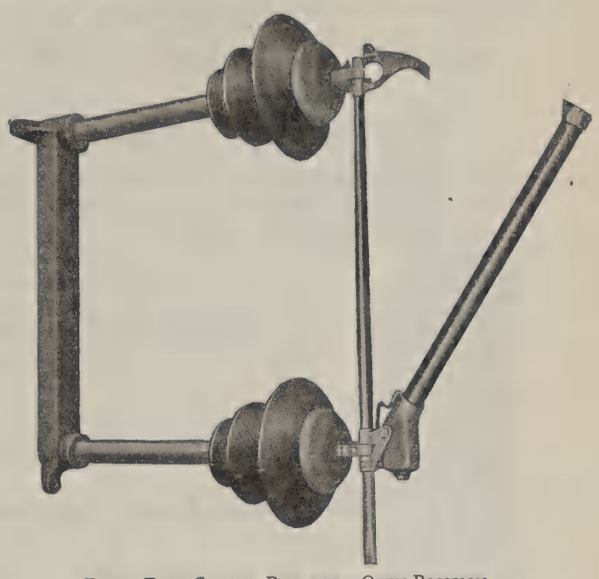
This type of circuit-breaker has the same relation to the high-voltage oil circuit-breakers that the enclosed fuse does to the low-voltage oil circuit-breakers, in that it is a low-priced device that will open the circuit under nearly any condition of short-circuit. However, it is not so convenient to handle, requiring some delay and expense to re-fuse, and cannot be opened manually. These high-voltage fused circuit-breakers are now in use successfully on 60,000-kilovoltampere systems.

On 11,000-volt circuits and 66,000-volt circuits, 4 feet and 15 feet headroom, respectively, should be allowed above the circuit-breakers to ungrounded material, such as marble; if the material above the breakers is grounded, such as steel beams, etc., a greater headroom is required.

The minimum distance between centers for successive breakers is as follows:

Volts	Distance Between Centers—Inches
15000	42
25000	48
37000	54
44000	60
66000	72

CAUTION—Fused Breaker on Polyphase Service—Since all fused-type circuit-breakers are of the single-pole form, where several of these are used on polyphase service one device might open, leaving the remaining legs of circuit alive and in certain installations, such as star-connected or three-phase four-wire systems, this opening of one leg without the others, will result in subjecting the transformers or other apparatus to serious rises of voltage which may result in damage.



FUSED TYPE CIRCUIT-BREAKER—OPEN POSITION

OPERATION

When the load on the line exceeds the capacity of the fuse, the latter blows, and the arm of the breaker swings by its own weight away from the upper line terminals, thus giving a positive indication that the fuse has blown. Before being inserted in the fuse tube the fuse wire should be enclosed in an asbestos sleeving (see catalogue on "Insulating Material and Supplies"). The asbestos sleeving prevents the gradual charring of the inside of the fuse tube by the overheated fuse and thereby eventually lengthens the life or prevents the burning out of the fuse tube.

Adjustment—First: Remove the mechanism from it base, taking hold of the long pole.

Second: Remove the screw-plug terminal from the lower end of the expulsion chamber and attach the fuse to the terminal.

Third: After passing the fuse through the fuse tube replace the screw-plug and attach the other end of the fuse to the wing-nut on the bracket at the upper end of the long pole, passing a turn or two around the lug, at the same time drawing the moving arm into its proper position against the end of the bracket.

Fourth: Replace the mechanism on the base and the breaker is ready for use.

CONSTRUCTION

The construction of the fused circuit-breaker is such as to make it light and at the same time, strong. The operating mechanism consists of a long hardwood pole on which is mounted a movable arm consisting of a reinforced fuse tube. At the bottom of the fuse tube is a brass expulsion chamber which is connected to the lower terminal of the breaker by a flexible copper shunt. Attached to the top of the pole and forming the upper breaker terminal there is a brass bracket, with a groove along its top to support the fuse, and a wing-nut to hold the end of the fuse when the breaker is closed. The fuse passes from the wing-nut over the bracket and down through the fuse tube to the expulsion chamber where it is attached to the screw-plug terminal in the end of the expulsion chamber.

HIGH-VOLTAGE FUSED CIRCUIT-BREAKERS—Continued

The pole of the circuit-breaker is provided with spring jaws or clips so that it may be quickly and easily attached to, or detached from the line terminals on the base.

Mounting—The circuit-breaker mechanism is mounted upon a cast-iron base, from which it is insulated by means of porcelain insulators set up on pins.

The base is secured to the wall or other support by three lag screws.

RATINGS AND PRICES

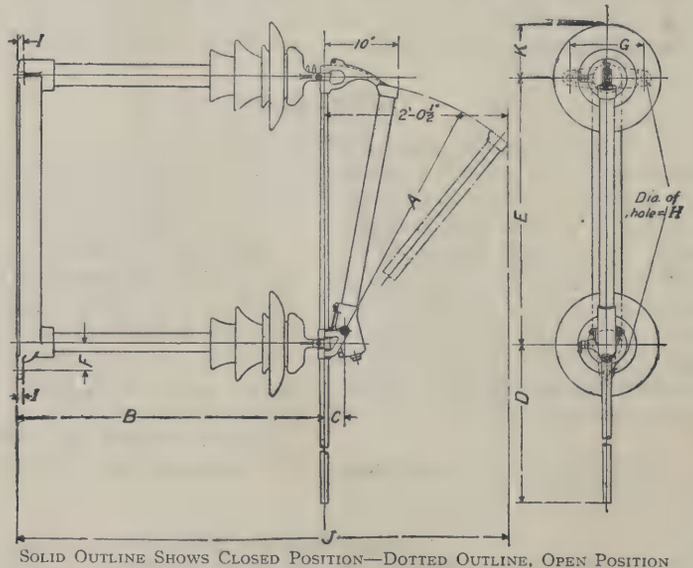
The style number and list price do not include fuse wire or asbestos sleeving. For fuse wire see pages of this catalogue on "Fuse Wire, Fuse Ribbon, and Link Fuses"; for asbestos sleeving see catalogue on "Insulating Material and Supplies."

Normal Voltage	Maximum Voltage	Maximum Capacity, Amperes	Approx. Net Weight Lb.	Style No.	List Price
High-Voltage Fused Circuit-Breaker Complete					
.....	15000	50	95	97519	$113 00
.....	25000	30	100	97520	122 00
.....	37000	20	110	97521	131 00
44000*	.....	20	120	97522*	145 00
66000*	.....	20	160	97523*	154 00
Removable Mechanism					
15000–66000*	.....	50	30	112323*	78 00
Circuit-Breaker Base, Insulating Cap, and Support					
.....	15000	50	65	97527	35 00
.....	25000	30	70	97528	44 00
.....	37000	20	80	97529	53 00
44000*	.....	20	90	97530*	67 00
66000*	.....	20	130	97531*	76 00

*Style Nos. 97522 and 97530 listed at normal voltage of 44000 are 50000-volt maximum-rated devices; Style Nos. 97523 and 97531 listed at normal voltage of 66000 are 73000-volt maximum-rated devices; and Style No. 112323 listed at normal voltage of 15000 to 66000 is a 73000-volt maximum-rated device. These devices may be applied up to maximum rating.

Order by Style Number

OUTLINE DIMENSIONS



SOLID OUTLINE SHOWS CLOSED POSITION—DOTTED OUTLINE, OPEN POSITION

Volts	DIMENSIONS IN INCHES CORRESPONDING TO LETTERS IN OUTLINE DRAWINGS										
	A	B	C	D	E	F	G	H	I	J	K
15000	33½	21 9/32	2 13/16	72½	36	2¾	10	⅞	⅞	45 23/32	3
25000	33½	27 7/16	2 13/16	72½	36	3¾	10	⅞	⅞	51 15/16	3⅜
37500	33½	32 5/16	2 13/16	72½	36	3¾	10	⅞	⅞	56 13/16	4 5/16
50000	33½	36 1/4	2 13/16	72½	36	3¾	10	⅞	⅞	60 5/16	5
73000	33½	41 15/32	2 13/16	72½	36	3¾	10	⅞	⅞	65 21/32	7

The above dimensions are for reference only. For official dimensions apply to nearest district office.

MOTOR-STARTING KNIFE SWITCHES

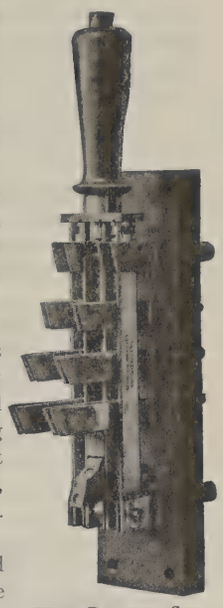
For Starting Capacities up to 3600 Amperes Rear-Connected—For Voltages up to 600

Application—These switches are used as a simple and inexpensive method of starting rotary converters from the direct-current end and direct-current motors of large capacity having starting conditions that will permit cutting out the starting resistance in four steps. They are intended for starting conditions only, being rated in terms of the starting current, and a short-circuiting line switch or circuit-breaker should be used to carry the running load. They will, however, carry one-fourth their rated current continuously, so that the short-circuiting line switch can be omitted where the full-load current is only one-fourth of the starting-current rating.

Operation—To start a motor the switch blade is thrown into the first jaw and after a moment's pause between steps, into each succeeding jaw until the last is closed. The short-circuiting line switch, where used, is then thrown in. The circuit should always be opened by opening the line switch or circuit-breaker.

Construction—These switches have four sets of contacts of such length that the switch blade makes contact with each set in succession. Each switch has four blades, a construction that allows of ample ventilation and reduces the depth of the switch from the switchboard.

To prevent large machines being started too quickly by throwing the switch through all the positions without stopping on any one position, a ratchet device is provided on the 1200, 2400, and 3600-ampere switches.



WITH RATCHET STOP

Style number and price include motor-starting switch with terminal lugs and arranged for mounting on panels from 1¼ to 2 inches thick, but do not include resistor or switch base.

Maximum Starting Current, Amperes	Continuous Carrying Capacity, Amperes*	Approx. Wt., Lb., with Base Net	Approx. Wt., Lb., with Base Shipping	Style No.	Additional List Price for Slate Base, Including Mounting	List Price
300	75	10	12	201868	$6 80	35 00
600	150	15	18	201869	7 60	58 00
1200	300	26	31	201870	20	100 00
2400	600	35	42	201871	11 30	125 00
3600	900	43	52	201872	13 60	167 00

*30 degree Centigrade rise, or less.

Order by Style Number

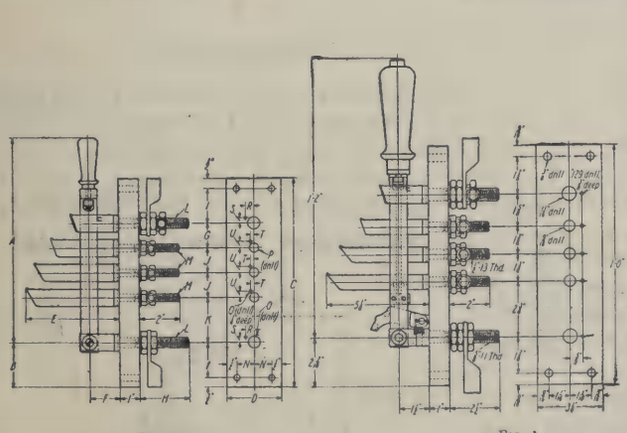


FIG. 1

FIG. 2

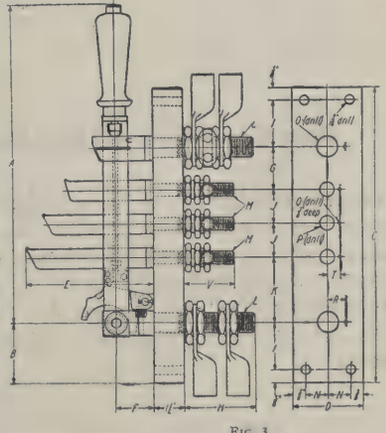


FIG. 3

Style No.	Fig. No.	Dimensions in Inches Corresponding to Letters in Outline Views																				
		A	B	C	D	E	F	G	H	I	J	K	L*	M*	N	O	P	Q	R	S	T	U	V
201868	1	8⅜	2⅛	9½	2½	3⅜	1⅛	1⅛	2⅛	1⅛	1⅛	1⅛	⅜–16	⅛–18	⅜	⅛	⅜	.067	⅛	⅛	⅛	⅛	.....
201869	1	10⅛	2¼	10½	2¾	4¾	1½	1¼	2⅜	1⅝	1¼	2¼	½–13	⅝–16	⅝	⅛	⅛	.107	⅛	¼	⅛	⅛	.....
201870	2	All dimensions are given on figure.																					
201871	3	16	3	14¾	3½	6⅜	1⅞	2⅛	3½	2⅜	1⅛	3⅛	1 –14	⅝–11	1⅛	1⅛	⅛	.129	⅜	..	⅝	..	2½
201872	3	17⅜	3⅜	16¾	5	7⅛	2⅛	2½	4½	2¾	1⅛	3⅜	1¼–14	¾–16	1⅛	1⅛	⅛	.194	1⅛	..	¾	..	3

*Diameter and threads per inch..

These dimensions are for reference only. For official dimensions apply to the nearest district office.

TYPE A FIELD SWITCHES

Rear-Connected—For Voltages up to 600

Two forms of field switches are listed, discharge (with discharge resistors) and transfer.

Application

Field-Discharge Switches—Field discharge switches are used in the field circuit of generators to serve as a means of opening and closing the field circuit and, when the switch is opened, of making the necessary connections of the field winding to a resistor, so that the energy in the inductive field winding may be dissipated in the resistor instead of causing undue strain on its insulation.

Field-Transfer Switches—Field transfer switches are used for transferring the field circuits of rotary converters or generators from one source of supply to another without opening the supply circuits, where there is not likely to be a difference of potential between the two supplies. Where such a difference is likely to occur, the transfer switch with additional jaws for inserting a limiting resistor between the supply circuits should be used (Fig. 2). They are used especially where it is necessary to transfer a rotary converter or a generator field circuit from the bus-bars to the armature for self-excitation or to a direct-connected exciter as with rotaries or synchronous motor-generator sets started from the direct-current side.

The single-pole switches are used particularly in railway service using grounded return.

Operating Characteristics

Temperature—The current carrying parts of these switches will carry their full rated current continuously with a maximum temperature rise of 30 degrees C. above that of the surrounding atmosphere, corrections to be made when the temperature of the surrounding atmosphere is other than 25 degrees C.

Dielectric Test—These switches are subjected for one minute to a dielectric test of 5000 volts between poles.

Current Ratings—The current ratings shown for the field switches listed are maximum, based on the allowable temperature rise that is reached after a continuous run of approximately one hour at the rated current.

Operation

Field-Discharge Switches—Just before the knife blades of the switch leave the contact jaws, an auxiliary blade makes contact in such a way that the discharge resistor is connected across the field winding, thus allowing the inductive discharge of the field winding to die out gradually.

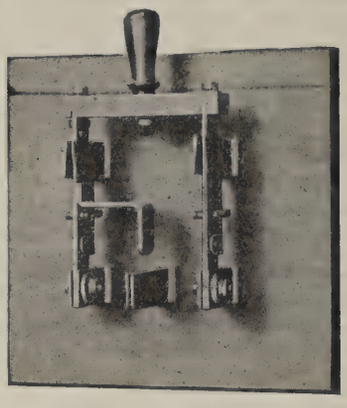


FIG. 1—FIELD-DISCHARGE SWITCH

Field-Transfer Switches—The field transfer switches are operated on the rocker principle with their blades so shaped that just before one side leaves the contact jaws the other makes contact with its jaws. Thus the field circuit is not opened.

Construction

These switches are of the standard Westinghouse Type A rear-connected knife-switch construction. They have satin finish, are neat in appearance and very substantial and simple in design. All current-carrying parts are of the best hard-drawn copper.

The field-discharge switches have quick-break blades.

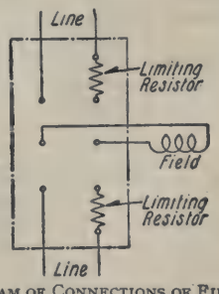


FIG. 2—DIAGRAM OF CONNECTIONS OF FIELD-TRANSFER SWITCH USING LIMITING RESISTORS

The remote-control type has the switch mounted on a sub-base in the rear of the panel and connected

through levers to an operating handle mounted with a cover plate on the switchboard panel. The operating handle has a ratchet, by means of which the switch may be locked in the open or closed position at the will of the operator.

Resistors

Resistors are listed for use with the field-discharge switches.

Capacity—In selecting a resistor for use with field-discharge switches select the ampere rating corresponding to the exciting current when the generator with which it is used is delivering normal full load. The resistors are of a capacity sufficient to take care of the discharge when the generator is operating on overload.

Voltage—The voltages shown for resistors listed in this section are the normal excitation voltages; the resistors being applicable to exciting voltages 25 per cent below these values.

RATINGS AND PRICES

Field-Discharge Switches

Panel-Mounting

Style number and list price include switch complete without base or resistor ready for installation on base or panel.

Capacity Amperes	Poles	Single-Throw Style No.	Single-Throw List Price	Double-Throw Style No.	Double-Throw List Price
		For Voltages up to 250			
100	Single	284989	$ 8 00	284990	$11 00
100	Double	284991	16 00	284992	22 00
200	Single	285000	10 00	285001	14 00
200	Double	285002	20 00	285003	30 00
400	Single	285024	22 00	285025	29 00
400	Double	285026	44 00	285027	60 00
600	Single	285032	34 00	285033	43 00
600	Double	285034	67 00	285035	86 00
800	Single	285036	44 00	285037	59 00
800	Double	285038	88 00	285039	118 00
		For Voltages up to 600			
100	Single	284993	11 00	284994	16 00
100	Double	284995	24 00	284996	32 00
200	Single	285004	13 00	285005	19 00
200	Double	285006	30 00	285007	40 00
300	Single	285016	22 00	285017	29 00
300	Double	285018	44 00	285018	58 00

Style number and list price include switch complete with slate base, operating handle, and cover plate with mounting bolts, but do not include resistor or connecting rod.

Capacity Amperes	Poles	Single-Throw Style No.	Single-Throw List Price	Double-Throw Style No.	Double-Throw List Price
		For Voltages up to 250			
300	Double	257772	$ 84 50	257773	$107 00
400	Double	257774	119 00	.....	.....

Resistors

For Use with Field-Discharge Switches

Style number and list price include resistor complete.

100 to 150 Volts: Normal Field Current, Amperes	Style Number	List Price	200 to 300 Volts: Normal Field Current, Amperes	Style Number	List Price	400 to 600 Volts: Normal Field Current, Amperes	Style Number	List Price
4–8	159091	$ 3 40	4–8	159091	$ 3 40	4–8	87652	$ 14 75
8–11	159092	3 40	8–11	159092	3 40	8–11	87653	15 00
11–14	159093	3 40	11–14	159097	3 40	11–15	87654	15 25
14–20	159094	3 40	14–20	87643	8 50	15–22	87655	15 25
20–30	159095	3 40	20–30	87644	8 75	22–32	87656	21 00
30–40	159096	3 40	30–45	87645	8 75	32–42	87657	21 00
40–75	159098	3 65	45–80	87646	9 60	42–62	87658	22 75
75–100	159099	3 65	80–125	87647	10 50	62–75	87659	31 75
100–150	159100	5 65	125–170	87648	22 75	75–125	87660	32 50
150–250	159101	5 65	170–225	87649	23 50	125–200	87661	53 00
250–400	159532	21 00	225–275	87650	25 00	200–275	87662	65 00
.....	.....	.....	275–400	87651	34 00	275–400	87663	113 00

Field-Transfer Switches

Style number and list price include switch complete without base.

Capacity Amperes	Single-Pole Style No.	Single-Pole List Price	Double-Pole Style No.	Double-Pole List Price
		Without Limiting Resistor		
60	289468	$10 50	289469	$18 00
100	289470	13 30	289471	23 50
200	289472	20 50	289473	36 50
100	.....	.....	289475	46 75
		For Use With Limiting Resistors*		
100	230318	14 50	230319	26 00

*Style number and price do not include resistors, prices for which will be supplied on request. Specify voltage of supply circuits and the characteristics of the field.

Order by Style Number

FIELD SWITCHES—Continued

OUTLINE DIMENSIONS
Field-Discharge Switches

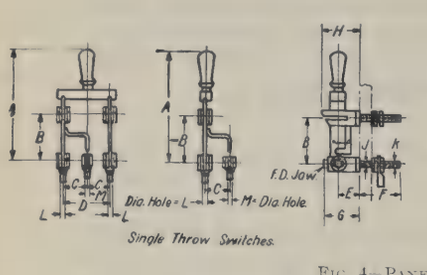


FIG. 4—PANEL MOUNTING

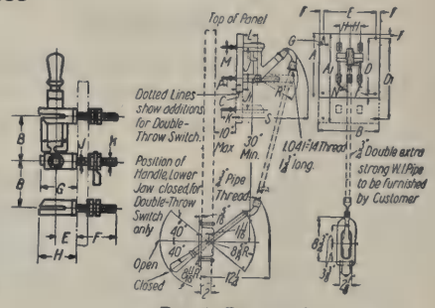

Top of Panel
Dotted Lines show additions for Double-Throw Switch
Position of Handle, Lower Jaw closed, for Double-Throw Switch only
Open
Closed
30° Max.
30° Min.
1 Pipe Thread
1 Double extra strong W.I. Pipe to be furnished by Customer

FIG. 5—REMOTE CONTROL

Panel Mounting, Fig. 4

Amps.	Volts	Dimensions in Inches A	B	C	D	E	F	G	H	J	K	L	M
						For Voltages up to 250							
100	250	6 1/2	3	1 3/16	3 1/8	1 1/2	3	2 3/16	2 1/4	3/8	3/8	.384	.384
200	250	7 29/32	3 1/2	1 7/8	3 3/4	1 7/8	3 1/4	2 13/16	3	3/8	1/2	.558	.384
300	250	8 3/4	3 3/4	2	4	2 1/4	3 1/2	3 7/16	3 23/32	3/8	5/8	.87	.384
400	250	9 7/8	4 1/4	2 1/16	4 1/8	2 1/2	3 3/4	3 7/8	4 3/16	1/2	5/8	.87	.558
600	250	10 11/16	4 7/8	2 1/4	4 1/2	2 3/4	4 1/2	4 3/16	4 1/4	1/2	3/4	1.28	.558
800	250	12 13/16	5 1/2	2 7/16	4 7/8	2 7/8	5 1/4	4 3/4	4 3/4	1/2	1	1.385	.558
						For Voltages up to 600							
100	600	8 1/2	5	2 3/4	5 1/2	1 1/2	3	2 7/16	2 1/4	3/8	3/8	.384	.384
200	600	9 29/32	5 1/2	3	6	1 7/8	3 1/4	2 13/16	3	3/8	1/2	.558	.384
300	600	10 5/8	5 3/4	3	6	2 1/4	3 1/2	3 7/16	3 23/32	3/8	5/8	.87	.384

Remote Control, Fig. 5
For Voltages up to 250

Capacity, Amp.	A	A1	B	C	D	D1	E	F	G	H	J	J1	K	L	M	N	P	R	S
300	11 1/4	16 3/4	11 1/4	1	9 1/2	15	9 1/2	7/8	5/16	2	5 3/4	5 3/4	3	2 5/8	5/8–11	.372–16	1 3/4	7 5/8	13 5/8
400	13	....	9 7/8	1 1/4	11	..	7 7/8	1	3/8	2 1/16	7	...	3	2 7/8	3/4–16	3/8–16	1 1/2	7 5/8	14 1/4

Field-Transfer Switches

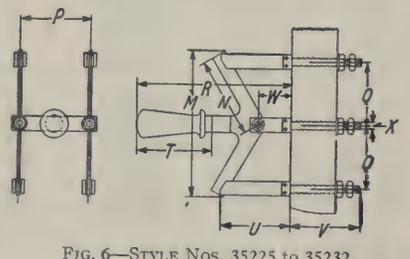


FIG. 6—STYLE NOS. 35225 to 35232

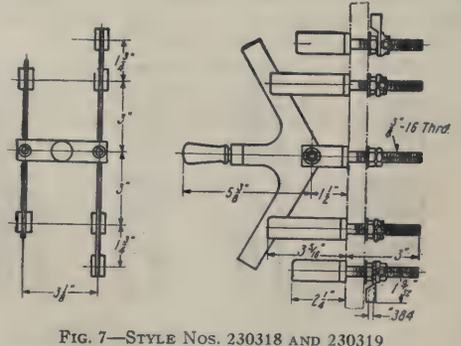


FIG. 7—STYLE NOS. 230318 AND 230319

Rating	Pole	Dimensions in Inches—Fig. 6 M	N	P	Q	R	T	U	V	W	X
60	Single	6	3 1/4	....	2 5/8	4 1/2	1 5/8	2 1/16	3	1 3/16	5/16
100	Single	7 3/16	3 7/8	....	3	5 7/8	2	3 1/4	3	1 1/2	5/8
200	Single	8 3/4	4 11/16	....	3 1/2	7 3/8	2 1/2	4	3 1/4	1 7/8	1/2
60	Double	6	3 1/4	3	2 5/8	4 1/2	1 5/8	2 1/16	3	1 3/16	1/2
100	Double	7 3/16	3 7/8	3 1/8	3	5 7/8	2	3 1/4	3	1 1/2	3/8
200	Double	8 3/4	4 11/16	3 3/4	3 1/2	7 3/8	2 1/2	4	3 1/4	1 7/8	1/2
400	Double	10 5/8	5 1/2	4 1/8	4 1/4	7 7/8	3 1/8	4 1/16	3 3/4	1 7/8	5/8

These dimensions are for reference only. For official dimensions apply to nearest district office.

DISCONNECTING SWITCHES

Types M, O and P

Disconnecting switches are used primarily for isolating apparatus from the circuit for purposes of inspection and repair; also for sectionalizing feeders. In connection with lightning arrester installations, disconnecting switches are particularly useful, providing a simple and effective means for isolating the arresters while cleaning and inspecting.

Switches are listed for indoor or for outdoor use. The indoor switches can be obtained single or double-throw, upright or inverted, and for panel, wall, or pipe mounting. Outdoor switches are made in either the upright or inverted style for wall or pipe-mounting. In the case of wall-mounting switches for outdoor service, the ratings are reduced under those given for indoor service.

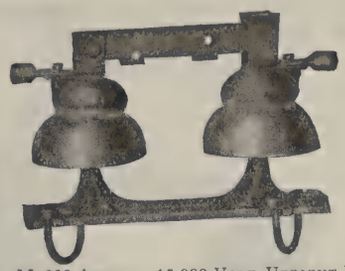
TYPE M INVERTED 300-AMPERE, 15,000-VOLT INDOOR, 7500-VOLT OUTDOOR DISCONNECTNG SWITCH

Three types of disconnecting switches are listed: types M, O and P.

A line of selector-type disconnecting switches—transfer switches which do not require the circuit to be interrupted while making the change—is also listed. These selector-type switches can also be used to connect two independent circuits in parallel.

Temperature—The current-carrying parts adjacent to the contact of Westinghouse disconnecting switches will carry their full-rated current continuously with a maximum temperature rise of either 20 or 30 degrees centigrade above the temperature of the surrounding atmosphere, depending on the class of service as mentioned below into which the switches are placed.

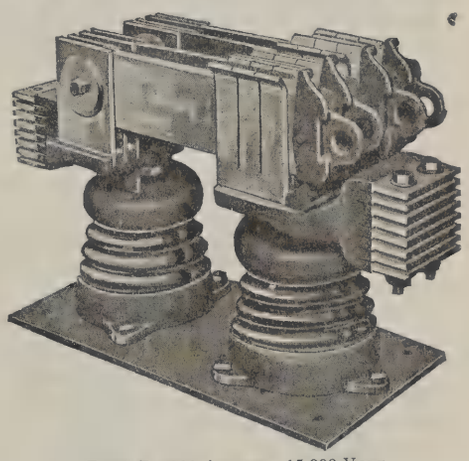
TYPE M 300-AMPERE, 37,000-VOLT WALL-MOUNTING, UPRIGHT INDOOR DISCONNECTING SWITCH



TYPE M 300-AMPERE, 15,000-VOLT UPRIGHT INDOOR DISCONNECTING SWITCH

It is necessary that adjacent apparatus does not heat the switch; that conductors to the switch are ample to carry the current with a temperature rise, not exceeding that of the switch; and that reasonable ventilation is provided.

The 20-degree rise basis is recommended when the maximum temperature of the air where the switch is located may approximate 40 degrees centigrade, and the load is practically continuous as on generator, rotary, or transformer circuits.



TYPE P 4000-AMPERE, 15,000-VOLT DISCONNECTING SWITCH

The 30-degree rise basis is recommended where maximum temperature of the air where switch is located may approximate 30 degrees centigrade or less, and the load is intermittent as on feeder circuits.

Insulation Test—All Westinghouse disconnecting switches are subjected to a dielectric dry test, of 2¼ times rated voltage plus 2000 volts, for one minute between conducting details and ground and between terminals, in accordance with A.I.E.E. rules. Switches for outdoor service will withstand a dielectric wet test of 2 times rated voltage plus 1000 volts. All switches will open successfully at voltages not more than 5 per cent above normal-voltage rating.

Application of Rating—In selecting a disconnect-

ing switch, it is recommended that the rated capacity should be at least as great as the maximum rated one-hour (or more) overload current of all the apparatus supplied by the circuit in which the switch is to be placed.

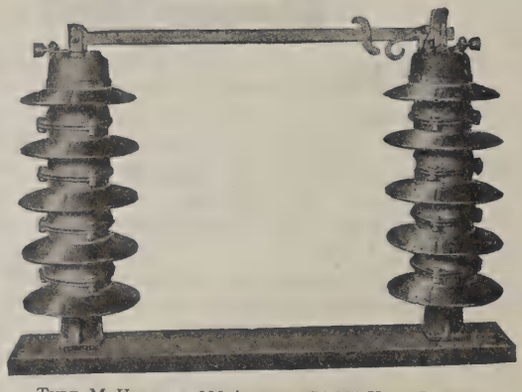
Operation—These switches are opened and closed with a hook on the end of a wooden pole, which engages in a hole in the switch blade or in a latch on switches supplied with latches.

Disconnecting switches are not intended for opening under load and therefore no attempt should be made to open them with current in the circuit.

TYPE M DISCONNECTING SWITCHES

TYPE M 100-AMPERE, 7500-VOLT WALL-MOUNTING UPRIGHT INDOOR DISCONNECTING SWITCH

TYPE M INVERTED 300-AMPERE, 66,000-VOLT INDOOR, 50,000-VOLT OUTDOOR DISCONNECTING SWITCH



TYPE M UPRIGHT 300-AMPERE, 73,000-VOLT INDOOR, 40,000-VOLT OUTDOOR DISCONNECTING SWITCH

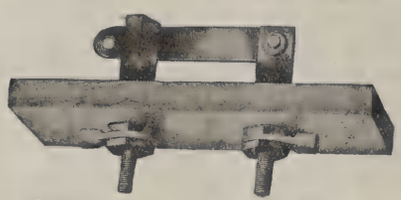
The type M switches are listed for indoor or for outdoor service. These disconnecting switches have their live parts mounted on porcelain insulators carried on an iron yoke, or base. The switch parts may be mounted above the insulators and the base below (upright form) as used for mounting on a wall; or the switch parts may be mounted below and the base above (inverted form) as used for mounting on the ceiling.

Type M switches are in general wall-mounting switches, the bases being made for bolting to the wall, or ceiling. A few switches are listed, however, for mounting on 1¼-inch pipe frames by U-bolts.

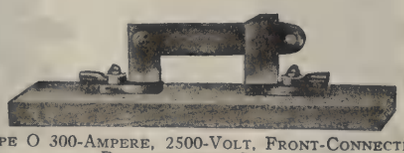
For indoor service 66,000 volts and above and outdoor service 44,000 volts and above, type M switches are provided with the disc type of insulator post. This type of insulator is made up of separate insulator units having caps and couplings on the top and bottom respectively provided with three lugs for ½-inch bolts, so that one unit can be bolted to another. Different heights of posts can, therefore, be made up for different voltages by bolting together the required number of units. This form of construction makes a post of great mechanical strength and one that can be installed and replaced easily.

All parts except the porcelain insulators are finished in dull black, the outdoor switches having a protective paint.

TYPE O DISCONNECTING SWITCHES



TYPE O 300-AMPERE, 2500-VOLT, REAR-CONNECTED DISCONNECTING SWITCH

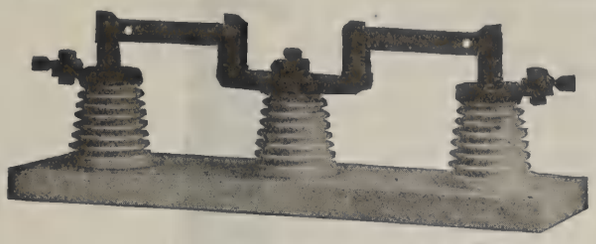


TYPE O 300-AMPERE, 2500-VOLT, FRONT-CONNECTED DISCONNECTING SWITCH

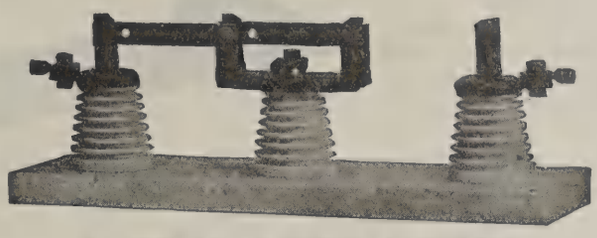
Type O indoor disconnecting switches are made for either front or rear connection, and can be supplied upon application for any combination of front and rear connection desired. Type O switches are listed for 2500 volts, maximum. On these switches, the live parts are mounted directly on a marble base or panel.

The copper parts of these switches are dipped and lacquered.

SELECTOR-TYPE DISCONNECTING SWITCHES



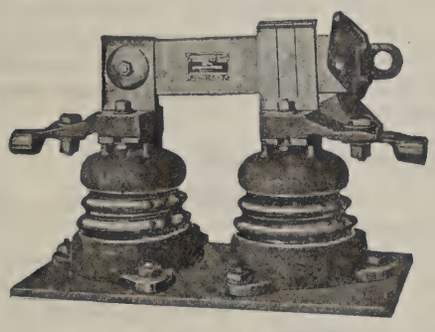
TYPE O 300-AMPERE, 15,000-VOLT SELECTOR TYPE DISCONNECTING SWITCH WITH BOTH SIDES CLOSED



TYPE O 300-AMPERE, 15,000-VOLT SELECTOR TYPE DISCONNECTING SWITCH WITH ONE SIDE OPEN

The selector-type disconnecting switches are two single-throw, single-pole, type M or O switches with the hinge jaws, mounted on the same jaw block and insulator. The hinge jaw is also provided with catches, to hold either blade in the open position. Except for these differences in the hinge jaws, the construction of these switches is similar to the type M and O switches of the same ratings.

TYPE P DISCONNECTING SWITCHES

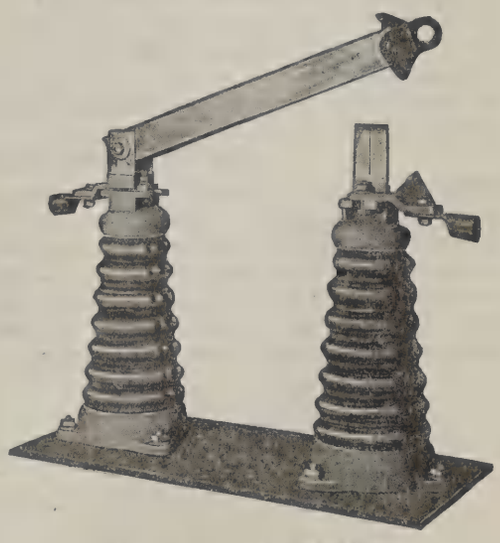


TYPE P 600-AMPERE, 7500-VOLT DISCONNECTING SWITCH

Type P indoor disconnecting switches are mounted on marble bases for 2500 volts and on steel bases for higher voltages. Above 2500 volts, the live parts are carried on corrugated porcelain pillar-type insulators on which top and bottom caps of malleable iron are cemented.

The insulators are assembled in such a way as to maintain the location of the pillar-mounting bolt holes in the bottom cap in definite relation to the contact-bolt holes in the upper cap, thus making the pillars interchangeable, and readily removable from the base and contact parts.

All sizes of switches have the contact details bolted to the pillar caps, so that they are readily removable for repair or replacement. With this construction, pillars can readily be changed in individual switches in the field.



TYPE P 400-AMPERE, 37,000-VOLT DISCONNECTING SWITCH

The cementing of the caps to the insulators gives the strongest possible construction, inasmuch as porcelain cannot be made uniform enough for proper fitting of mechanical clamps only, and withstand the strain resulting from the operation of the switch.

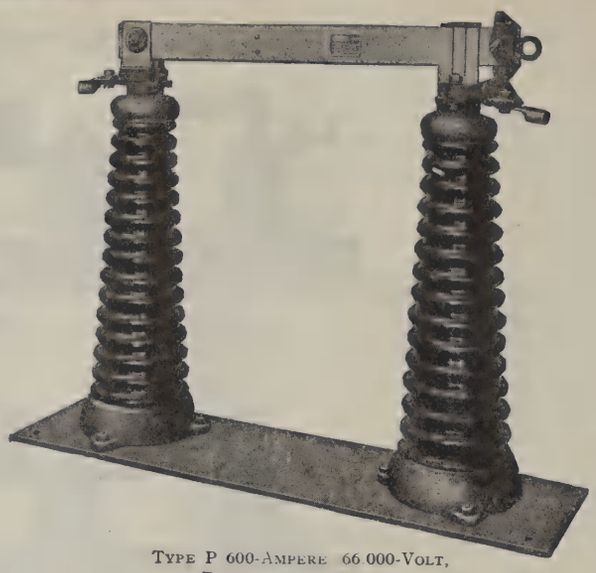
DISCONNECTING SWITCHES—Continued

On all type P 400 and 600-ampere switches of voltages above 7500 the truss form of blade is used, which gives an unusually rigid construction. This form of construction is especially desirable on the 400 and 600-ampere switches, (due to the mechanical weakness of a long thin blade), as it prevents the blade from being forced out of alignment with the break jaw by side pressure during the operation of the switch.

Large flares on the break-jaw ends of switches up to and including 2000 amperes insure proper alignment of the contacts during the closing of the switch.

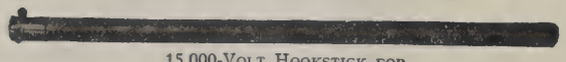
All switches are provided with a locking latch. By inserting the end of the hook stick in the hole of the latch and pulling, the latch is unlocked and the switch opened by the same operation.

All jaws and blades have dipped and lacquered copper finish. The caps and base have a dull black finish.



TYPE P 600-AMPERE 66 000-VOLT, DISCONNECTING SWITCH

AUXILIARY APPARATUS



15,000-VOLT HOOKSTICK FOR INDOOR APPLICATION

Operating Sticks—Operating sticks are listed for operating the various disconnecting switches. They consist of a rod of strong insulating material, such as treated wood or micarta, with a hook on one end, which engages a hole provided in the switch blade or latch. On the sticks for general use above 66000 volts and for outdoor use, a chain is provided and so connected that a good ground connection can be made to fully protect the operator.

Latches—Latches for holding switches in the closed position are included in the style numbers of all inverted type M and all types P and R switches. They can also be supplied for wall-mounting type M and for type O switches, in which cases prices and delivery will be furnished on application. Latches are not usually required for large switches in small plants.

RATING AND MOMENTARY CURRENT

The maximum momentary current passing through disconnecting switches should not be greater, owing to mechanical and electrical limitations, than 50 times their normal 60-cycle, 20-degree ampere rating. If the switches will be subjected to greater current momentarily than this, switches of larger normal rating (amperes) should be used as they are both mechanically and electrically stronger.

The disconnecting switches listed herein are rated on the basis of 60-cycle alternating current. When used on 25-cycle alternating-current service, the switches will have a rating corresponding to the same rated (amperes) type A knife switches.

PRICES
TYPE M DISCONNECTING SWITCHES

Indoor and Outdoor

Style number includes switch complete, without operating stick. List price includes switch complete without operating stick, but with terminal lugs. Operating sticks should be ordered from table on a following page.

INDOOR

Maximum Amps.*	Normal Voltage	Max. Volt	Mounting	Position	Approx. Wt.—Lbs. Net	Approx. Wt.—Lbs. Shipping	Style No.	Terminal Lugs Style No.	Terminal Lugs No. Required	List Price
Single-Throw										
100	.....	7500	Wall	Upright	14	18	50382	189913	2	$13 50
300	.....	7500	Wall	Upright	18	25	173295	103414	2	17 00
100	.....	15000	Wall	Upright	18	23	50383	189913	2	15 75
300	.....	15000	Wall	Upright	23	30	173296	103414	2	20 00
100	.....	25000	Wall	Upright	27	35	55384	80205	2	19 50
300	.....	25000	Wall	Upright	30	42	173297	103414	2	24 50
300	.....	37000	Wall	Upright	85	98	118768	¾" Hole**	2	46 00
300	44000§	.....	Wall	Upright	100	115	186814§	103414	2	62 00
100	.....	15000	1¼" Pipe	Upright	20	31	247210	189913	2	17 50
300	.....	15000	1¼" Pipe	Upright	25	54	167502	190639	2	25 00
300	.....	25000	1¼" Pipe	Upright	32	62	191880	80205	2	44 50
300	44000§	.....	1¼" Pipe	Upright	105	195	247211§	103414	2	58 50
300	.....	15000	Ceiling	Inverted	28	55	233474†	190212	2	56 50
300	.....	37000	Ceiling	Inverted	86	150	233475†	229128	2	99 00
300	66000§	.....	Ceiling	Inverted	125	209	233393†§	229128	2	105 00
300	110000¶	.....	Wall	Upright	430	830	233394¶	189923	2	209 00
Double-Throw										
100	.....	7500	Wall	Upright	20	31	247213	25019	3	18 25
300	.....	7500	Wall	Upright	27	54	247214	36451	3	23 50
100	.....	15000	Wall	Upright	26	51	247215	25019	3	21 50
300	.....	15000	Wall	Upright	33	62	247216	103414	3	27 75
100	.....	25000	Wall	Upright	40	72	247217	25019	3	27 00
300	.....	25000	Wall	Upright	45	94	247218	190639	3	51 50
300	.....	37000	Wall	Upright	118	193	247220	¾" Hole**	2	63 50
300	.....	25000	1¼" Pipe	Upright	45	90	191881	80205	3	58 50
300	.....	15000	1¼" Pipe	Inverted	42	77	247208†	190212	3	69 50
300	.....	37500	Flat Surface	Inverted	125	209	233476†	80205	3	138 00
300	66000§	.....	Flat Surface	Inverted	150	262	247212†§	190639	3	148 00

OUTDOOR

Single-Throw

300	.....	7500	1¼" Pipe	Inverted	28	55	233474‡	190212	2	56 50
100	.....	15000	Cross Arm	Inverted	29	57	233472	270467-8	1	59 00
300	.....	15000	Cross Arm	Inverted	30	58	233473	270467-8	1	61 00
300	.....	25000	Cross Arm	Inverted	86	150	233475‡	229128	2	99 00
300	44000§	.....	Cross Arm	Inverted	125	209	233393‡§	229128	2	105 00
300	110000¶	.....	Cross Arm	Inverted	650	1120	233395¶	189923	2	322 00

Double-Throw

300	.....	7500	1¼" Pipe	Inverted	42	77	247208‡	190212	3	69 50
300	.....	25000	Cross Arm	Inverted	125	209	233476‡	80205	3	138 00
300	44000*	.....	Cross Arm	Inverted	150	262	247212‡§	190639	3	148 00

*These switches will carry their rated current with a maximum temperature rise of 20° Centigrade.

†Can also be used outdoors at a lower working voltage. See "Outdoor Switches," marked "‡" above.

‡Also listed for indoor use at a higher working voltage. See "Indoor Switches" marked "†" above.

**Terminal consists of a thimble clamped in a socket.

§Style Nos. 186814, 247211, 233393 and 247212 listed at normal voltage of 44000 are 50000-volt maximum-rated switches and Style Nos. 233393 and 247212 listed at normal voltage of 66000 are 73000-volt maximum-rated switches. These switches may be applied up to maximum rating.

¶Switches listed at normal voltage of 110000 may be applied on systems having a maximum voltage not exceeding 5 per cent above normal listed voltage.

PRICES

TYPE O DISCONNECTING SWITCHES

Indoor

Style number includes switch complete without operating stick. List price includes switch complete, without operating stick, but with terminal lugs, with or without base as per the following table. Operating sticks should be ordered from table on a following page.

Max. Amps. Rating 30°	Max. Amps. Rating 20°	Max. Volts	Connection	Approx. Wt.—Lbs. Without Base Net	Without Base Ship.	With Base Net	With Base Ship.	Terminal Lugs Style No.	Terminal Lugs No. Required	Without Base Style No.	Without Base List Price	With Base* Style No.	With Base* List Price
							Single-Throw						
100	100	2500	Front	1	3	12	14	189913	2	61045	$8 50	235817	$13 00
200	200	2500	Front	2	5	17	20	36457	2	61046	9 50	235818	16 25
300	300	2500	Front	3½	8	23	26	36458	2	35152	11 50	235819	20 00
400	400	2500	Front	5	10	32	36	36459	2	35153	16 00	235820	25 00
600	600	2500	Front	12	17	43	47	190644	2	35154	42 00	235821	57 00
800	800	2500	Front	23	30	60	65	270450	2	35155	66 50	235822	81 50
1000	1000	2500	Front	33	40	65	71	270449	2	35156	88 00	235823	103 00
1600	1200	2500	Front	45	55	85	91	200873 7533	2 2	67192	138 00	235824	155 00
2000	1600	2500	Front	65	80	95	102	7534	6	67193	178 00	235825	201 00
100	100	2500	Rear	1¼	6¼	13	16	189914	2	61047	9 75	235826	14 25
200	200	2500	Rear	2½	7½	19	22	189920	2	61048	10 75	235827	17 50
300	300	2500	Rear	4½	9½	25	28	190212	2	35157	15 50	235828	24 00
400	400	2500	Rear	7	14	35	39	190640	2	35158	20 00	235829	29 00
600	600	2500	Rear	15	23	47	51	190644	2	35159	46 50	235830	61 50
800	800	2500	Rear	21	34	65	70	7527	4	35160	71 50	235831	86 50
1000	1000	2500	Rear	34	45	70	75	7530	4	35161	93 00	235832	108 00
1600	1200	2500	Rear	47	62	90	98	7532	6	67764	143 00	235833	160 00
2000	1600	2500	Rear	55	74	100	112	7534	6	67765	183 00	235834	206 00
							Double-Throw						
100	100	2500	Front	1½	3½	15	20	189913	3	198605	12 50	247225	21 00
200	200	2500	Front	3		18	21	36457	3	198561	13 75	247226	23 50
300	300	2500	Front	5	10	25	27	36458	3	247221	18 00	247227	29 50
400	400	2500	Front	8	16	34	38	36459	3	198714	23 50	247228	38 50
800	800	2500	Front	33	51	100	120	270450	3	198429	93 50	247229	113 00
1000	1000	2500	Front	45	94	140	160	270449	3	247222	126 00	247230	146 00
300	300	2500	Rear	6½	12	25	54	190212	3	247223	21 50	247231	33 00
600	600	2500	Rear	21	33	51	81	190644	3	247224	62 50	247232	78 00
1600	1200	2500	Rear	57	97	103	198	7532	9	198631	190 00	247233	213 00
2000	1600	2500	Rear	80	108	134	254	7534	9	198630	256 00	247234	280 00

*Style number and list price include marble base. Standard marble bases are furnished in black marine, but polished marble bases can be furnished in any shade on special order, prices on request.

SELECTOR-TYPE DISCONNECTING SWITCHES

Type M—Indoor

Style number includes switch complete without operating stick. List price includes switch complete without operating stick, but with terminal lugs. Operating sticks should be ordered from table on a following page.

Max. Amperes Rating 30°	Max. Amperes Rating 20°	Max. Volts	Connection	Approx. Wt.—Lbs. Net	Ship.	Style No.	Terminal Lugs Style No.	Terminal Lugs No. Required	List Price
100	100	15000	Front	30	42	194338	25019	3	$47 00
300	300	15000	Front	38	52	194339	80205	3	57 50
300	300	25000	Front	48	65	194342	190212	3	78 00

Type O—Indoor

Style number includes switch complete without operating stick. List price includes switch complete without operating stick, but with terminal lugs and clamping nuts with or without base as per the following table. Operating sticks should be ordered from table on a following page.

Max. Amps. Rating 30°	Max. Amps. Rating 20°	Max. Volts	Connection	Approx. Wt.—Lbs. Without Base Net	Without Base Ship.	With Base Net	With Base Ship.	Terminal Lugs Style No.	Terminal Lugs No. Req.	Without Base Style No.	Without Base List Price	With Base* Style No.	With Base* List Price	Additional List Price for Marble Base
300	300	15000	Front	50	66	125	150	190639	3	194340	$75 00	235835	$ 89 00	$8 00
300	300	15000	Rear	70	95	145	180	29763	3	194341	97 50	235836	112 00	8 00

*Style number includes soapstone base.

DISCONNECTING SWITCHES—Continued

PRICES

TYPE P DISCONNECTING SWITCHES

Indoor

Style number and list price include switch complete with marble base (on 2500-volt switches) or with steel plate base (on switches of higher voltages), terminal lugs where used and clamping nuts, but without operating stick. Operating sticks should be ordered from table below.

FRONT-CONNECTED SWITCHES

Single-Throw

Max. Amperes Rating* 30°	20°	Normal Voltage	Max. Volts	Method of Connection Break Jaw	Hinge Jaw	Approx. Wt., Lbs. Net	Shipping	Style No.	Terminal Lugs Style No.	No. Required	List Price
			2500	Hor.†	Hor.†	75	112	258616	.....	..	$223 00
3000	2400	.....	7500	Terminal Lugs	Terminal Lugs	50	70	258597	229127	2	33 00
400	400	.....	7500	Terminal Lugs	Terminal Lugs	55	75	258598	229133	2	46 50
600	600	.....	7500	Strap	Strap	65	90	258600	.....	..	73 00
1200	1200	.....	7500	Strap	Strap	73	103	258601	.....	..	82 50
2000	1600	.....									
400	400	.....	15000	Terminal Lugs	Terminal Lugs	54	74	258606	229127	2	41 50
600	600	.....	15000	Terminal Lugs	Terminal Lugs	65	90	258614	229133	2	56 00
1200	1200	.....	15000	Strap	Strap	72	95	258604	.....	..	82 50
2000	1600	.....	15000	Strap	Strap	93	130	258605	.....	..	87 00
4000	3000	.....	15000	Hor.†	Hor.†	150	208	258661	.....	..	268 00
400	400	.....	25000	Terminal Lugs	Terminal Lugs	65	90	258607	229127	2	45 50
600	600	.....	25000	Terminal Lugs	Terminal Lugs	74	100	258608	229133	2	62 00
400	400	.....	37000	Terminal Lugs	Terminal Lugs	76	108	258611	229127	2	59 50
600	600	.....	37000	Terminal Lugs	Terminal Lugs	85	120	258612	229133	2	71 50
400	400	44000‡	.....	Terminal Lugs	Terminal Lugs	84	125	258609‡	229127	2	71 50
600	600	44000‡	.....	Terminal Lugs	Terminal Lugs	92	137	258610‡	229133	2	81 00
600	600	66000‡	.....	Terminal Lugs	Terminal Lugs	155	232	269473‡	229133	2	148 00

*It is recommended that where switches are opened only seldom, the disconnecting switches be purchased based on the 20° rating. See also a preceding page on "Temperature."

†Jaw blocks are laminated for strap.

‡Style Nos. 258609 and 258610 listed at normal voltage at 44000 are 50000-volt maximum-rated switches and style No. 269473 listed at normal voltage at 66000 is a 73000-volt maximum-rated switch. These switches may be applied up to maximum rating.

REAR-CONNECTED SWITCHES

Max. Amperes Rating 30°	20°	Max. Volts	Method of Connection Break Jaw	Hinge Jaw	Break Jaw	Approx. Wt.—Lbs. Net	Shipping	Style No.	List Price
				Single-Throw					
2400	1900	2500	Hor.	Hor.	....	55	85	258593	$117 00
2400	1900	2500	Vert.	Vert.	....	55	85	258595	117 00
2400	1900	2500	Hor.	Vert.	....	55	85	258596	117 00
2400	1900	2500	Vert.	Hor.	....	55	85	258594	117 00
3000	2400	2500	Hor.	Hor.	....	75	112	258615	225 00

Other rear-connected type P disconnecting switches up to 2000 amperes, 15000 volts capacity, can be supplied on order. Prices are furnished on request.

COMBINATION FRONT-AND-REAR-CONNECTED SWITCHES

Max. Amperes Rating 30°	20°	Max. Volts	Connection Break Jaw	Hinge Jaw	Break Jaw	Method of Connection Break Jaw	Hinge Jaw	Break Jaw	Approx. Wt., Lbs. Net	Shipping	Style No.	List Price
						Double-Throw						
3000	2400	2500	Rear	Rear	Front	Hor.	Hor.	Hor.*	110	180	258633	$294 00
3000	2400	2500	Rear	Rear	Front	Vert.	Vert.	Hor.*	110	180	258650	294 00
3000	2400	2500	Front	Rear	Front	Hor.*	Hor.	Hor.*	110	180	258635	294 00
3000	2400	2500	Front	Rear	Front	Hor.*	Vert.	Hor.*	110	180	258657	294 00

*Jaw blocks laminated for strap.

OPERATING STICKS

For Types M, O and P Switches

Style number and list price include stick complete as described on a preceding page.

Normal Volts	Maximum Volts	Application	Length Feet	Approx. Wt.—Lbs. Net	Shipping	Style No.	List Price
.....	15000	Indoor	2½	1	1½	35299	$ 3 50
66000	.....	Indoor	10	10	20	35403	9 50
132000	.....	Outdoor*	20	20	40	272947	25 50
154000	.....	Indoor	16	18	35	247648	23 50

*When using this pole outdoors, the operator should be sure to have the chain thoroughly grounded.

DISCONNECTING SWITCHES—Continued

OUTLINE DIMENSIONS

Type M Disconnecting Switches

Single-Throw

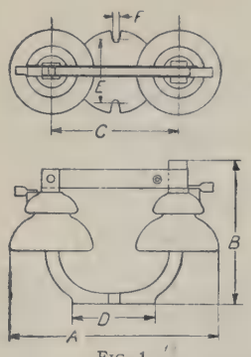
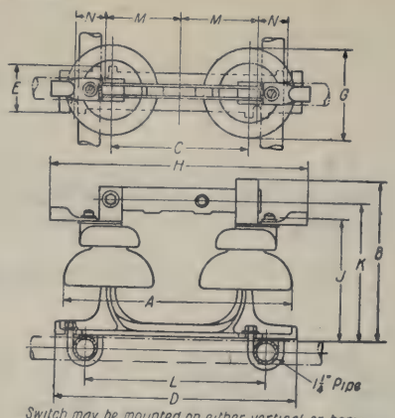


FIG. 1



Switch may be mounted on either vertical or horizontal pipes

FIG. 2

Style No.	Fig.	Dimensions in Inches												
		A	B	C	D	E	F	G	H	J	K	L	M	N
50382	1	12½	9 11/16	9	6	4½	½	..	..	..	..	..	..	..
50383	1	15	10 5/16	9	6	4½	½	..	..	..	..	..	..	..
55384	1	19¾	11 7/8	13	6½	5	11/16	..	..	..	..	..	..	..
167502	2	15	10 5/8	9	16	3¼	..	6	17	8	9¼	12	5	2
173295	1	15	10 3/8	9	6	4½	½	..	..	..	..	..	..	..
173296	1	15	11	9	6	4½	½	..	..	..	..	..	..	..
173297	1	19¾	12 3/16	13	6½	5	11/16	..	..	..	..	..	..	..
247210	2	15	10⅛	9	16	3¼	..	6	14	8 1/16	9	12	5	2

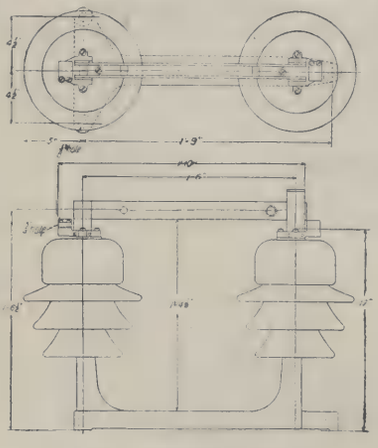


FIG. 3—STYLE NO. 118768

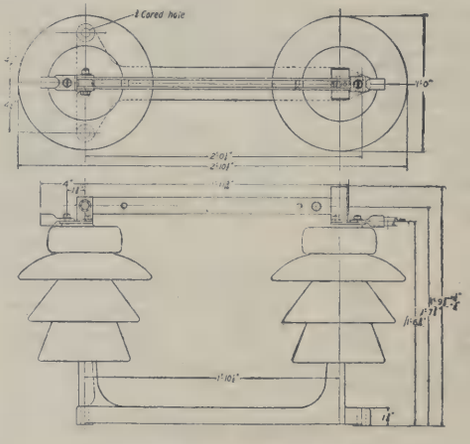


FIG. 4—STYLE NO. 186814

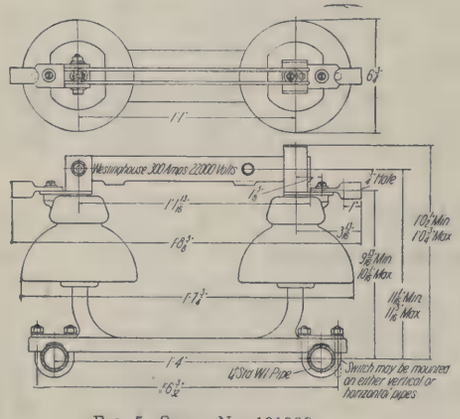


FIG. 5—STYLE NO. 191880

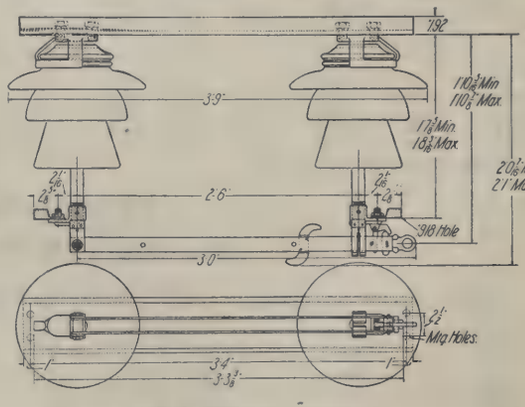


FIG. 6—STYLE NO. 233393

(Continued on next page)

These dimensions are for reference only. For official dimensions apply to nearest district office.

DISCONNECTING SWITCHES—Continued

OUTLINE DIMENSIONS

TYPE M DISCONNECTING SWITCHES—Continued

Single-Throw

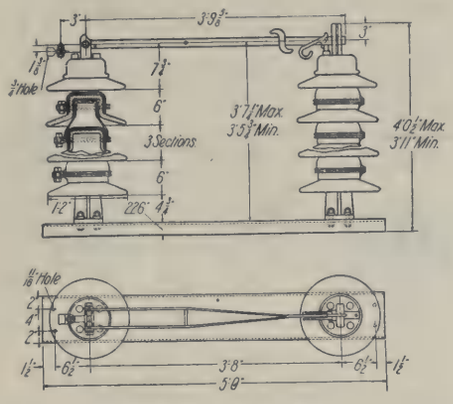


FIG. 7—STYLE NO. 233394

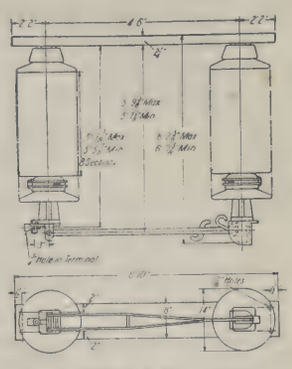


FIG. 8—STYLE NO. 233395

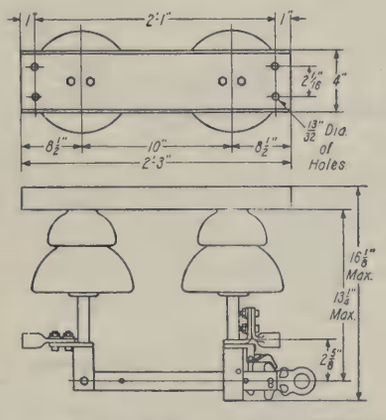


FIG. 9—STYLE NOS. 233472 AND 233473

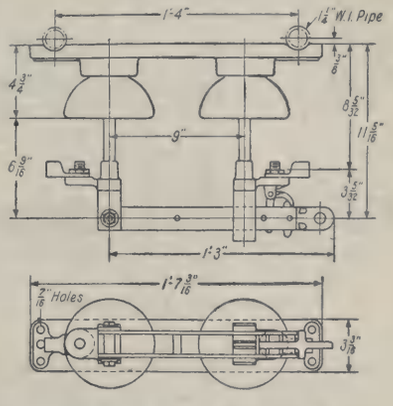


FIG. 10—STYLE NO. 233474

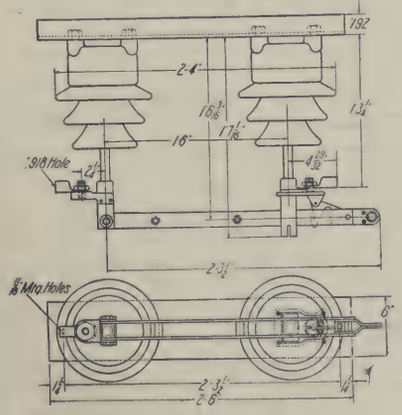


FIG. 11—STYLE NO. 233475

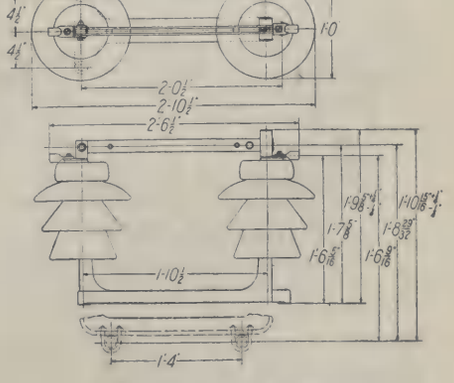


FIG. 12—STYLE NO. 247211
FOR STYLE NO. 247210, SEE FIG. 2

(Continued on next page)

These dimensions are for reference only. For official dimensions apply to nearest district office.

OUTLINE DIMENSIONS

TYPE M DISCONNECTING SWITCHES—Continued

Double-Throw

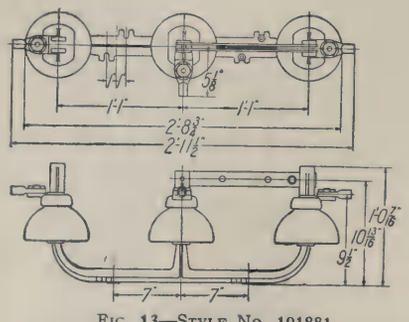


FIG. 13—STYLE NO. 191881

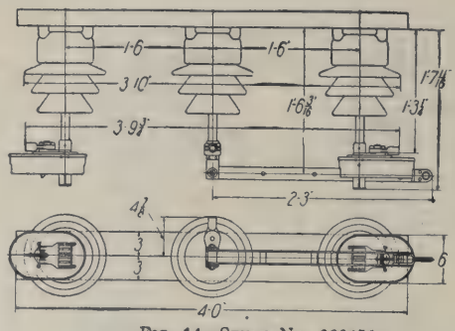


FIG. 14—STYLE NO. 233476

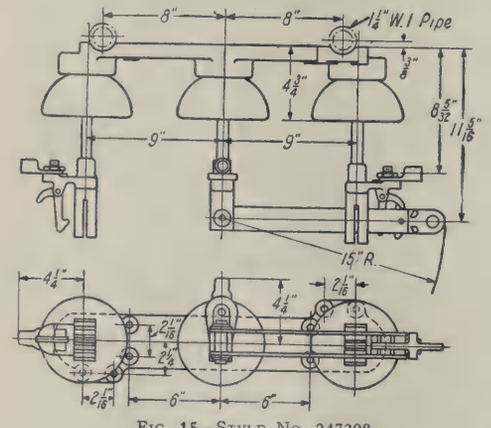


FIG. 15—STYLE NO. 247208

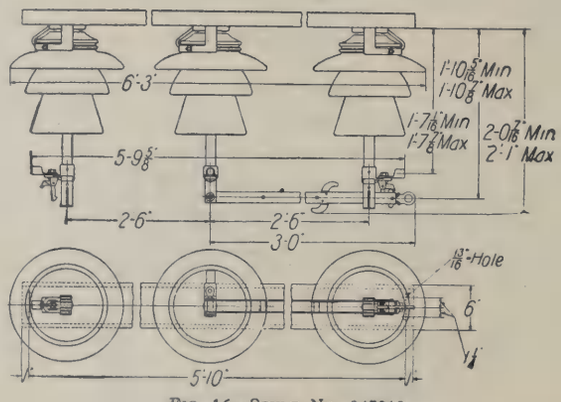


FIG. 16—STYLE NO. 247212

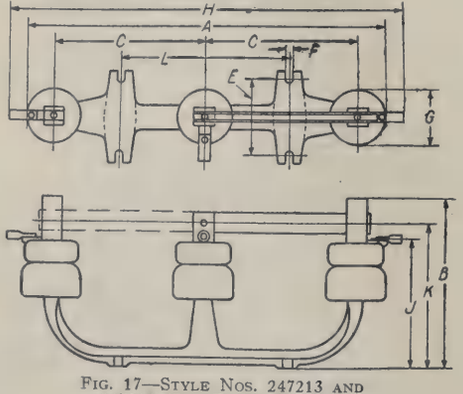


FIG. 17—STYLE NOS. 247213 AND 247214 (SEE TABLE BELOW)

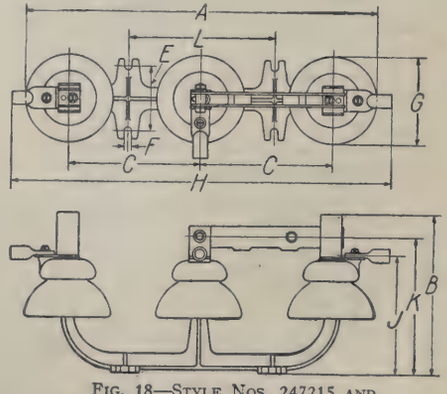


FIG. 18—STYLE NOS. 247215 AND 247216 (SEE TABLE BELOW)

Style No.	Fig.	Dimensions in Inches										
		A	B	C	D	E	F	G	H	J	K	L
247213	17	19 3/4	9 13/16	9	....	4 1/2	1/2	3 1/2	26 1/2	7 11/16	9	10
247214	17	19 3/4	10 3/4	9	....	4 1/2	1/2	3 1/2	27 1/4	7 11/16	9 1/8	10
247215	18	24	10 1/4	9	....	4 1/2	1/2	6	23 1/8	8 1/2	9 1/8	10
247216	18	24	10 13/16	9	....	4 1/2	1/2	6	24	8 1/4	9 1/2	10

(Continued on next page)

These dimensions are for reference only. For official dimensions apply to nearest district office.

DISCONNECTING SWITCHES—Continued

OUTLINE DIMENSIONS

TYPE M DISCONNECTING SWITCHES—Continued

Double-Throw

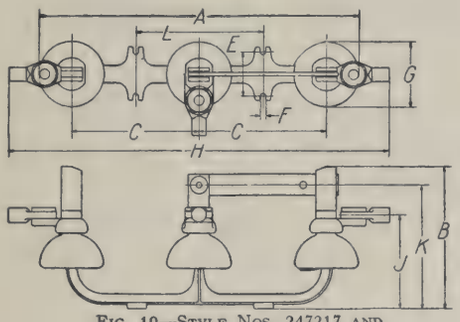


FIG. 19—STYLE NOS. 247217 AND 247218 (SEE TABLE BELOW)

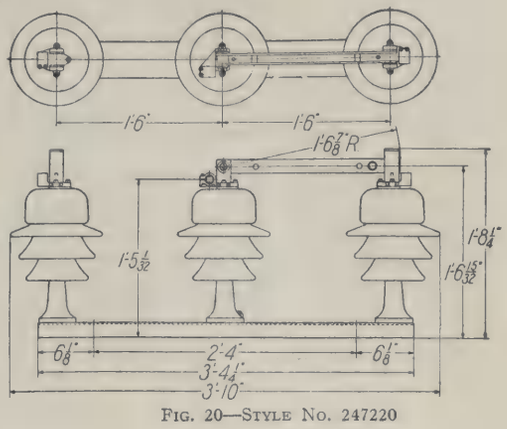


FIG. 20—STYLE NO. 247220

Style No.	Fig.	DIMENSIONS IN INCHES										
		A	B	C	D	E	F	G	H	J	K	L
247217	19	32 3/4	11 7/8	13	....	4 1/2	1/2	6 3/4	31 1/8	9 1/16	10 1/2	13
247218	19	32 3/4	12 1/16	13	....	4 1/2	1/2	6 3/4	35 1/2	9 1/2	10 13/16	13

Type O Disconnecting Switches

Single-Throw

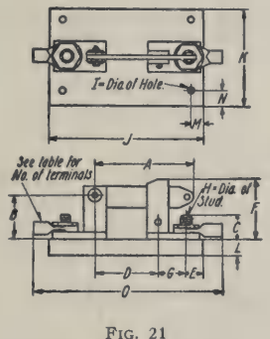


FIG. 21

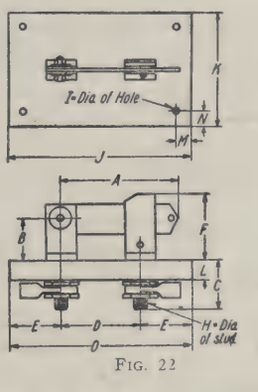


FIG. 22

STYLE NO.		Fig.	DIMENSIONS IN INCHES														Drill for Cables	Number Cables Per Stud
Without Base	With Base		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	
61045	235817	21	6 5/16	1 7/8	1	5	4 7/8	2 13/32	7/8	.242	5/16	16 1/2	6	1	3/4	3/4	9 1/4	11/32	1
61046	235818	21	7 1/4	2 3/8	1 1/4	5 1/2	4 13/16	3 3/8	1 1/16	.372	5/16	17 1/2	6	1 1/4	7/8	7/8	11 3/8	11/32	1
35152	235819	21	7 13/16	2 5/8	1 1/4	5 3/4	4 5/8	3 7/8	1 1/2	.372	5/16	18 1/2	6 1/4	1 1/4	7/8	7/8	13 1/2	11/32	1
35153	235820	21	8 3/8	2 7/8	1 3/8	6	5	4 5/16	1 3/4	.372	11/32	19 1/2	6 1/2	1 1/2	7/8	7/8	14 1/2	1	1
35154	235821	21	9 1/16	3 1/2	1 3/4	6 3/4	5	5 5/16	3	1	5/16	22 3/4	7 3/4	2	1	1	19 3/4	1 3/16	1
35155	235822	21	11 3/4	5	2 3/8	7 1/2	5	7 1/8	3 1/2	1 1/4	7/16	24 1/2	8	2	1 1/2	1 3/8	21 1/4	1 1/16	1
35156	235823	21	11 13/16	4 13/16	2 1/8	8	5 3/8	7 3/8	3 3/4	1 1/2	9/16	26 1/4	9	2	1 3/8	1 3/8	23 3/4	1 1/2	1
67192	235824	21	11 3/4	5	3 3/8	7 1/2	5 1/2	7 1/16	3 1/2	1 1/4	7/16	25 1/2	9 1/2	2	1 1/2	1 3/8	22 5/8	1 3/16	2
67193	235825	21	12 1/16	6 3/4	5 1/16	8	5 3/4	9 1/4	3 7/8	2	9/16	27 1/4	9 1/2	2	1 1/2	1 3/8	23 3/4	1 3/16	3
61047	235826	22	6 5/16	1 7/8	3	5	5 1/2	2 13/32	...	3/8	5/16	16	6	1	3/4	3/4	6 13/32	9/32	1
61048	235827	22	7 1/4	2 3/8	3 3/4	5 1/2	5 1/2	3 3/8	...	1/2	5/16	16 1/2	6	1	7/8	7/8	7 5/8	1/2	1
35157	235828	22	7 13/16	2 5/8	4	5 3/4	5 5/8	3 7/8	...	5/8	5/16	17	6 3/4	1 1/4	7/8	7/8	11 1/8	3/4	1
35158	235829	22	8 3/8	2 7/8	4 1/4	6	6	4 5/16	...	3/4	11/32	18	7	1 1/4	7/8	7/8	11 3/4	7/8	1
35159	235830	22	9 1/16	3 1/2	5 1/8	6 3/4	6 3/8	5 5/16	...	1	7/16	19 1/2	7 3/4	1 1/2	1 1/8	1 1/8	14	1 3/16	1
35160	235831	22	11 3/4	3 7/8	4	7 1/2	6 1/2	6	...	1 1/4	7/16	20 1/2	8	1 1/2	1	1	14	1	2
35161	235832	22	11 11/16	4 5/16	5 3/4	9	6 3/4	6 7/8	...	1 1/2	5/16	21 1/2	8 1/2	2	1 3/8	1 3/8	16 1/8	1 3/16	2
67764	235833	22	11 3/4	3 7/8	7	7 1/2	6 3/4	6 1/16	...	1 3/4	5/16	21	8 1/2	2	1	1	15 3/4	1 1/8	3
67765	235834	22	12 3/16	4 5/16	7	8	7	6 1/8	...	2	9/16	22	9	2	1	1	16 3/8	1 3/16	4

These dimensions are for reference only. For official dimensions apply to nearest district office.

DISCONNECTING SWITCHES—Continued

OUTLINE DIMENSIONS

TYPE O DISCONNECTING SWITCHES—Continued

Double-Throw

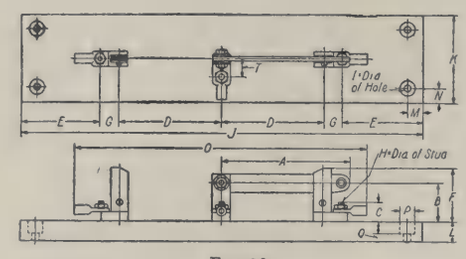


FIG. 23

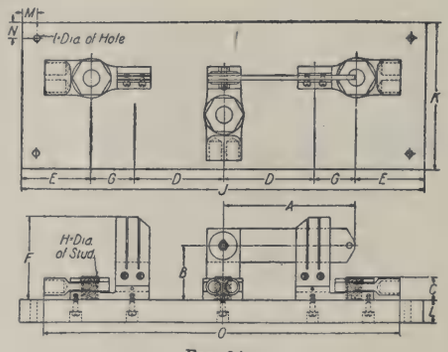


FIG. 24

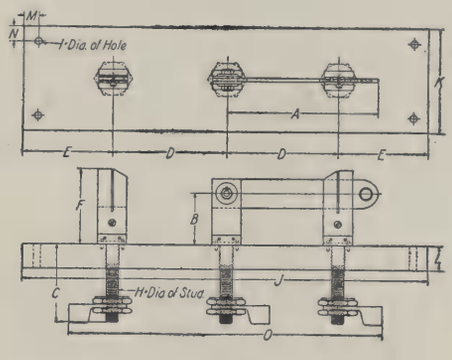


FIG. 25

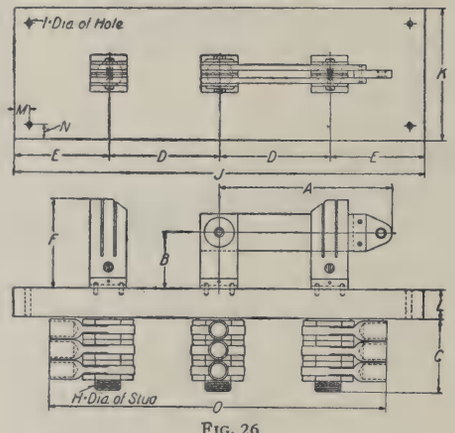


FIG. 26

Style No.		Fig.	Dimensions in Inches																Drill for Cables	Number Cables Per Stud
Without Base	With Base		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	T		
198605	247225	23	6 5/16	1 7/8	1	5	4 5/8	2 19/32	7/8	.242	7/16	21	5	1 1/4	7/8	7/8	14 3/8	7/8	11/32	1
198561	247226	23	7 1/4	2 3/8	1 1/4	5 1/2	4 13/16	3 3/8	1 1/16	.372	7/16	23	5 1/2	1 1/4	1	3/4	16 7/8	1 1/16	33/64	1
247221	247227	23	7 13/16	2 5/8	1 1/4	5 3/4	4 7/8	3 7/8	1 1/2	.372	7/16	24 1/4	6 3/4	1 1/4	1	3/4	19 1/4	1 1/2	13/16	1
198714	247228	23	8 3/8	2 7/8	1 3/8	6	5 1/4	4 5/16	1 3/4	.372	7/16	26	6 3/4	1 1/2	1	7/8	20 1/2	1 1/4	1	1
198429	247229	24	11 3/4	5	2 3/8	7 1/2	5 1/4	7 1/8	3 1/2	1 1/4	9/16	34	11	2	1 3/8	1 3/8	28 3/4	2 3/4	1	2
247222	247230	24	11 11/16	4 13/16	2 1/8	8	6 1/4	7 1/4	3 3/4	1 1/2	9/16	36	13	2	1 3/8	1 3/8	31 1/4	3 1/4	1 3/16	2
247223	247231	25	7 7/8	2 5/8	4	5 3/4	4 5/8	3 3/8	...	5/8	3/8	20 3/4	5 3/4	1 1/4	7/8	7/8	16	...	.747	1
247224	247232	25	9 7/16	3 1/2	5 1/8	6 3/4	5 5/8	5 1/4	...	1	7/16	24 3/4	7	1 1/2	1 1/8	1 1/8	20 3/4	...	1 3/16	1
198631	247233	26	11 3/4	3 7/8	7	7 1/2	6 3/4	6 1/16	...	1 3/4	7/16	28 1/2	8 1/2	2	1 3/8	1 3/8	22 3/4	...	1 1/8	3
198630	247234	26	12 7/16	4 5/16	7	8	7	6 7/8	...	2	9/16	30	9	2	1 3/8	1 3/8	24 1/8	...	1 3/16	3

These dimensions are for reference only. For official dimensions apply to nearest district office.

DISCONNECTING SWITCHES—Continued

OUTLINE DIMENSIONS

Selector-Type Disconnecting Switches

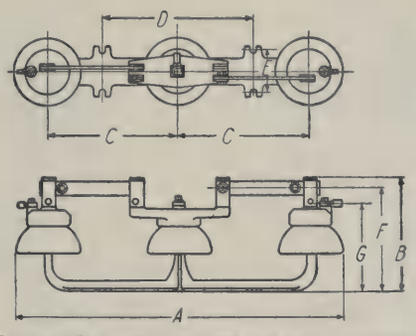


FIG. 27—STYLE NOS. 194338, 194339, AND 194342
(SEE TABLE BELOW)

Style No.	DIMENSIONS, INCHES						
	A	B	C	D	E	F	G
194338	30 3/8	10 1/2	12 5/16	14	4	9 5/8	7 3/4
194339	31 3/4	11 3/8	11 15/16	14	4	10 5/16	8 1/2
194342	44 1/8	13 1/16	18	18	4 1/2	12 5/16	9 11/12

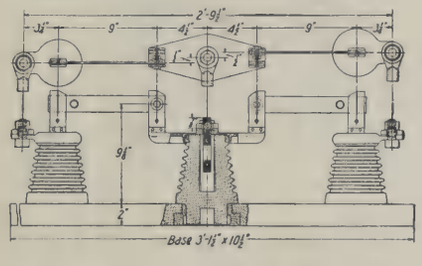


FIG. 28—STYLE NOS. 194340 AND 235835

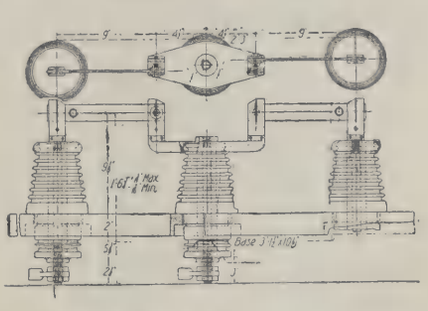


FIG. 29—STYLE NOS. 194341 AND 235836

Type P Disconnecting Switches

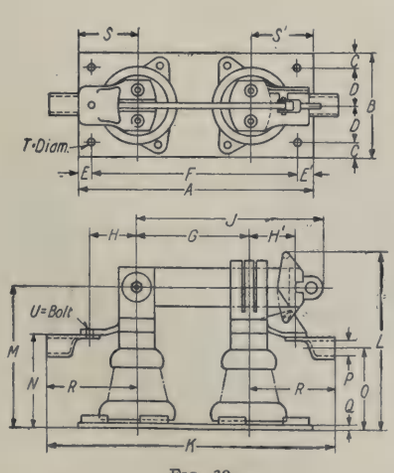


FIG. 30

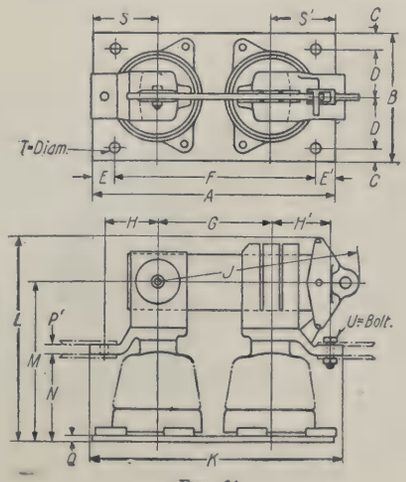


FIG. 31

(Continued on next page)

These dimensions are for reference only. For official dimensions apply to nearest district office.

DISCONNECTING SWITCHES—Continued

OUTLINE DIMENSIONS

TYPE P DISCONNECTING SWITCHES—Continued

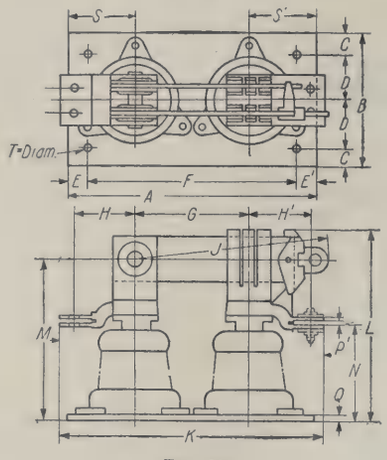


FIG. 32

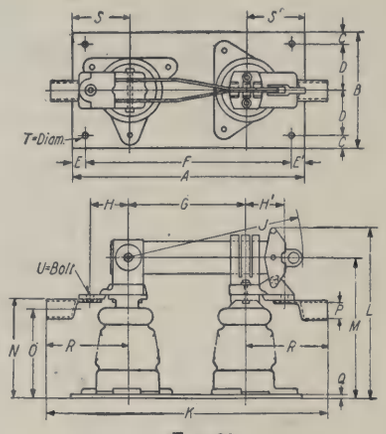


FIG. 33

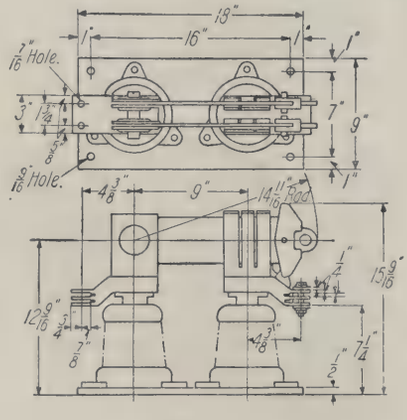


FIG. 34

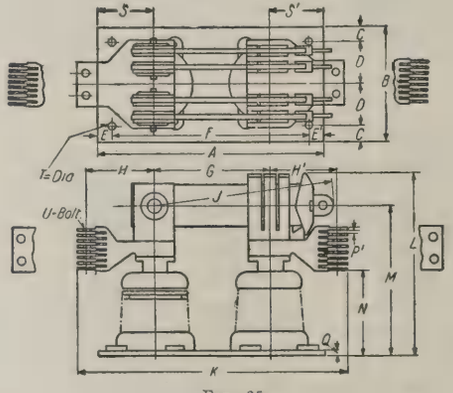


FIG. 35

Front-Connected Switches

Style No.	Fig.	Dimensions in Inches																						
		A	B	C	D	E	E	F	G	H	H¹	J	K	L	M	N	O	P	P¹	Q	R	S	S¹	T	U
258597	30	15 1/4	7	1	2 1/2	1	1	13 1/4	7 1/2	2 3/4	2 3/4	11 7/8	17 13/16	10	8 5/16	5 5/8	5 3/32	.918	..	1/4	5 13/32	37/8	37/8	1/2	3/8
258598	30	15 1/4	7	1	2 1/2	1	1	13 1/4	7 1/2	3	3	12 5/16	19 5/16	11 1/4	8 5/16	5 3/4	5	1.28	..	1/4	6 1/8	37/8	37/8	5/16	1/2
258600	31	16	8 1/2	1	3 1/4	1 3/8	1 3/8	13 1/4	7 1/2	3 9/16	4	13 1/16	17 15/16	13 3/4	10 1/16	5 3/4	....	....	..	3/8	...	4 1/4	4 1/4	1/16	1/2
258601	32	16	8 1/2	1	3 1/4	1 3/8	1 3/8	13 1/4	7 1/2	4	4	12 23/32	17 23/32	12 1/2	10 3/8	5 11/16	....	....	1/4	3/8	...	4 1/4	4 1/4	9/16	*
258604	31	18	9	1	3 1/2	1	1	16	9	3 9/16	4	14 1/16	19 7/16	15 1/8	12 1/8	7 1/16	....	....	..	3/8	...	4 5/8	4 5/8	9/16	1/2
258605	32	18	9	1	3 1/2	1	1	16	9	4	4	14 7/16	19 7/8	13 13/16	10 13/16	7 3/8	....	....	1/4	3/8	...	4 1/2	4 1/2	9/16	..
258606	33	18	9	1	3 1/2	1	1	16	9	2 3/4	2 3/4	13 3/8	19 11/16	11 15/16	10 1/4	7 3/16	7 1/32	.918	..	1/4	5 13/32	4 1/2	4 1/2	9/16	3/8
258607	33	20	9	1	3 1/2	2	2	16	11	2 3/4	2 3/4	15 3/8	21 13/16	14 1/16	12 1/2	9 13/16	9 9/32	.918	..	5/16	5 13/32	4 1/2	4 1/2	9/16	3/8
258608	33	20	9	1	3 1/2	2	2	16	11	3	3	15 3/4	23 7/8	15 5/16	13 1/8	9 5/16	9 9/16	1.28	..	5/16	6 1/16	4 1/2	4 1/2	9/16	1/2
258609	33	27	9	1	3 1/2	6 1/4	2	18 3/4	18	2 3/4	2 3/4	22 3/8	28 1/16	22 5/16	20 5/8	17 1/16	17 7/16	.918	..	3/8	5 13/32	4 1/2	4 1/2	9/16	3/8
258610	33	27	9	1	3 1/2	6 1/4	2	18 3/4	18	3	3	22 13/16	30 7/8	23 5/16	21 1/4	18 1/16	17 5/16	1.28	..	3/8	6 7/16	4 1/2	4 1/2	9/16	1/2
258611	33	23 1/2	9	1	3 1/2	2 3/8	2 3/8	18 3/4	14 1/2	2 3/4	2 3/4	18 1/8	25 7/16	18 1/16	16 1/2	13 13/16	13 5/16	.918	..	3/8	5 13/32	4 1/2	4 1/2	9/16	3/8
258612	33	23 1/2	9	1	3 1/2	2 3/8	2 3/8	18 3/4	14 1/2	3	3	19 5/16	27 3/8	19 5/16	17 1/8	13 5/16	13 9/16	1.28	..	3/8	6 7/16	4 1/2	4 1/2	9/16	1/2
258614	33	18	9	1	3 1/2	1	1	16	9	3	3	13 11/16	21 7/8	13 1/16	10 7/8	7 7/16	6 15/16	1.28	..	1/4	6 7/16	4 1/2	4 1/2	9/16	3/8
*258616	36	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
*258661	35	20	10	1 3/8	3 5/8	1 3/8	1 3/8	17 1/4	10 1/4	6 1/4	6 1/4	15 15/16	24 1/4	15 11/16	13	7 3/8	....	....	1/4	3/8	...	4 7/8	4 7/8	1/2	..
269473	33	33 1/4	11	1 1/4	4 1/4	7 1/4	7 1/4	18 3/4	24	3	3	28 1/16	36 7/8	31 1/8	28 1/16	25 3/4	25 3/4	1.28	..	1/16	6 7/16	5	4 1/4	9/16	1/2

*For direction of laminations of jaw blocks, see price table.

These dimensions are for reference only. For official dimensions apply to nearest district office.

OUTLINE DIMENSIONS

TYPE P DISCONNECTING SWITCHES—Continued

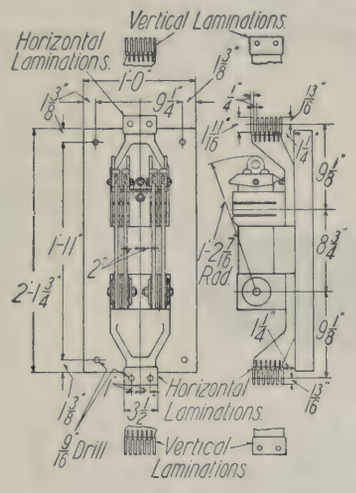


FIG. 36

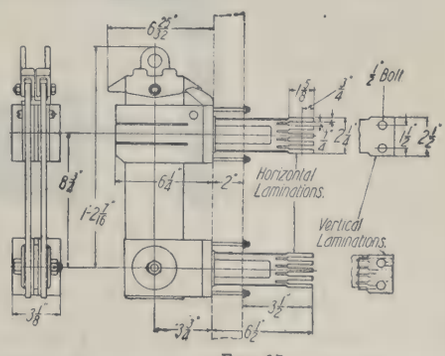


FIG. 37

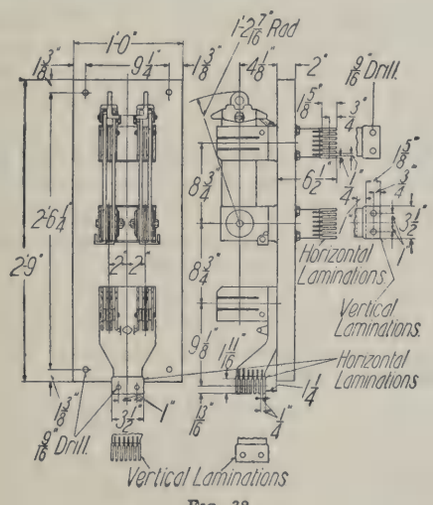


FIG. 38

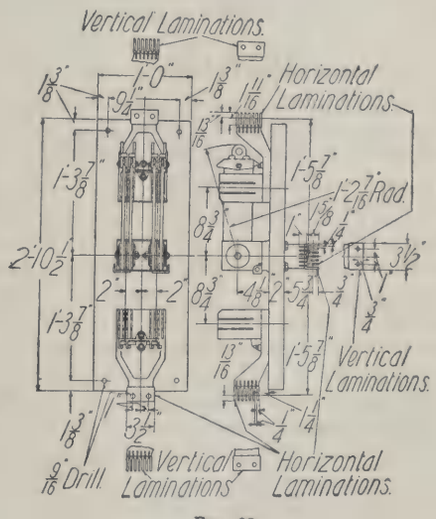


FIG. 39

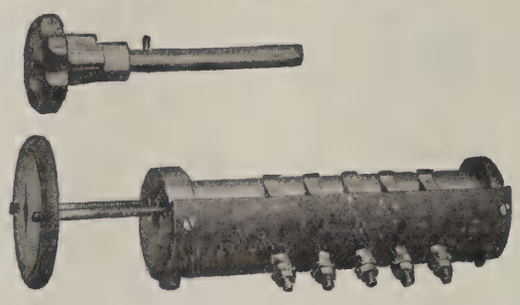
Rear-Connected and Front-and-Rear-Connected Switches

*Style No.	Fig.	*Style No.	Fig.
258593	37	258615	†
258594	37	258633	38
258595	37	258635	39
258596	37	258650	38
.....	..	258657	39

*For direction of laminations of jaw blocks or studs, see price table.
†Outline dimensions will be furnished on application.
These dimensions are for reference only. For official dimensions apply to nearest district office.

INSTRUMENT SWITCHES

TYPE RS DRUM-TYPE SWITCHES



VOLTMETER SWITCH AND KEY

Application

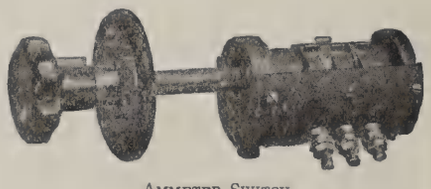
Type RS instrument switches are used for connecting one instrument to any one of several circuits and for making the multipoint connections required when synchronizing generators.

Operation

All type RS instrument switches, with the exception of the ammeter and thermo-couple switches, have removable keys or handles. These keys are labeled and constructed so that they cannot be inserted in the wrong switches.

Ammeter Switch—With one ammeter, one ammeter switch and two or more current transformers on a polyphase circuit, the ammeter can be connected so as to read the current in any phase. Switching contacts are so arranged that the current transformer secondary circuits are never opened.

Two forms of ammeter switches are listed. The two-phase and three-phase switches make the neutral connection in the switch, while the three-circuit and four-circuit switches keep the several circuits entirely independent. (Figs. 2 and 3.)



AMMETER SWITCH

Thermo-Couple Switch—With one switch per generator, the potentiometer or temperature indicator can be connected so as to read the temperature in any couple on any machine. (Fig. 4.)

Voltmeter Switch—With one voltmeter switch for each polyphase circuit, one voltmeter, and, for service above 600 volts, the necessary potential transformers, the voltmeter can be connected so as to read the voltage on any phase of any circuit. (Fig. 5.) One key is required for each voltmeter and its group of switches. If more than one group of voltmeter and switches is desired, each group can be supplied with a different key arrangement.

Frequency Meter Switch—With one frequency meter, the necessary potential transformers and one switch for each bus system, the frequency can be read on any bus system. (Fig. 5). One key is required for each frequency meter.

Wattmeter, Watthour Meter, Power Factor Meter and Reactive Factor Meter Switches—With one instrument, one switch with proper labeling and key arrangement for each single or polyphase circuit, and the necessary instrument transformers, readings can be taken on any circuit. (Figs. 6, 7 and 8.) One key is required for each instrument.

Synchronizing Switch for Synchronizing Between Machines—With one synchronoscope equipment, one switch for each machine, and the necessary potential transformers, a synchronizing indication can be obtained between any two machines. (Fig. 9.) One **running key** and one **incoming key** are required. The running key is to be placed in the synchronizing switch of one of the machines running and can be turned in the running position only; the incoming key is to be placed in the synchronizing switch of the machine being brought in and can be turned in the incoming position only. Each switch has a running and an incoming position.

Synchronizing Switch for Synchronizing Between Machine and Bus—With one synchronoscope equipment, one switch for each generator on a single-bus system and two switches for each generator on a double-bus system and the necessary potential transformers, a synchronizing indication between the bus and any incoming machine can be obtained. (Fig. 10.) One key is required.

Synchronizing Switches are listed with and without interlock contacts for the closing circuit of electrically-operated circuit-breakers.

INSTRUMENT SWITCHES—Continued

Construction

Ruggedness and compactness are salient features of the type RS instrument switches. Movable contact members, securely mounted on a substantial bakelite-micarta drum, engage with stamped contact fingers as the drum is rotated to the right or left. The switching element is housed in a substantial bakelite-micarta tube. A segment of the housing is easily removable for inspection and adjustment.

Finish—The operating key is of black moulded material with a polished black finish; the dial-plate markings are polished copper on the raised parts with a black mat background; and the housing is finished in dull black.

Instructions for Ordering

Where switches are shown without keys the style number and list price include the switch complete. Where switches are shown with keys the switch style number and list price include the switch only without key, the necessary key or keys should be ordered extra by style number and at the list price shown.

Prices—Type RS Drum-Type Switches

Description of Switch	Fig. No.	Dimension A Inches Fig. 1	Panel Thickness—1½ Inches				Panel Thickness—2 Inches			
			Switch Style No.	List Price	Key Style No.	List Price	Switch Style No.	List Price	Key Style No.	List Price
Two-Phase Ammeter Switch	2 and 3	3⅛	279055	$11.75	*	*	279054	$11.75	*	*
Three-Phase Ammeter Switch	2 and 3	3⅛	279057	11.00	*	*	279056	11.00	*	*
Three-Circuit Ammeter Switch	2 and 3	6⅝	279059	14.50	*	*	279058	14.50	*	*
Four-Circuit Ammeter Switch	2 and 3	8⅛	279061	20.25	*	*	279060	20.25	*	*
D. C. Single-Circuit Voltmeter Switch	5	4⅛	279063	10.50	279103	$1.75	279062	10.50	279102	$1.75
A. C. Single-Circuit Voltmeter Switch	5	4⅛	279065	10.50	279105	1.75	279064	10.50	279104	1.75
D. C. Two-Circuit Voltmeter Switch‡	5	5⅝	279067	12.00	279103	1.75	279066	12.00	279102	1.75
A. C. Single-Phase Voltmeter Switch	5	5⅝	279069	11.75	279105	1.75	279068	11.75	279104	1.75
A. C. Two-Phase Voltmeter Switch	5	7⅛	279075	13.50	279115	1.75	279074	13.50	279114	1.75
A. C. Three-Phase Voltmeter Switch	5	6⅜	279073	13.75	279113	1.75	279072	13.75	279112	1.75
D. C. Three-Wire Voltmeter Switch	5	7⅛	279077	13.50	279117	1.75	279076	13.50	279116	1.75
Frequency Meter Switch	5	5⅝	279071	9.50	279111	1.75	279070	9.50	279110	1.75
Polyphase Wattmeter or Watthour Meter Switch with Voltage and Current Contacts	6	5⅞	279079	18.25	279119	1.75	279078	18.25	279118	1.75
Polyphase Wattmeter or Watthour Meter Switch with Current Contacts only	6	4	279085	12.75	279119	1.75	279084	12.75	279118	1.75
Power Factor Meter Switch with Voltage and Current Contacts**	7	5⅞	279083	18.25	279123	1.75	279082	18.25	279122	1.75
Power Factor Meter Switch with Current Contacts only	7	4	279089	12.75	279123	1.75	279088	12.75	279122	1.75
Reactive Factor Meter Switch	8	5⅝	279101	17.00	279131	1.75	279100	17.00	279130	1.75
Switch without Interlocks for Synchronizing Between Machines	9	4⅞	279093	14.00	†279126 279127	1.75	279092	14.00	†279124 279125	1.75
Switch with Interlocks for Synchronizing Between Machines	9	6⅜	279095	14.75	†279126 279127	1.75	279094	14.75	†279124 279125	1.75
Switch without Interlocks for Synchronizing to Bus	10	6⅜	279097	13.00	279129	1.75	279096	13.00	279128	1.75
Switch with Interlocks for Synchronizing to Bus	10	7⅞	279099	13.75	279129	1.75	279098	13.75	279128	1.75
Thermo-Couple Switch	4	5½	279091	12.25	*	*	279090	12.25	*	*

*Separate keys not required.

†Two keys—one of each style are required for synchronizing between machines.

‡This switch can be used as a single-circuit 600-volt railway switch.

Approximate weight of switch with key — net, 3 pounds; shipping, 5 pounds.

**If three voltage contacts are required, order reactive factor meter switch with power factor meter dial plate at same list price as standard reactive factor meter switch.

Order by Style Number

INSTRUMENT SWITCHES—Continued

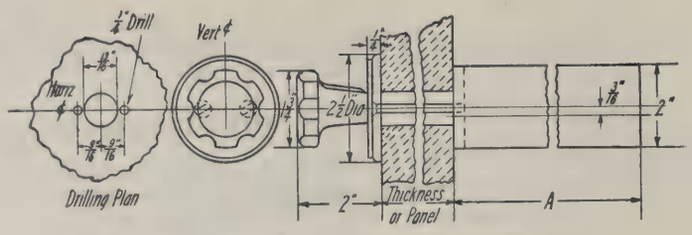


FIG. 1—OUTLINE DIMENSIONS AND DRILLING PLAN

DIAGRAMS OF CONNECTIONS

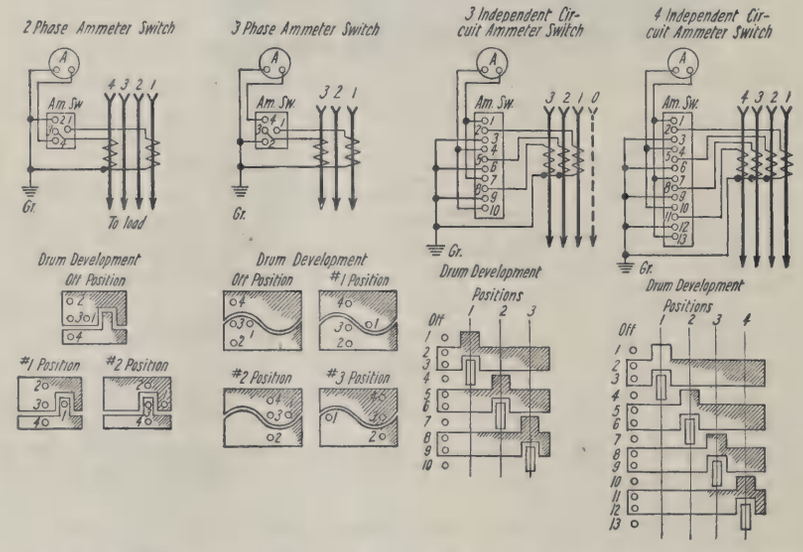


FIG. 2—TWO AND THREE-PHASE, AND THREE AND FOUR-CIRCUIT AMMETER SWITCHES

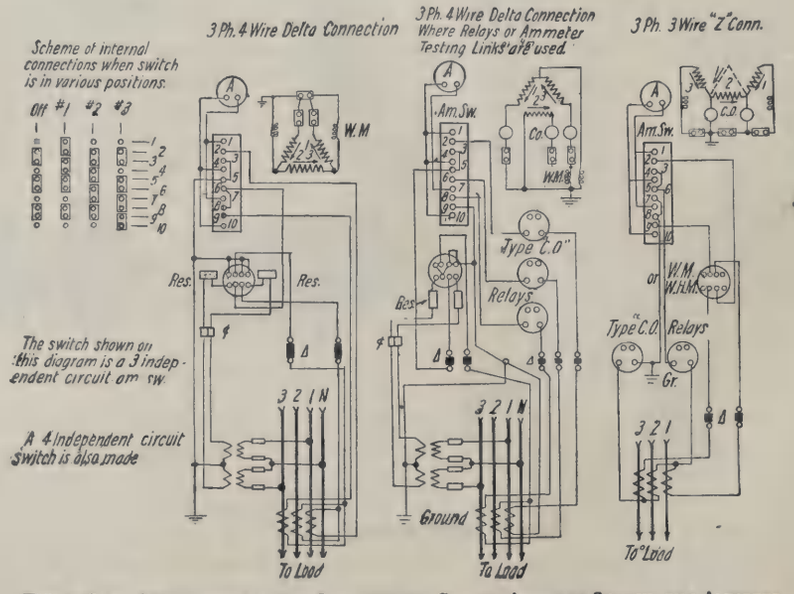

Scheme of internal connections when switch is in various positions.
Off
#1
#2
#3
3 Ph. 4 Wire Delta Connection
3 Ph. 4 Wire Delta Connection Where Relays or Ammeter Testing Links are used
3 Ph. 3 Wire "Z" Conn.
W.M.
Res.
Type C.O. Relays
or W.M. W.H.M.
The switch shown on this diagram is a 3 independent circuit am. sw.
A 4 independent circuit switch is also made
Ground
To Load

FIG. 3—SOME APPLICATIONS OF THE INDEPENDENT CIRCUIT AMMETER SWITCH, THE AMMETER BEING USED IN CONNECTION WITH OTHER INSTRUMENTS

INSTRUMENT SWITCHES—Continued

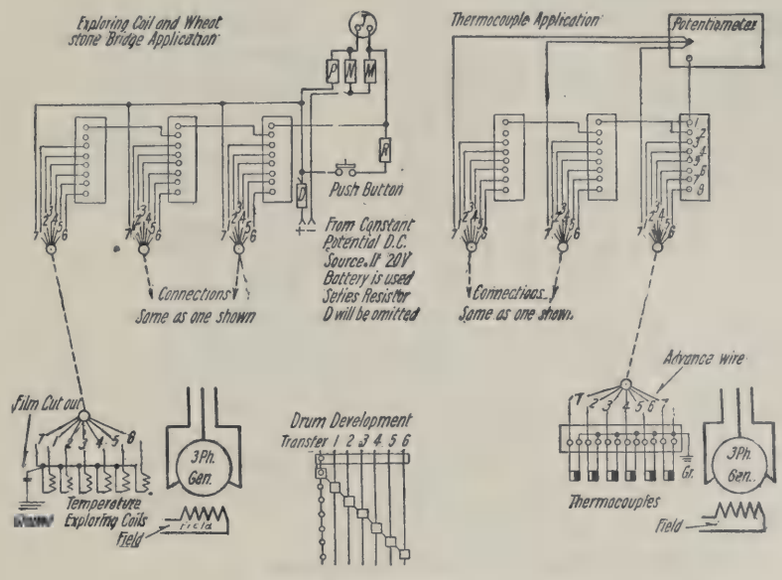


FIG. 4—THERMO-COUPLE OR POTENTIOMETER SWITCHES

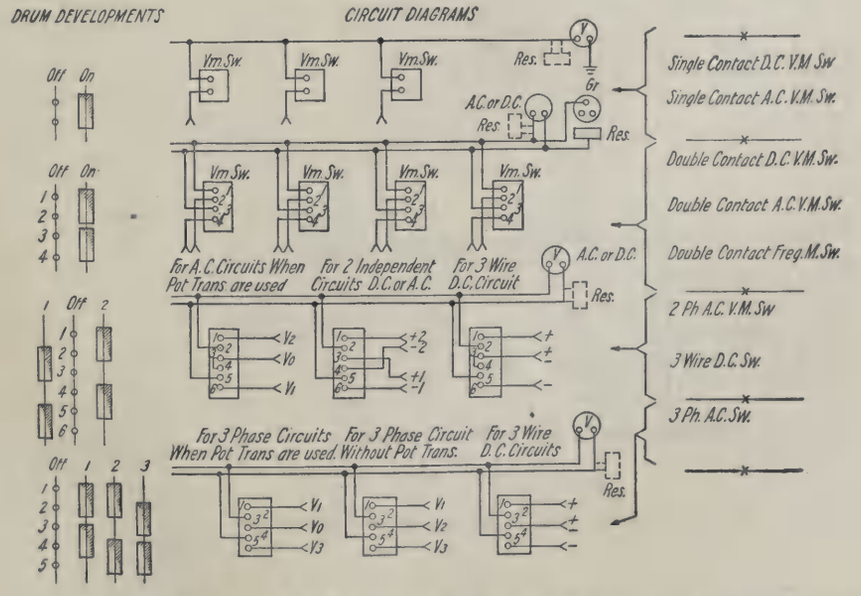

DRUM DEVELOPMENTS
CIRCUIT DIAGRAMS
Vm Sw.
Res.
A.C. or D.C.
Single Contact D.C. V.M. Sw
Single Contact A.C. V.M. Sw.
Double Contact D.C. V.M. Sw.
Double Contact A.C. V.M. Sw.
Double Contact Freq. M. Sw.
2 Ph. A.C. V.M. Sw
3 Wire D.C. Sw.
3 Ph. A.C. Sw.
For A.C. Circuits When Pot Trans. are used
For 2 Independent Circuits D.C. or A.C.
For 3 Wire D.C. Circuit
For 3 Phase Circuits When Pot Trans are used
For 3 Phase Circuit Without Pot Trans.
For 3 Wire D.C. Circuits

FIG. 5—A. C. AND D. C. VOLTMETER AND FREQUENCY METER SWITCHES

INSTRUMENT SWITCHES—Continued

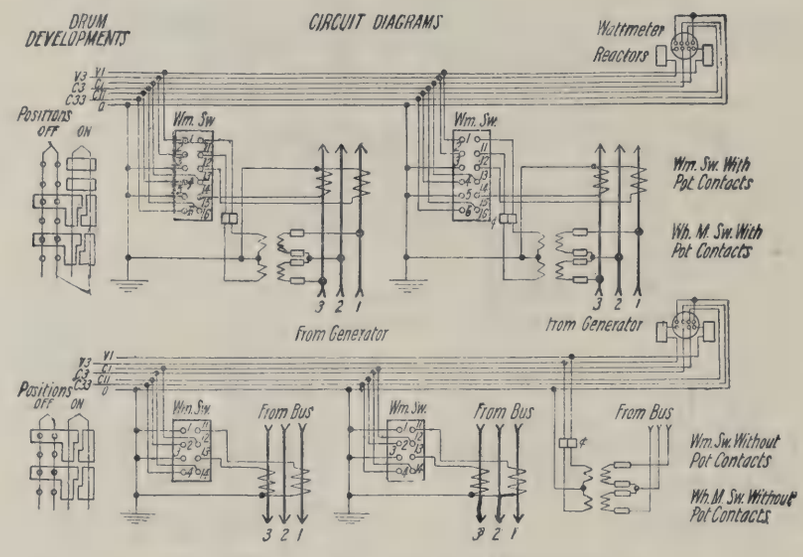


FIG. 6—WATTMETER AND WATTHOUR METER SWITCHES

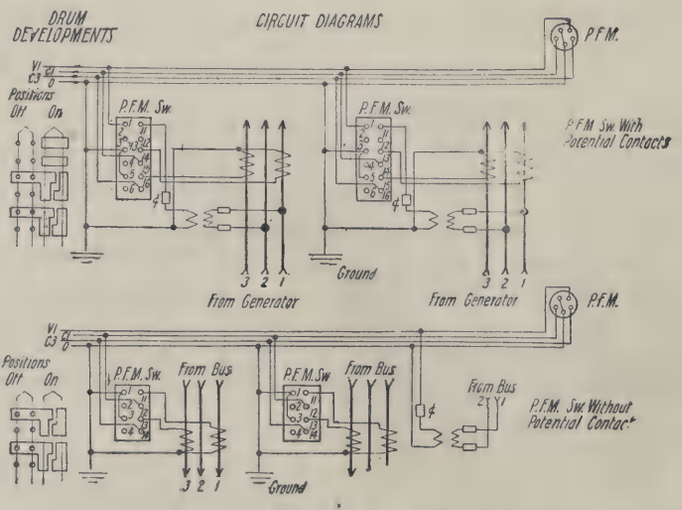


FIG. 7—POWER FACTOR METER SWITCHES*

*With [redacted] voltage coil and two current coils.

INSTRUMENT SWITCHES—Continued

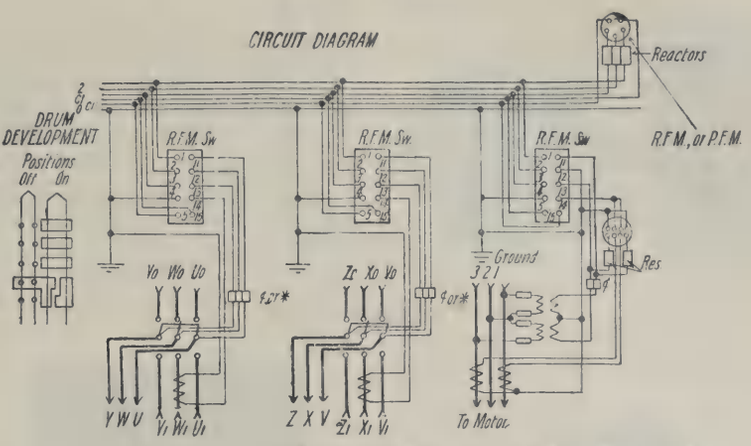


FIG. 8—REACTIVE FACTOR AND POWER FACTOR METER SWITCHES*

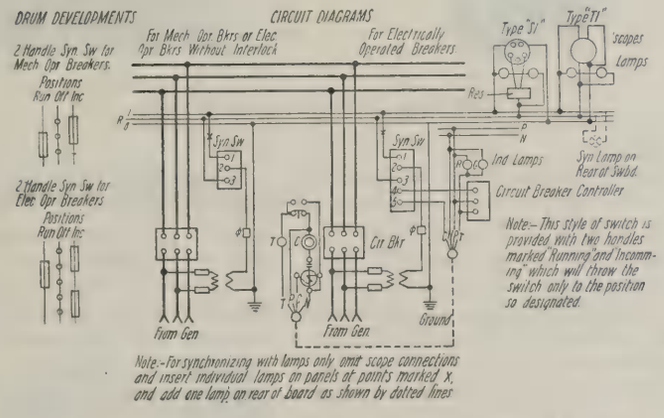

DRUM DEVELOPMENTS
CIRCUIT DIAGRAMS
2 Handle Syn Sw for Mech Opr Breakers.
Positions
Run Off Inc
2 Handle Syn Sw for Elec Opr Breakers
Positions
Run Off Inc
For Mech Opr Bkrs or Elec Opr Bkrs Without Interlock
For Electrically Operated Breakers
Type "S"
Type "T"
scopes
Lamps
Res
Syn Sw
Ind Lamps
Syn Lamp on Rear of Swbd.
Circuit Breaker Controller
Note:- This style of switch is provided with two handles marked "Running" and "Incomming" which will throw the switch only to the position so designated.
Cir Bkr
From Gen
Ground
Note.-For synchronizing with lamps only omit scope connections and insert individual lamps on panels at points marked X, and add one lamp on rear of board as shown by dotted lines

FIG. 9—SYNCHRONIZING SWITCH FOR SYNCHRONIZING BETWEEN MACHINES

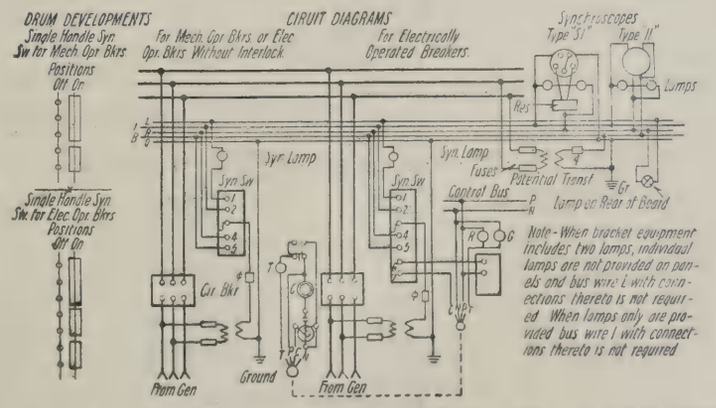

DRUM DEVELOPMENTS
CIRUIT DIAGRAMS
Single Handle Syn Sw for Mech. Opr. Bkrs.
Positions
Off On
Single Handle Syn Sw for Elec. Opr. Bkrs
Positions
Off On
For Mech. Opr. Bkrs. or Elec Opr. Bkrs Without Interlock
For Electrically Operated Breakers.
Synchroscopes
Type "S"
Type "T"
Lamps
Res
Syn Lamp
Syn Sw
Syn Lamp Fuses
Potential Transf
Control Bus
Lamp on Rear of Board
Cir Bkr
From Gen
Ground
From Gen
Note - When bracket equipment includes two lamps, individual lamps are not provided on panels and bus wire L with connections thereto is not required. When lamps only are provided bus wire I with connections thereto is not required

FIG. 10—SYNCHRONIZING SWITCH FOR SYNCHRONIZING BETWEEN BUS AND ANY MACHINE

*With one current coil and two voltage coils.

PLUG TYPE

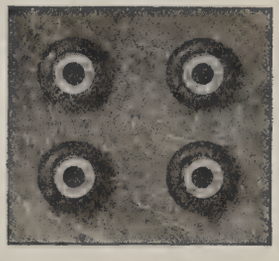
Westinghouse plug-type instrument switches are used for connecting one voltmeter, ammeter, or power factor meter to any one of several generators, and for making the multipoint connections required when synchronizing generators.

These switches have the same general construction as the plug-type field and arc-lamp switches listed on a preceding page; the contacts hold the plug securely in the receptacle so that it cannot be accidentally knocked out of place, after being put in position. Contact surfaces are large for rated current capacity and the rise of temperature is slight.

The terminals supplied admit of readily making neat and secure connection of all wires to the switch.

For Voltmeter Circuits

STYLE NO. 5136



STYLE NO. 5135

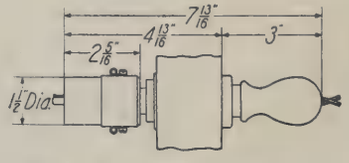
FOR SWITCHBOARD VOLTMETER CIRCUITS

For Switchboard-Voltmeter Circuits—Receptacles for voltmeter circuits are listed with single, four, six, or eight points. The metal parts are recessed in a bushing of insulating material so as to avoid danger of accidental short circuits. The separate sockets are spaced in such a way that the plug cannot be inserted wrongly, it thus being impossible to short-circuit the line through the fuses. The single point receptacle cannot be used alone; as four, six, or eight are required to form the four, six, and eight point receptacles, respectively.

Where it is desirable to have a voltmeter plug switch on one side of the line only, such as railway circuits, the two-point ground detector plug Style No. 5262 and two single point receptacles Style No. 30780 are used.

One-ampere enclosed fuses should be used in all the circuits.

For Portable-Voltmeter Circuits—Receptacle and plug, Style Nos. 76824 and 76823 respectively, are used for connecting a portable voltmeter in parallel with the switchboard voltmeter for the purpose of testing the accuracy of the latter. A lamp cord running through the end of the handle of the plug connects with the portable instrument, while the receptacle is permanently wired up to the switchboard instrument.



STYLE NOS. 76823 AND 76824

Style number and list price of the multipoint receptacles include receptacles only without base.

Maximum Volts	Description	Number Points	Panel Thickness, Inches	Style No.	List Price
		For Switchboard Voltmeters			
600	Receptacle	1	1¼ to 2	259164	$ 60
600	Plug	4	.....	5136	2 20
600	Receptacle	4	1¼ to 2	259166	1 70
600	Receptacle	6	1¼ to 2	259167	2 50
600	Receptacle	8	1¼ to 2	259168	3 50
		For Portable Voltmeters			
600	Plug	..	.....	76823	5 60
600	Receptacle	..	1¼ to 2	76824	7 50

Order by Style Number

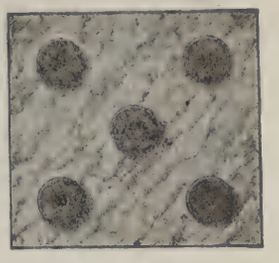
INSTRUMENT SWITCHES—Continued

For Ground Detector Circuits

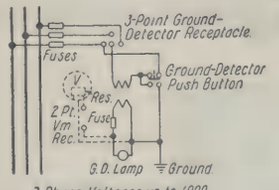
These plugs and receptacles are used with high potential push buttons, Style Nos. 4772, 4944 and 5796, described and listed on a later page, and a voltmeter or lamp to indicate the existence of a ground on one, two, or three-phase circuits. For circuits of voltage over 125, switchboard transformers or the necessary lamps in series are required. See the upper figure of Diagram of Connections.

Another form, the bayonet type, of ground-detector receptacle and plug is listed. These require small space on the front of the panel. This switch connects the transformer to the line or the ground, the line connection being made in order to indicate that the testing circuit is not defective. See the lower figure of Diagram of Connections; this diagram shows three-phase only, the number of points of the three-point receptacle being one less for single phase and one greater for two-phase. The voltmeter connections, shown dotted, are used when it is desired to read voltage by means of the ground detector receptacles. Two only of the three voltages can be read. The two-point voltmeter receptacle shown in the diagram consists of two single receptacles Style No. 30780 and the two-point plug Style No. 5262 listed under ground detector switches.

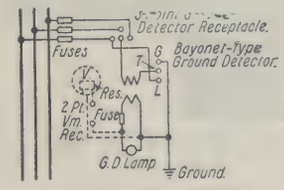
STYLE NO. 5262



STYLE NO. 5263

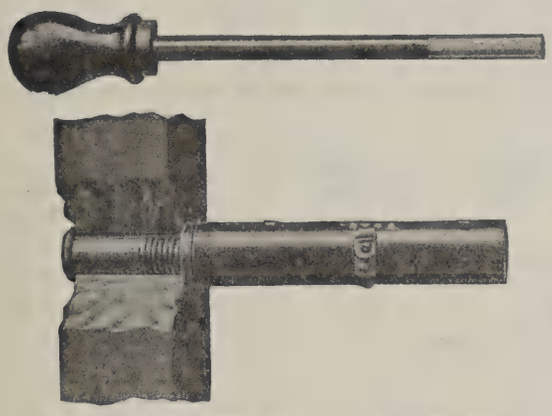


3 Phase, Voltages up to 1000.

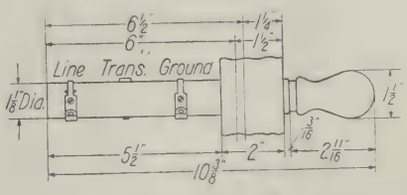


3 Phase, 1100 to 3300 Volts.

DIAGRAM OF CONNECTIONS FOR GROUND DETECTOR CIRCUITS



PLUG, STYLE NO. 76826; RECEPTACLE, STYLE NO. 76827



STYLE NO. 76825

Style number and list price of the multipoint receptacles include receptacles only without base.

Capacity Amps.	Maximum Volts.	Interrupting Capacity, Amps.	Description	Number Points	For Circuits Phase	Panel Thickness, Inches	Style No.	List Price
			Multiple-Point Form					
1	1000	1	Duranoid-and brass plug	2	..	.....	5262	$1 70
1	1000		Receptacle	1	..	1¼ to 2	30780	1 70
1	1000	1	Receptacle	2	1	1¼ to 2	5590	3 50
1	1000	1	Receptacle	3	3	1¼ to 2	5591	4 70
1	1000	1	Receptacle	4	2	1¼ to 2	5263	5 75
1	1000	1	Receptacle	4		1½	97456	3 60
1	3300	1	Plug	2	..	2	97457	3 60
1	3300	1	Plug	2	..		99080	5 10
1	3300	1	Receptacle	2	1	1½ to 2	99081	6 90
1	3300	1	Receptacle	3	3	1½ to 2	99082	9 00
1	3300	1	Receptacle	4	2	1½ to 2		
			Bayonet Form					
1	3300	1	Switch Com.	2	..	1¼ to 2	76825	6 80
1	3300	1	Plug only	..	..	1¼ to 2	76826	2 40
1	3300	1	Recept. only	2	..	1¼ to 2	76827	4 35

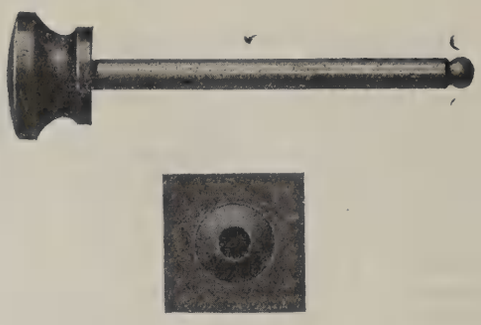
Order by Style Number

INSTRUMENT SWITCHES—Continued

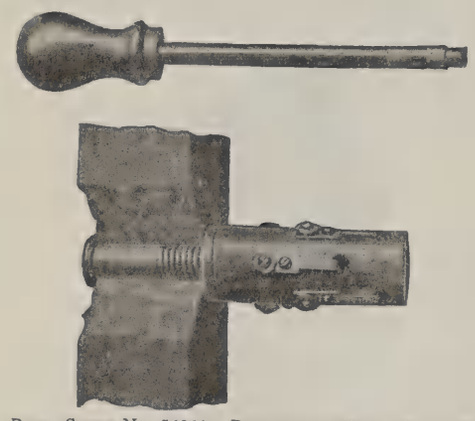
For Synchronizing Circuits

These plugs and receptacles are used for making connections to synchronizing instruments. Style Nos. 56822 and 56823 have, in addition to the contacts for making the connections to the synchronizing instruments, a set of contacts of 40 amperes capacity through which the control circuit of the electrically operated generator circuit-breaker may be connected so that the generators can be thrown on the bus-bars only when the synchronizing instruments are in circuit.

See Diagram of Connections.



PLUG, STYLE NO. 5307. RECEPTACLE, STYLE NO. 5306



PLUG, STYLE NO. 56364. RECEPTACLE, STYLE NO. 56365

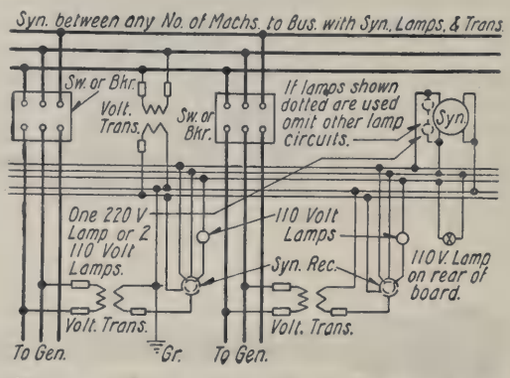
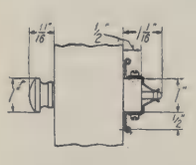

Syn. between any No. of Machs. to Bus. with Syn. Lamps. & Trans
Sw. or Bkr.
Volt. Trans.
Sw. or Bkr.
If lamps shown dotted are used omit other lamp circuits.
Syn.
One 220 V Lamp or 2 110 Volt Lamps.
110 Volt Lamps
Syn. Rec.
110 V. Lamp on rear of board.
Volt. Trans.
Volt. Trans.
To Gen.
Gr.
To Gen.

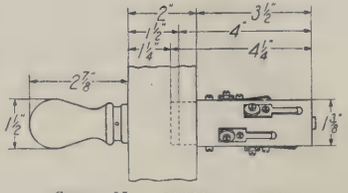
DIAGRAM OF CONNECTIONS FOR SYNCHRONIZING CIRCUITS

Capacity Amps.	Max. Volts	Interrupting Capacity, Amps.	Description	Number Points	Panel Thickness inches	Style No.	List Price
1	500	1	Plug	2 or 3	.....	5307	$1 40
1	500	1	Plug	6	.....	56364	2 40
1	500	1	Plug	6	.....	56822	3 35
1	500	1	Receptacle	2	1¼ to 2	5306	1 90
1	500	1	Receptacle	3	1¼ to 2	25376	3 00
1	500	1	Receptacle	6	1¼ to 2	56365	4 70
1	500	1	Receptacle	6	1¼ to 2	56823	5 00

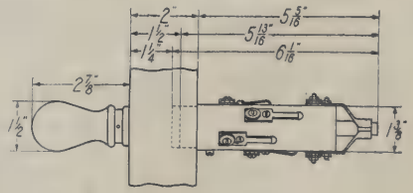
Order by Style Number



STYLE NOS. 5307, 5306 AND 25376



STYLE NOS. 56364 AND 56365



STYLE NOS. 56822 AND 56823

INSTRUMENT SWITCHES—Continued

PUSH BUTTON TYPE SWITCHES

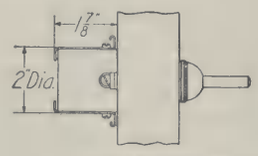
For Ground Detector and Auxiliary Circuits

STYLE No. 7034

STYLE No. 4772

Two forms of these push button switches are listed. In the first, Style No. 7034, the circuit is normally open and pushing the button closes it. In the second form, Style Nos. 4944, 5796 and 4772, one contact is normally closed while the other is normally open; pushing the button opens the first contact and then closes the second.

For other forms of push button switches see "Carbon Circuit-Breaker Accessories."



STYLE NOS. 4944, 5796 AND 4772

Capacity Amps.	Maximum Volts	Interrupting Capacity Amps.	Number Contacts	Panel Thickness Inches	Style No.	List Price
1	125	1	Single	1 to 2	7034	$1 00
1	1000	1	Double	1¼	4944	9 15
1	1000	1	Double	1¼	5796	9 15
1	1000	1	Double	2	4772	9 15

Order by Style Number

FIG. 1

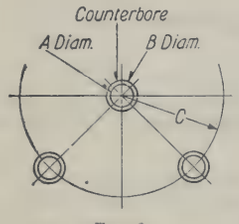


FIG. 2

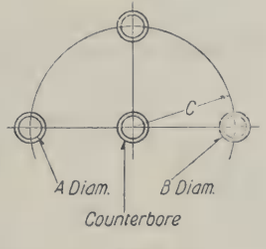


FIG. 3

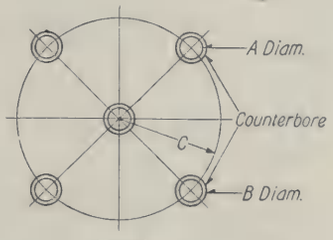


FIG. 4

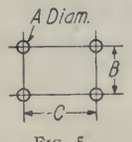


FIG. 5

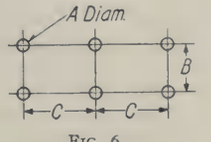


FIG. 6

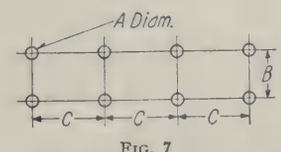


FIG. 7

Style No.	Fig. No.	Dimensions in Inches A	B	C
4772	1	13/16	..	...
4944	1	13/16	..	...
5135	5	½	2	1½
5263	4	7/16	..	1¾
5306	1	7/16	..	...
5523	6	½	2	1½
5590	2	7/16	..	1¾
5591	3	7/16	..	1¾
5796	1	13/16	..	...
6745	7	½	2	1½
7034	1	¾	..	...

Style No.	Fig. No.	Dimensions in Inches A	B	C
25376	1	7/16	..	...
56365	1	13/16	..	...
56823	1	13/16	..	...
76824	1	13/16	...	...
76825	1	13/16	...	...
99080	2	½	11/16*	2¼
99081	3	½	11/16*	2¼
99082	4	½	11/16*	2¼
.....	..	..	...	...
.....	..	..	...	...
.....	..	..	...	..

*Counterbore 1-inch deep for 2-inch panel and ¾-inch deep for 1½-inch panel.
These dimensions are for reference only. For official dimensions apply to nearest district office.

APPLICATION OF CARBON CIRCUIT-BREAKERS

Temperature—The current-carrying parts adjacent to the contact surfaces of Westinghouse carbon circuit-breakers will carry their full-rated current continuously with a maximum temperature rise of either 20 degrees or 30 degrees Centigrade, above the temperature of the surrounding atmosphere, and should be applied according to the class of service as recommended below:

Note—It is essential that adjacent apparatus does not heat the breaker; that conductors to the breaker are ample to carry the current with a temperature rise not exceeding that of the breaker; and that reasonable ventilation is provided.

The 20-degree rise basis is recommended when the maximum temperature of the air where the breaker is located may approximate 40 degrees Centigrade and the load is practically continuous as on generator, rotary, or transformer circuits. When operating conditions are particularly severe, carbon circuit-breakers should be applied on a 12-degree rise basis. This basis will be explained on request.

The 30-degree rise basis is recommended where the maximum temperature of the air where the breaker is located may approximate 30 degrees Centigrade or less, or the load is intermittent as on feeder circuits.

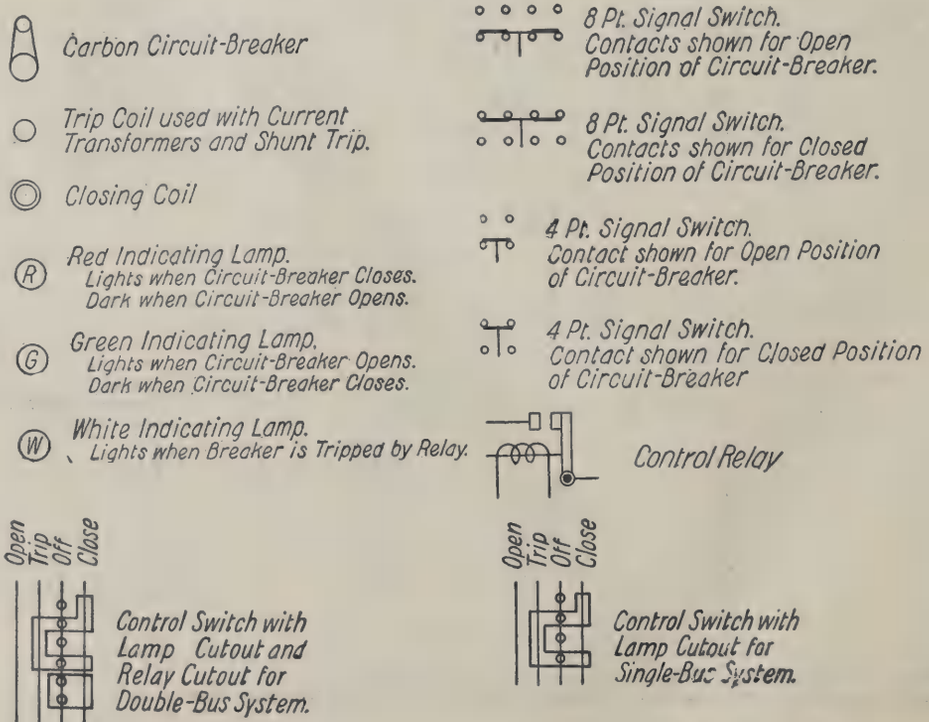
The insulated coils of Westinghouse carbon circuit-breakers will carry their full-rated current continuously with a maximum temperature rise of 50 degrees Centigrade above the temperature of the surrounding atmosphere.

Current Ratings—The current ratings shown for all carbon circuit-breakers listed in this catalogue are maximum, based on the allowable temperature rise that is reached after a continuous run of approximately one hour or more at the rated current.

Application of Rating—Inasmuch as a circuit-breaker reaches its final temperature quickly with steady current load, it is necessarily a maximum-rated device. In selecting a breaker, it is therefore recommended that the rated capacity should be at least as great as the maximum rated one-hour (or more) overload current of the apparatus that the breaker will be required to control. Thus, if the full-load current of a maximum-rated machine is 2000 amperes, a 2000-ampere-rated circuit-breaker can be applied to handle the current of this machine. If the machine, however, has a 25 per cent overload rating of an hour or more, a 2500-ampere circuit-breaker must be selected.

Owing to the "skin-effect" and eddy-current heating in alternating-current conductors, a circuit-breaker with the same rise in temperature has a lower alternating-current rating than direct-current rating. Also, on 25-cycle service a circuit-breaker

Key to Symbols Used in Diagrams


Carbon Circuit-Breaker
Trip Coil used with Current Transformers and Shunt Trip.
Closing Coil
Red Indicating Lamp. Lights when Circuit-Breaker Closes. Dark when Circuit-Breaker Opens.
Green Indicating Lamp. Lights when Circuit-Breaker Opens. Dark when Circuit-Breaker Closes.
White Indicating Lamp. Lights when Breaker is Tripped by Relay.
8 Pt. Signal Switch. Contacts shown for Open Position of Circuit-Breaker.
8 Pt. Signal Switch. Contacts shown for Closed Position of Circuit-Breaker.
4 Pt. Signal Switch. Contact shown for Open Position of Circuit-Breaker.
4 Pt. Signal Switch. Contact shown for Closed Position of Circuit-Breaker
Control Relay
Open Trip Off Close
Control Switch with Lamp Cutout and Relay Cutout for Double-Bus System.
Open Trip Off Close
Control Switch with Lamp Cutout for Single-Bus System.

above 300 amperes rating will carry, continuously, considerably more than its 60-cycle rating.

Interrupting Capacity—While the interrupting capacities of Westinghouse types CD, CC, and CA carbon circuit-breakers meet the requirements of the National Electrical Code, and in the case of the type CA are considerably greater, it should be noted that the types CD and CC breakers should not be connected too closely to apparatus or bus-bars capable of delivering larger amounts of power than specified in the Code. The relatively small wires ordinarily used to connect these lower-capacity circuit-breakers with sources of power should be such as to introduce sufficient resistance to limit the current that can be drawn through the breaker under short-circuit conditions to the amount specified in the Code.

DIAGRAMS OF CONNECTIONS FOR CARBON CIRCUIT-BREAKERS

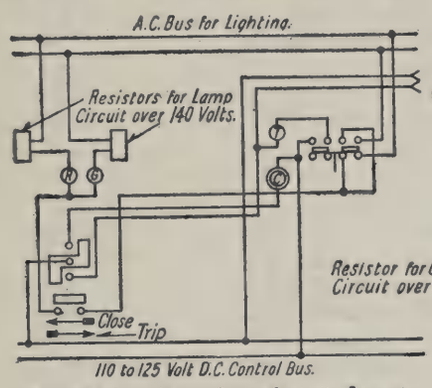


FIG. 1

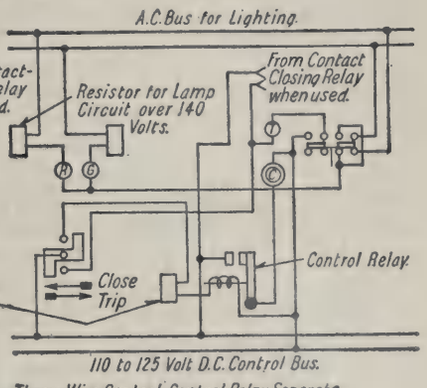


FIG. 2

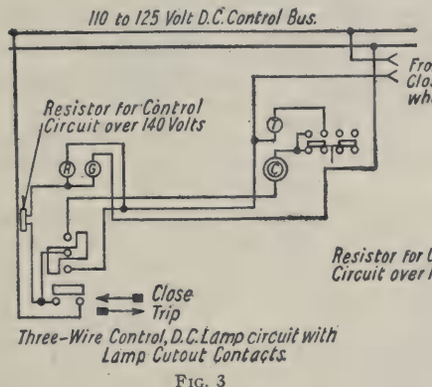


FIG. 3

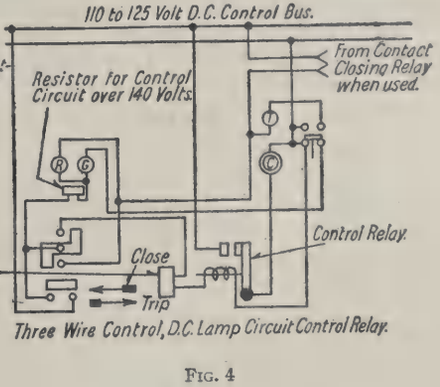


FIG. 4

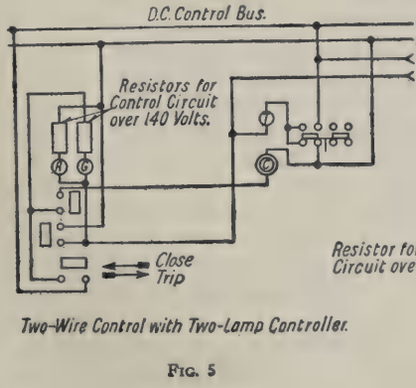


FIG. 5

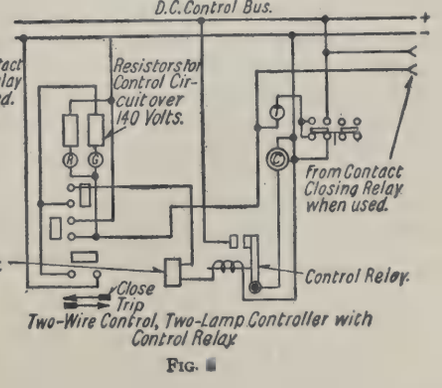
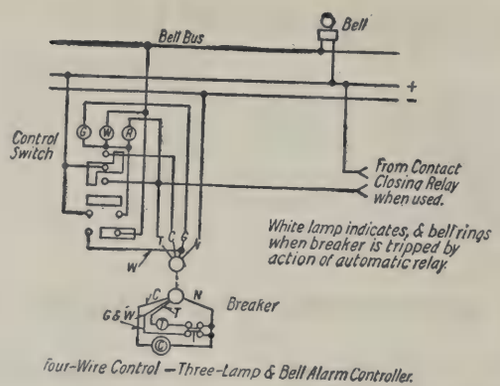


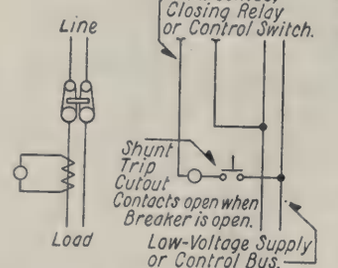
FIG. 6

APPLICATION OF CARBON CIRCUIT-BREAKERS—Continued



Four-Wire Control — Three-Lamp & Bell Alarm Controller.

FIG. 7



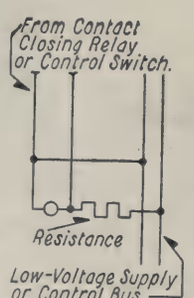
Connections for Underload Trip Coil with Hand Resetting Mechanism.

FIG. 11

From Contact Closing Relay or Control Switch.
Shunt Trip Cutout Contacts open when Breaker is open.
Low-Voltage Supply or Control Bus.

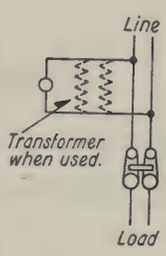
Connections for Shunt Trip Coil to Shunt Trip Cutout Contacts.

FIG. 12



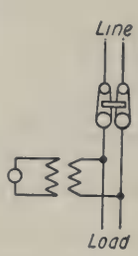
Connections for Undervoltage Trip Coil used with Resistance as a Shunt Trip.

FIG. 13



Connections for Self-resetting Type of Undervoltage Trip Device.

FIG. 14



Connections for Hand-resetting Undervoltage Trip Device.
Connection also applies for Overvoltage Trip.

FIG. 15

CARBON CIRCUIT-BREAKERS, GENERAL

Types CD, CC and CA

What to Look For in any Carbon Circuit-Breaker

While the various uses to which carbon circuit-breakers are subjected may require different features in details, certain common points are demanded by modern practice for every breaker. In selecting a breaker it is important, therefore, that the following points be given consideration:

Space Required—The modern tendency is to economize in space wherever possible. So much apparatus must be installed in so little space that it is often necessary to choose the smaller of two similar pieces of apparatus. A circuit-breaker that gives the required performance, and at the same time is small, often means considerable saving in space.

Good Contact—It is essential that there be good contact between the current-carrying parts of a breaker in order to obtain the maximum current rating. Poor contact produces local heating.

Efficiency—A millivolt drop as low as possible is desirable in a circuit-breaker. This is best obtained by having perfect contacts and current-carrying parts of ample size.

Carrying Capacity—The carrying capacity of a breaker depends on the contact and conductivity losses, the degree of ventilation, and the allowable temperature rise. The last point is of special significance. In comparing the capacities of different breakers, the allowable temperature rise must be taken into account in order to provide the same basis of rating for each breaker; otherwise the ratings will not afford a true comparison of capacities.

Easy Closing—In order that a circuit-breaker give the best service it must be easy closing.

Positive Holding—To obtain good service on the system, the breaker must be "positive holding", that is, when it is closed, it must stay closed until tripped by one of its tripping devices. Vibration or stray fields should not open it.

Positive and Quick Release—When a breaker opens, whether tripped by the operator, by overload, or by any other means, it is absolutely essential that its release be positive and quick so that it breaks the circuit instantly. It should never open sluggishly.

Self-Cleaning Contacts—Dust and other foreign particles are liable to lodge on the contacts of carbon circuit-breakers. Repeated opening of the breakers under load will burn the contacts slightly, making them rough. In order that the dust may be cleaned off and that the slightly rough surface may be kept smooth, a breaker should have a self-cleaning action, that is, its contacts should be so arranged that there is a slight wiping action between them when they are opened and closed.

Easy Adjustment—A circuit-breaker should be easily adjusted, but when set, its adjustment should be permanent until changed by the operator.

Reliability—A circuit-breaker must be reliable. It should have positive operation under all conditions. Better have none on the line at all than have one that cannot be depended upon.

Simplicity—Intricate mechanism in a circuit-breaker means endless trouble. Simplicity should be looked for in every part.

Facility for Repairs—Accidents that cannot be foreseen are always liable to happen, and repairs must be sometimes made to the best breaker. A circuit-breaker should be so designed as to facilitate repairing, and thus cause the least possible delay in putting it back in service.

Caution—It should be noted, however, that no carbon circuit-breakers are suitable for operation in cement or flour mills, plaster or furniture factories, or any similar industry where acid fumes or excessive dust and dirt are present. For operation in such locations, the installation of oil-circuit breakers is strongly recommended.

Where carbon circuit-breakers are installed in places subject to an accumulation of dust and dirt, special care should be taken to keep the contacts clean and bright. Circuit-breakers that in the course of operation are rarely opened, should be regularly opened and cleaned by the attendant to insure good contact. In these applications, circuit-breakers should be applied on the 20-degree temperature rise basis.

National Board of Fire Underwriters' Approval—All Westinghouse carbon circuit-breakers meet requirements of National Board of Fire Underwriters.

Distinctive Features

Among the distinctive features of the Westinghouse types CD, CC and CA carbon circuit-breakers are: exceptional ruggedness and neatness of appearance; simplicity of construction, operation, and installation; few parts, all easily accessible, and those parts likely to require replacement, easily renewable; great compactness, thus saving in space; long rigid carbon arms, giving long break of arcing members; current-carrying parts of ample size that no portion of breaker will exceed guaranteed temperature rise; main moving contacts are laminated copper brushes, self-wiping or self-cleaning; auxiliary contacts in addition to main contacts; self-aligning self-cleaning carbon contacts; contact pressure adjustable; low resistance from main contacts to carbon-arcing contacts; small millivolt contact drop; very simple toggle mechanism; all breakers trip easily, quickly and positively; auxiliary tripping and signalling attachments are easily applied.

Construction

In Westinghouse types CD, CC and CA carbon circuit-breakers special attention has been given the

problem of keeping the size of breakers down to a minimum for the required performance. The construction is such that the best possible ventilation is secured, the object being to obtain the maximum radiating surface on all current-carrying parts, and thus insure a breaker of the highest current-carrying capacity for its size.

Operating Mechanism—On the mechanically operated breakers, the closing mechanism consists of the operating handle and the toggle mechanism connecting the handle lever and the main contact arm. On the electrically operated breakers, the closing is effected by means of a direct-current solenoid mounted below the main mechanism. The solenoid plunger is connected to the closing mechanism in such a way that when current flows through the solenoid and the plunger is drawn down, the main contacts are closed.

The contacts of these breakers are held closed automatically by a trigger, or latch. The various trip mechanisms are constructed to disengage this latch and permit the breakers to open.

Main Contacts—All current-carrying contacts are made of copper. The movable element is a laminated brush composed of several strips of copper and makes an end-on, or butt, contact with the fixed element; this gives a relatively large wiping, or self-cleaning contact when the breaker is closed and insures uniform pressure over the entire contact surface. A high contact pressure is obtained because of the form of mechanism between the handle and contacts. This pressure reduces the heating of the contacts to a minimum and enables a low contact-resistance. A means is provided for adjusting this contact pressure and for equalizing the pressure on both ends of the moving element. For additional information on the main contacts see description of the various types of breakers on the following pages.

The main contact block or fixed element, and the **terminal studs** are of two forms: the round threaded form and the slotted-bar or laminated form for laminated connections. In the smaller capacities below 2500 amperes direct-current, they are made up of drawn round or rectangular copper bar stock, electrobrazed to form the terminal stud and contact blocks. In the larger capacities, higher than 2000 amperes direct-current, they are "pressure moulded" of extremely high-conductivity copper.

The slotted-bar studs are arranged with horizontal laminations in the top stud and vertical laminations in the bottom stud. Vertical laminations in the top stud or horizontal laminations in the bottom stud can be furnished (special) on order.

Auxiliary Contacts—For description of the auxiliary contacts see description of the various types of breakers on the following pages:

Except as hereinafter noted the finish of the Westinghouse types CD, CC, and CA carbon circuit-breakers conform to that of Westinghouse switchboard standards. The exposed copper current-carrying parts are polished and all other parts are black marine.

Multipole Breakers—Westinghouse types CD, CC and CA carbon circuit-breakers are listed with one, two, three, or four poles. Each multipole breaker is provided with a "common trip", that is, an overload on any one pole trips all the poles.

Field-Discharge Breaker—A combined shunt-trip and field-discharge contact is usually supplied with the two-pole form of breaker for use in connection with exciter generators or as main field switches to large alternating-current generators. In this service the breaker is usually made non-automatic as the excitation should only be interrupted at the will of the operator. Reverse-current trip is sometimes applied to this field-discharge form of breaker, when it is used as the exciter-generator main switch or breaker.

Barriers—Multipole breakers for voltages over 300 volts and for all voltages over 125 where the poles are placed closer together than standard spacing, must be supplied with barriers between poles in order to prevent arcing over. Barriers are not included with some of the standard breakers but must be ordered separately (see tables of "Accessories for Carbon Circuit-Breakers").

Operation Characteristics

Temperature—Refer to data in pages on "Application of Carbon Circuit-Breakers".

Dielectric Test—All Westinghouse carbon circuit-breakers are subjected to a dielectric test for one minute between current-carrying parts and ground, and between terminals, of at least twice their rated voltage plus 1000 volts.

Interrupting Capacity—Refer to data in pages on "Application of Carbon Circuit-Breakers".

Methods of Operation

Under average conditions, for simple plants having not over 10,000 ampere 750-volt units, carbon circuit-breakers can be mounted directly on the switch-board panel. Where the requirements exceed these remote-controlled breakers mounted apart from the panel and electrically controlled from the panel by an auxiliary circuit become advisable. For 1500-volt service in capacities up to 2500 ampere the single-pole manually operated remote-control breakers are recommended. Electrically operated remote-controlled breakers are also listed for lower capacities for applications where for other reasons it is preferred not to mount the breaker directly on the panel.

Manual Operation—Manual closing by a handle connected directly to the breaker is the ordinary method of closing carbon circuit-breakers. Pulling down on the handle closes the breaker.

Electric Operation—In the field of power-operated circuit-breakers the Westinghouse Electric & Manufacturing Company has long adopted as standard the direct-current electrical-solenoid magnet method of

closing. This is now used almost universally to the exclusion of various other methods, such as motor, hydraulic and pneumatic closing.

Westinghouse electrically operated carbon circuit-breakers are closed by means of a simple cylindrical magnet mounted below the breaker mechanism. The solenoid is equipped with a dash-pot device that takes care of the shock at the end of the closing operation, and yet permits the breaker to close quickly. When the closing switch is thrown, current flows through the solenoid and the plunger is drawn down. This closes the contacts, which are held closed automatically by a latch. The solenoid plunger rises when the closing circuit is opened, so that it will not retard the opening of the breaker when tripped. The breaker is opened by the automatic overload trip or by the shunt-trip attachment mounted at the side of the breaker mechanism. The breakers can be tripped manually by pushing up on the operating handle or back on the insulated-trip handle near the bottom of the breaker.

Standard closing coils are wound for direct current. Direct-current mechanisms, besides being simpler in construction, more reliable in operation, and more easily kept in repair, are much more economical of space and power than alternating-current mechanisms. Alternating-current shunts and current-transformer-trip coils are available on special order.

The closing and tripping mechanisms are operated by a control switch with or without a control relay (see pages on various types of breakers) in the operating circuit, and usually with signal lamps, all of which are described and listed on pages on "Circuit-Breaker Accessories" in the catalogue on "Oil-Break Switching Equipment". The electric operating mechanism has a small double-throw switch to operate the signal lamps and to open the shunt-trip coil circuit when the circuit-breaker has opened. See Fig. 12 in pages on "Application of Carbon Circuit-Breakers" for diagrams.

Acceleration—On account of the reaction of the laminated moving contact members, no separate means of accelerating the breaker to its open position are necessary. The laminated members, which act as powerful springs, the toggle-lever springs, the secondary contact springs, and the carbon-arm springs, all serve to accelerate the opening of the breaker.

Methods of Mounting

In general, carbon circuit-breakers are listed for either panel or separate mounting. For separate mounting they are furnished mounted on a slate base with black marine finish. When furnished for panel mounting they are shipped mounted on a wooden template for remounting on switchboard panels 2 inches thick.

Methods of Tripping

Non-Automatic breakers are simply switches capable of opening overloads, but opened and closed only at the desire of the operator. They can be made automatic through relays operating on a shunt-trip coil.

Plain-Automatic Overload Trip—All standard overload-trip carbon circuit-breakers are plain-automatic, that is, when closed with an overload on the line, they will remain closed as long as the closing handle is held down or the closing coil is energized, but will not remain closed when the handle is released or the closing circuit is opened. Multipole manually operated breakers of the "double-arm-trip-free type" can be supplied (see "Accessories").

Series Trip—All standard overload-trip carbon breakers are arranged for direct-acting (series) tripping without relays.

Transformer Trip—In some cases breakers used on alternating-current circuits can be supplied on special order for transformer tripping. Breakers used on alternating-current circuits and equipped with shunt-trip coils can be made transformer-trip through relays acting on the shunt-trip coils. For information write to the nearest District Office.

Calibration—The standard range of calibration for automatic-overload trip is from 80 to 160 per cent of the 30 degree rise ampere rating. Breakers can readily be set to trip at any point within their range. Calibration higher than standard can be furnished on special order.

Accessories

Attachments for effecting automatic operation of Westinghouse carbon circuit-breakers are described and listed in this catalogue. Additional auxiliaries for electrically operated circuit-breakers, such as control switches, indicating lamps, etc., are listed in the section on "Westinghouse Oil Circuit-Breakers." For relays see section on "Westinghouse Instruments and Relays." Attachments are mounted on and calibrated with the circuit-breakers at the Works. They are not sold separately except where the purchaser assumes the responsibility of correct application and installation in the field.

Attachments Applied—Any single auxiliary-trip attachment is arranged to trip all poles of a multipole carbon circuit-breaker, and therefore one attachment can be used for all poles. If proper space between poles (or pole centers) is allowed, one attachment per pole can be used, if desired.

For information as to whether the tripping attachments described on the following pages can be applied to a particular type of breaker, see pages of description on that type.

Shunt-Trip Attachment—The shunt-trip attachment enables the breaker to be tripped electrically from some distant point. A direct-current shunt-trip mechanism is included as standard with each electrically operated breaker and can be supplied as an accessory on almost all manually operated break-

ers. If the circuit-breaker is not arranged to cut out the shunt-trip circuit (see description on the various types of breakers), signal contacts described below should be provided to do this when the circuit-breaker trips, as the tripping coils are designed for intermittent service only. These standard shunt-trip coils are made for 125-volt direct-current circuits and will trip the circuit-breaker within a range of from 55 per cent to 115 per cent of the normal voltage. Coils to operate on other direct-current voltages or on alternating-current can be supplied on special order.

Non-automatic breakers can be made automatic through relays operating on the shunt-trip coil.

The automatic undervoltage-trip attachment described below, when supplied with a suitable resistor, can be used as a shunt-trip mechanism by momentarily short-circuiting the coil.

Inverse-Time-Limit Attachment — All inverse-time-limit dash pot with an adjustable time feature can be used with some of the breakers herein listed. This attachment will cause the breaker to trip almost instantly on heavy overload and much more slowly on light overloads, giving the circuit on light overload the chance to clear the trouble before the breaker trips. For information whether an inverse-time-limit attachment can be applied to any particular breaker see description of that breaker or refer to the nearest District Office.

Automatic Undervoltage-Trip Attachment—The undervoltage-trip attachment is used to trip the breaker when the line voltage fails or falls approximately 50 per cent or more under the rated normal voltage. It is of particular advantage in automatically disconnecting a motor from the circuit at the time of temporary interruption of the supply circuit, for should the motor come to rest and still be connected to the line it would be subjected to full voltage upon the power being restored. The automatic undervoltage-trip attachments listed for Westinghouse carbon circuit-breakers are reset by hand or automatically on the opening of the breakers according to description in tables listing them.

Only one undervoltage attachment is necessary with multipole breakers. No additional protection is afforded by the use of a coil across each phase of a two-phase or three-phase circuit for the reason that the motors, when the voltage of one phase fails, will run single-phase and feed back into the idle phase, thus preventing the undervoltage device from acting; but the resulting overload on the working phase, due to the entire load being on that phase, will trip a properly set breaker.

The undervoltage-trip attachment, if supplied with suitable resistor, can be used also as a shunt-trip attachment by momentarily short-circuiting the coil.

Automatic Reverse-Current Trip Attachment—This attachment is particularly applicable to storage battery charging, or the operation of direct-current generators or synchronous converters in parallel, its function being to disconnect the generator from the bus whenever the current reverses due to any cause, as for example, rise in battery voltage, drop in generator voltage, or stopping of the prime mover. It is not affected by an overload in the normal direction, and can be applied to non-automatic breakers where the reverse-current protection only is desired. The automatic reverse-current trip attachment automatically resets itself after the tripping operation and is prompt and reliable in its action. Two windings are provided, one shunt and the other series, the former having a shunt cutout which automatically opens the circuit when the breaker trips. If desired the tripping current may be obtained from a circuit other than that in which the circuit-breaker is connected.

The tripping range can be easily adjusted by means of the calibrating screw. If the shunt coil is supplied with normal voltage, the attachment can be set to trip the breaker at any current value from 5 per cent of normal rating in the reverse direction to 25 per cent of normal rating in the negative, or reverse direction. The amperes required to trip the breaker will be only slightly affected by small changes in voltage.

A series resistance is required in the shunt-coil circuit for the higher voltages.

The magnets of the attachment for types CD and CA circuit-breakers are so arranged that with current flowing in the normal direction, they tend to hold the plunger down, but when the current in the series coil reverses, they tend to lift the plunger and trip the breaker. For small reversals of current, the impulse tending to start the plunger upward is proportional to the product of the volts on the shunt coil and the amperes on the series coil.

Automatic Overvoltage-Trip Attachment—The automatic overvoltage-trip attachment is used principally in connection with storage battery charging, where it is desired to cut off the current supply when the battery becomes fully charged. It may, however, be used in any alternating-current or direct-current circuit which it is desired to open automatically in case of either moderate or abnormal rise in voltage.

On alternating-current circuits and direct-current circuits below 130 volts the coil is connected directly across the circuits, but in direct-current circuits over 130 volts, a series resistance is used. The tripping circuit may be entirely distinct from the breaker circuit.

The tripping range is exceedingly wide, the maximum point being 100 per cent greater than the minimum voltage calibration. No permanent magnets are used in the construction of this attachment. It trips the breaker directly and consequently requires no shunt-trip auxiliary attachment.

Automatic Underload-Trip Attachment — The automatic underload-trip attachment is principally used on storage battery-charging circuits. When the charging current decreases to a certain predetermined value, the breaker is tripped; the circuit is

thus opened and the chance of current flowing back from the battery to the generator and causing trouble is thus avoided. For this application the attachment is generally set to trip at 10 per cent of normal load; but the standard attachments can be set to trip at any point from 10 to 25 per cent.

The automatic underload-trip attachments listed are reset by hand or automatically by the opening of the breaker, according to description in tables listing them.

Signal Contacts—For use as shunt-trip cut-outs and in operating signal lamps, a single-pole double-throw plunger switch that automatically closes one signal circuit when the breaker is closed and another when it is open is listed. This attachment is fastened to the panel and is operated by an insulated rod actuated from the moving main-contact brush of the breaker. It has a switching capacity carrying from 10 amperes at 125 volts to 1 ampere at 750 volts.

Bell-Alarm Contacts—For this service any small double-throw single-pole switch can be used in conjunction with the signal switch above referred to, for indicating by lamps, bells, or other signal, the operation of the breaker. The signal contact switch is connected as a single-pole, double-throw switch; and, in conjunction with the single-pole, double-throw bell-alarm cut-out switch, makes the necessary connections to ring a bell or operate a signal when the breaker is in the position opposite that desired by the operator.

Relays—Where a more reliable time-limit is required for selective operation of circuit-breakers than can be provided by the type of dashpot described above, protective relays should be used in connection with the circuit-breaker shunt-trip coils. For a description of the selective protection possible with relays and for relay connection diagrams, see section on "Westinghouse Instruments and Relays." The use of relays in connection with an auxiliary source of direct-current power for tripping obviates the use of overload coils and time-limit feature on the circuit-breaker.

Control Relays for use in the closing-coil circuit of electrically-operated single-pole and multipole breakers are listed in the section of this catalogue on "Switchboard Accessories." These control relays are not required except as noted on pages on the various types of breakers.

Double-Arm Attachment—The double-arm attachment eliminates the necessity for switches in series with a two-pole single-handle breaker in low-capacity and low-voltage service and at the same time affords automatic protection to the circuit throughout the closing period. With this arrangement, each pole of the breaker is closed independently and in succession, so that the pole first closed is left free to open while the second or final pole is being thrown in. The breaker being closed, an overload in either positive or negative line, or both, will trip both poles simultaneously.

This double-arm common-trip attachment is used with two identical standard single-pole circuit-breakers either front or rear-connected, each with standard single-pole independent closing handle. It can easily be added to breaker already mounted, provided the center to center distance between poles is as given in the table, in which case no modification of the breaker is required to install the attachment.

Where the double-arm feature is desired for two phase four-wire service, we recommend the closing of one leg of each phase with one two-pole single-handle breaker and completing the circuit by closing the remaining two-pole single-handle breaker, using the "double-arm" common trip feature to connect the poles of the four-pole structure.

Trip-Free-on-Overload Attachment—The trip-free-on-overload attachment (also known as "full-automatic-overload trip") on a breaker makes it impossible to hold the breaker in a closed position while a continued overload condition or short-circuit exists on the line.

This feature can be supplied on special order on electrically operated or manually operated remote-controlled breakers.

Full-automatic on "trip-free" operation particularly on direct-hand-controlled carbon breakers is not recommended for high-capacity circuits or for service of over 250 volts, D.C., or 440 volts, A.C. Carbon breakers should not be closed on a circuit under heavy load. Another switch should be used to close the circuit, especially on an overload; otherwise damage to the secondary and carbon contacts, or injury to the operator, may result.

INSTRUCTIONS FOR ORDERING CARBON CIRCUIT-BREAKERS

Style number and **list price include** the breaker complete ready for installation, but without attachments, control switches, signal lamps, or relays.

Rear-connected round-stud breakers are furnished with clamp and contact nuts equivalent to the breaker rating.

A cable terminal (or terminals) is furnished for rear-connected, round-stud breakers on one stud of all poles of types F, CD, CC and CA breakers of 800-ampere capacity and below. Cable terminals for one stud of all poles of 1000 and 1200-ampere capacity type CA breakers will be supplied without extra charge, if specified as a separate item on the breaker order.

Where cable terminals other than those specified above are required, they should be ordered as a separate item. (Nuts and terminals are listed in the section of this catalogue on "Switchboard Accessories").

The panel-mounting breakers are furnished mounted on a wood template, unless otherwise specified in the description on individual types of breakers.

The separate mounting breakers are furnished mounted on a black marine slate base unless otherwise specified in the description on individual types of breakers. It is recommended that multipole electrically operated breakers be ordered on their final mounting bases.

Special circuit-breakers, or those not fully covered by style number, should be ordered (or quotation requested thereon) by referring to the style number of nearest standard breaker and stating: "Same as Style Number.....except....." **(giving, as on all orders):**

Type.

Amperes.

Volts.

Direct-current or alternating-current.

Cycles.

Poles (if multipole, closing handles or magnets desired).

Studs (round or laminated, and if laminated position of lamination).

Method of trip (automatic, non-automatic or with attachments, giving all characteristics).

Method of operation (manually operated direct-control; manually operated remote-control; electrically-operated, with range of voltage; 125 volts direct-current is standard).

Mounting (panel or separate—if separate, characteristics of base as to thickness, etc.).

Accessories (as designated, with full characteristics).

Terminals (when ordered give size and number of cables per stud).

Maximum temperature in degrees of surrounding air, and, in addition, where breakers are to be duplicates of breakers previously furnished, give order number or style numbers.

Attachments that are to be assembled with the breaker should be specified as part of the circuit-breaker item and fully described therein.

Control accessories not assembled as part of the breaker should be specified as separate items.

Westinghouse Carbon Circuit Breakers are not an experiment — their dependability has been proved by years of service

TYPE CD CARBON CIRCUIT-BREAKERS

FIG. 1—SINGLE-POLE REAR-CONNECTED BREAKER WITH OVERLOAD TRIPPING COIL—50 AMPERES, 600 VOLTS

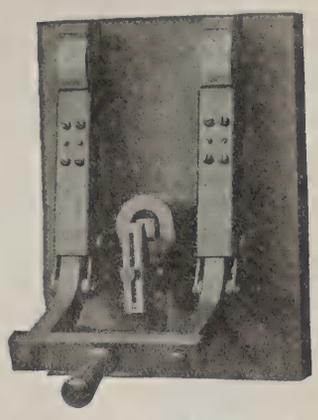


FIG. 2—TWO-POLE REAR-CONNECTED BREAKER WITH ONE OVERLOAD TRIPPING COIL—100 AMPERES, 300 VOLTS

Type CD carbon circuit-breakers are supplied for separate or panel mounting. They may be used for motor-starting, control of industrial circuits and as feeder circuit-breakers in moderate size.

Capacity—These breakers are supplied for voltages up to 750 and for capacities up to 300 amperes.

Calibration—Unless otherwise specified on order, the single-pole and double-pole breakers are calibrated on direct current, and three-pole and four-pole breakers on 60-cycle alternating current. Any other calibration can be obtained if so ordered.

Material—Punchings of wrought material are used throughout, thus giving a breaker that is small for its capacity while at the same time exceptionally strong and durable.

Main Contacts—The main or brush contact is made of laminated copper having high-pressure contact with an excellent wiping or self-cleaning action. When the breaker is opened, the main contact is opened first and the current is shunted upward through auxiliary contacts where the circuit is broken.

Auxiliary Contacts—The secondary contacts are of flat Phosphor Bronze. The arcing contacts are of carbon and have a wiping action, making them self-aligning and self-cleaning.

Multipole Breakers—Multipole type CD breakers are regularly supplied with a single closing handle but can be furnished with separate handles when so ordered.

Barriers between poles of multipole breakers are supplied where the voltage exceeds 300. The

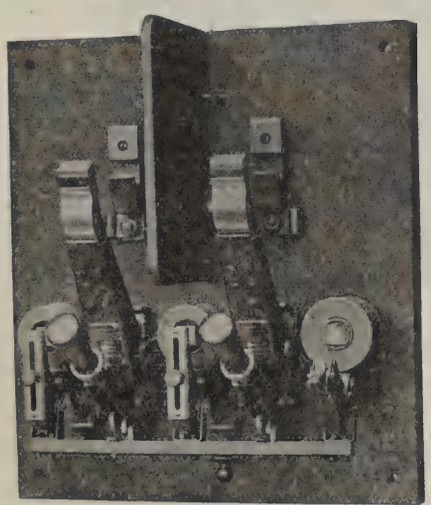


FIG. 3—TWO-POLE FRONT-CONNECTED BREAKER WITH SEPARATE CLOSING HANDLES AND COMMON TRIP, ONE UNDERVOLTAGE, AND TWO OVERLOAD TRIPPING COILS—100 AMPERES, 600 VOLTS

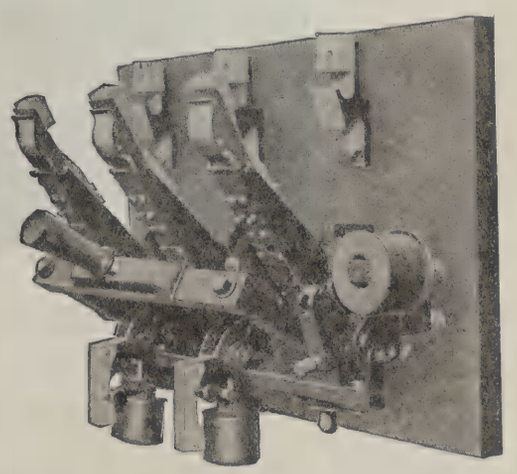


FIG. 4—THREE-POLE REAR-CONNECTED BREAKER WITH INVERSE-TIME-LIMIT AND UNDERVOLTAGE RELEASE—150 AMPERES, 300 VOLTS

voltage should therefore be specified in every order.

Mounting—These circuit-breakers are mounted on slate slabs for separate mounting. If desired for mounting on panels thicker than the 1¼-inch standard, the rear-connected breakers will be shipped on wooden templates or scrap slabs of the thickness specified. Price will be the same as for standard mounting.

Auxiliary Tripping Attachments—All type CD breakers will be supplied with overload trip unless otherwise ordered. Reverse current, underload, overvoltage, and undervoltage and shunt-tripping attachments can be furnished with these breakers. For description of the attachments see data on Accessories under "Carbon Circuit-Breakers, General." For prices see tables of "Accessories for Carbon Circuit-Breakers" following tables of standard circuit-breakers. The standard number of overload and underload tripping coils of the various kinds required for multipole circuit-breakers is as follows (however, one coil per pole can be supplied for overload or underload tripping if specified):

	—Number of Series Coils Required—			
Kind of Trip	Single Pole	Two-Pole	Three-Pole	Four-Pole
Overload	1	1	2	2
Underload	1	1	2	2

Special size of base is required when auxiliary tripping attachments are added to overload breakers.

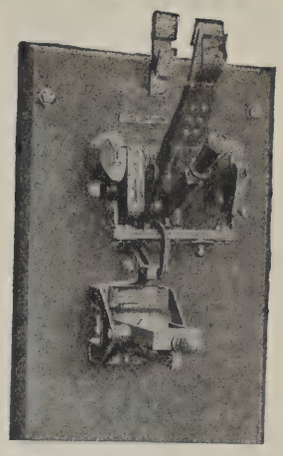


Fig. 5—Single-Pole Rear-Connected Breaker With Overload and Reverse-Current Trip and Undervoltage Release—50 Amperes, 600 Volts

This base must be ordered by style number separately when auxiliary tripping attachments are added to breakers already in purchaser's possession.

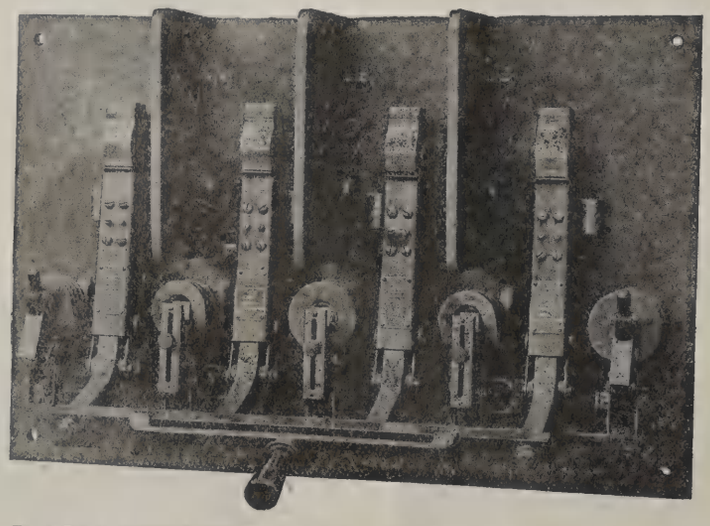


Fig. 6—Four-Pole, Front-Connected Breaker with Two Overload, One Underload, One Undervoltage, and One Shunt Tripping Coil—300 Amperes, 600 Volts

TYPE CD CARBON CIRCUIT-BREAKERS—Continued

MANUALLY OPERATED CARBON CIRCUIT-BREAKERS

Separate Mounting—For A. C. and D. C.

Front-connected—Round Studs—Automatic

Number Poles	Max. Amperes 30° Rating	Max. Amperes 20° Rating	Max. Volts	Type	Approx. Shipping Wt., Lb.	Style No.	List Price
1	5	5	600	CD	50	168246	$ 45 50
1	10	10	600	CD	50	168247	45 50
1	25	25	600	CD	50	168248	45 50
1	50	50	600	CD	50	168249	45 50
1	75	75	600	CD	50	168250	45 50
1	100	100	600	CD	50	168251	45 50
1	150	150	600	CD	50	168252	57 00
1	200	200	600	CD	50	168253	57 00
1	300	240	600	CD	50	168254	66 50
2	5	5	300	CD	70	168255	68 50
2	5	5	600	CD	75	168282	84 00
2	10	10	300	CD	70	168256	68 50
2	10	10	600	CD	75	168283	84 00
2	25	25	300	CD	70	168257	68 50
2	25	25	600	CD	75	168284	84 00
2	50	50	300	CD	70	168258	68 50
2	50	50	600	CD	75	168285	84 00
2	75	75	300	CD	70	168259	68 50
2	75	75	600	CD	75	168286	84 00
2	100	100	300	CD	70	168260	68 50
2	100	100	600	CD	75	168287	84 00
2	150	150	300	CD	70	168261	85 00
2	150	150	600	CD	75	168288	105 00
2	200	200	300	CD	70	168262	85 00
2	200	200	600	CD	75	168289	105 00
2	300	240	300	CD	70	168263	104 00
2	300	240	600	CD	75	168290	123 00
3	5	5	300	CD	95	168264	112 00
3	5	5	600	CD	105	168291	135 00
3	10	10	300	CD	95	168265	112 00
3	10	10	600	CD	105	168292	135 00
3	25	25	300	CD	95	168266	112 00
3	25	25	600	CD	105	168293	135 00
3	50	50	300	CD	95	168267	112 00
3	50	50	600	CD	105	168294	135 00
3	75	75	300	CD	95	168268	112 00
3	75	75	600	CD	105	168295	135 00
3	100	100	300	CD	95	168269	115 00
3	100	100	600	CD	105	168296	157 00
3	150	150	300	CD	95	168270	138 00
3	150	150	600	CD	105	168297	171 00
3	200	200	300	CD	95	168271	138 00
3	200	200	600	CD	105	168298	171 00
3	300	240	300	CD	95	168272	170 00
3	300	240	600	CD	105	168299	171 00
4	5	5	300	CD	140	168273	170 00
4	5	5	600	CD	155	178263	170 00
4	10	10	300	CD	140	168274	170 00
4	10	10	600	CD	155	178264	170 00
4	25	25	300	CD	140	168275	170 00
4	25	25	600	CD	155	178265	170 00
4	50	50	300	CD	140	168276	170 00
4	50	50	600	CD	155	178266	170 00
4	75	75	300	CD	140	168277	170 00
4	75	75	600	CD	155	178267	170 00
4	100	100	300	CD	140	168278	170 00
4	100	100	600	CD	155	178268	170 00
4	150	150	300	CD	143	168279	205 00
4	150	150	600	CD	158	178269	205 00
4	200	200	300	CD	140	168280	205 00
4	200	200	600	CD	158	178270	205 00
4	300	240	300	CD	140	168281	240 00
4	300	240	600	CD	158	178271	240 00

*The two-pole, three-pole, and four-pole type CC breakers listed above may be used on circuits up to 600 volts by the addition of barriers. For these barriers add to the list prices $7.00 for the two-pole breakers, $10.00 for the three-pole, and $15.00 for the four-pole breakers.

For information as to what material is furnished with these breakers, see "Instructions for Ordering Carbon Circuit-Breakers" on a previous page.

Order by Style Number

TYPE CD CARBON CIRCUIT-BREAKERS—Continued

MANUALLY OPERATED CARBON CIRCUIT-BREAKERS

Separate Mounting—For A. C. and D. C.

Rear-Connected—Round Studs—Automatic

Number Poles	Max. Amperes 30° Rating	Max. Amperes 20° Rating	Max. Volts	Type	Approx. Shipping Wt. Lb.	Style No.	List Price
1	5	5	600	CD	50	168300	$ 45 50
1	10	10	600	CD	50	168301	45 50
1	25	25	600	CD	50	168302	45 50
1	50	50	600	CD	50	168303	45 50
1	75	75	600	CD	50	168304	45 50
1	100	100	600	CD	50	168305	45 50
1	150	150	600	CD	50	168306	57 00
1	200	200	600	CD	50	168307	57 00
1	300	240	600	CD	50	168308	66 50
2	5	5	300	CD	70	168309	68 50
2	5	5	600	CD	75	168336	84 00
2	10	10	300	CD	70	168310	68 50
2	10	10	600	CD	75	168337	84 00
2	25	25	300	CD	70	168311	68 50
2	25	25	600	CD	75	168338	84 00
2	50	50	300	CD	70	168312	68 50
2	50	50	600	CD	75	168339	84 00
2	75	75	300	CD	70	168313	68 50
2	75	75	600	CD	75	168340	84 00
2	100	100	300	CD	70	168314	68 50
2	100	100	600	CD	75	168341	84 00
2	150	150	300	CD	70	168315	85 00
2	150	150	600	CD	75	168342	105 00
2	200	200	300	CD	70	168316	85 00
2	200	200	600	CD	75	168343	105 00
2	300	240	300	CD	70	168317	104 00
2	300	240	600	CD	75	168344	123 00
3	5	5	300	CD	95	168318	112 00
3	5	5	600	CD	105	168345	135 00
3	10	10	300	CD	95	168319	112 00
3	10	10	600	CD	105	168346	135 00
3	25	25	300	CD	95	168320	112 00
3	25	25	600	CD	105	168347	135 00
3	50	50	300	CD	95	168321	112 00
3	50	50	600	CD	105	168348	135 00
3	75	75	300	CD	95	168322	112 00
3	75	75	600	CD	105	168349	135 00
3	100	100	300	CD	95	168323	115 00
3	100	100	600	CD	105	168350	157 00
3	150	150	300	CD	95	168324	138 00
3	150	150	600	CD	105	168351	171 00
3	200	200	300	CD	95	168325	138 00
3	200	200	600	CD	105	168352	171 00
3	300	240	300	CD	95	168326	170 00
3	300	240	600	CD	105	168353	171 00

For information as to what material is furnished with these breakers, see "Instructions for Ordering Carbon Circuit-Breakers," on a previous page

Order by Style Number

TYPE CD CARBON CIRCUIT-BREAKERS—Continued

Number Poles	Max. Amperes 30° Rating	Max. Amperes 20° Rating	Max. Volts	Type	Approx. Shipping Wt., Lb.	Style No.	List Price
4	5	5	300	CD	140	168327	$170 00
4	5	5	600	CD	155	178272	170 00
4	10	10	300	CD	140	168328	170 00
4	10	10	600	CD	155	178273	170 00
4	25	25	300	CD	140	168329	170 00
4	25	25	600	CD	155	178274	170 00
4	50	50	300	CD	140	168330	170 00
4	50	50	600	CD	155	178275	170 00
4	75	75	300	CD	140	168331	170 00
4	75	75	600	CD	155	178276	170 00
4	100	100	300	CD	140	168332	170 00
4	100	100	600	CD	155	178277	170 00
4	150	150	300	CD	143	168333	205 00
4	150	150	600	CD	158	178278	205 00
4	200	200	300	CD	143	168334	205 00
4	200	200	600	CD	158	178279	205 00
4	300	240	300	CD	143	168335	240 00
4	300	240	600	CD	158	178280	240 00

MANUALLY OPERATED CARBON CIRCUIT-BREAKERS

Separate Mounting—Direct Current

Single-Pole

Rear-connected, Round Studs—Automatic, With Reverse-Current Trip*

Max. Amperes 30° Rating	Max. Amperes 20° Rating	Max. Volts	Type	Approx. Shipping Wt., Lb.	Style No.†	List Price
5	5	125	CD	85	263244	$200 00
10	10	125	CD	85	263245	200 00
25	25	125	CD	85	263246	205 00
50	50	125	CD	85	263247	205 00
75	75	125	CD	85	263248	205 00
100	100	125	CD	85	263249	205 00
150	150	125	CD	85	263250	210 00
200	200	125	CD	85	263251	210 00
300	240	125	CD	85	263252	210 00
5	5	250	CD	85	263253	200 00
10	10	250	CD	85	263254	200 00
25	25	250	CD	85	263614	205 00
50	50	250	CD	85	263232	205 00
75	75	250	CD	85	263233	205 00
100	100	250	CD	85	263234	205 00
150	150	250	CD	85	263235	210 00
200	200	250	CD	85	263236	210 00
300	240	250	CD	85	263237	210 00
5	5	600	CD	85	263238	200 00
10	10	600	CD	85	263239	200 00
25	25	600	CD	85	263240	205 00
50	50	600	CD	85	263241	205 00
75	75	600	CD	85	263242	205 00
100	100	600	CD	85	263243	205 00
150	150	600	CD	85	263266	210 00
200	200	600	CD	85	263267	210 00
300	240	600	CD	85	263268	210 00

*When ordering, specify style number of auxiliary switch (see pages on "Carbon Circuit-Breaker Accessories") desired for shunt coil circuit (one cutout switch required with each attachment).

NOTE—Two-pole breakers of capacities listed above, with reverse-current-trip attachments may be obtained by ordering two single-pole breakers of the required capacity, specifying single-pole breaker style numbers "except for two-pole".

†Bases are not included. Prices for special bases on request. We recommend that these breakers be ordered on their final bases.

For information as to what material is furnished with these breakers, see "Instructions for Ordering Carbon Circuit-Breakers" on a previous page.

TYPE CD CARBON CIRCUIT-BREAKERS—Continued

MANUALLY OPERATED CARBON CIRCUIT-BREAKERS

Separate Mounting—Direct Current

Single-Pole

Rear-Connected, Round Studs—Non-Automatic, With Reverse-Current Trip*

Max. Amperes 30° Rating	Max. Amperes 20° Rating	Max. Volts	Type	Approx. Shipping Wt. Lbs.	Style No.	List Price
5	5	125	CD	80	263269	$195 00
10	10	125	CD	80	263270	195 00
25	25	125	CD	80	263271	200 00
50	50	125	CD	80	263272	200 00
75	75	125	CD	80	263273	200 00
100	100	125	CD	80	263274	200 00
150	150	125	CD	80	263275	205 00
200	200	125	CD	80	263276	205 00
300	240	125	CD	80	263277	205 00
5	5	250	CD	80	263255	195 00
10	10	250	CD	80	263256	195 00
25	25	250	CD	80	263257	200 00
50	50	250	CD	80	263258	200 00
75	75	250	CD	80	263259	200 00
100	100	250	CD	80	263260	200 00
150	150	250	CD	80	263261	205 00
200	200	250	CD	80	263262	205 00
300	240	250	CD	80	263263	205 00
5	5	600	CD	80	263264	195 00
10	10	600	CD	80	263265	195 00
25	25	600	CD	80	263278	200 00
50	50	600	CD	80	263279	200 00
75	75	600	CD	80	263280	200 00
100	100	600	CD	80	263281	200 00
150	150	600	CD	80	263282	205 00
200	200	600	CD	80	263283	205 00
300	240	600	CD	80	263284	205 00

*When ordering, specify style number of auxiliary switch (see pages on "Carbon Circuit-Breaker Accessories") desired for shunt-coil circuit (one cutout switch required with each attachment).

NOTE—Two-pole breakers, of capacities listed above, with reverse-current-trip attachments may be obtained by ordering the single-pole style number of the required capacity, specifying single-pole breaker style numbers "except for two-pole."

†Bases are not included. Prices for special bases on request. We recommend that these breakers be ordered on their final bases.

For information as to what material is furnished with these breakers, see "Instructions for Ordering Carbon Circuit-Breakers" on a previous page.

Order by Style Number

ACCESSORIES FOR TYPE CD CARBON CIRCUIT-BREAKERS

Style number and list price include one complete tripping device mounted on circuit-breaker. For number required for multipole breakers see pages of this catalogue on type CD breakers. Special bases listed below are required when these auxiliary tripping devices are added to overload breakers already mounted on standard bases, 1¼-inches thick. When ordering auxiliary tripping devices to be fitted to breakers already installed, it will be necessary to state on the order the Style No. of the auxiliary trip mechanism and the Style No. of the breaker to be fitted; also give thickness of base if other than 1¼ inches.

Shunt-Trip Attachments

When ordering, give Style No. of cutout contact required.

Voltages			Approx. Wt.—Lbs.		Style No.		List Price
D.C.	25 Cycles	60 Cycles	Net	Boxed	Front Connection	Rear Connection	
20 to 35	55 to 100	110 to 200	6	7	270809	168995	$10 00
40 to 90	110 to 220	220 to 550	5	7	270810	168996	10 00
100 to 250	275 to 550	600	5	7	270811	168997	10 00
260 to 600	600	...	5	7	270812	168998	10 00

Undervoltage Release Attachment

The following Style Nos. include magnet, coil and resistor.

Voltages A.C. or D.C.	Approx. Wt.—Lbs. Net	Boxed	Style No. Front Connection	Rear Connection	List Price
110	6	7	270822	270817	$14 00
220 } 250 }	6	7	270821	270816	16 00
300	6	7	270820	270815	20 00
440 } 500 }	6	7	270819	270814	20 00
600	6	7	270818	270813	20 00

Overvoltage Trip

Normal D.C. Voltage†	Approx. Wt.—Lbs. Net	Boxed	Style No.	List Price
55	5	7	*	$17 00
110	6	9	*	22 00
110	..	..	*	22 00

(Including resistor) above

*Order by description.

†Tripping range 80 to 160 per cent of normal voltage rating.

Underload Trip Attachments

Amperes Rating of Breaker	Amperes Trips at	Approx. Wt.—Lbs. Net	Boxed	Style No. Front Connection Right-Hand* Mounting	Front Connection Left-Hand Mounting	Rear Connection Right-Hand* Mounting	Rear Connection Left-Hand Mounting	List Price
5	0.5	5	7	168354	255867	168363	255876	$28 00
10	1	5	7	168355	255868	168364	255877	28 00
25	2.5	5	7	168356	255869	168365	255878	28 00
50	5	5	7	168357	255870	168366	255879	28 00
75	7.5	5	7	168358	255871	168367	255880	29 00
100	10	5	7	168359	255872	168368	255881	29 00
150	15	5	7	168360	255873	168369	255882	32 00
200	20	5	7	168361	255874	168370	255883	32 00
300	30	5	7	168362	255875	168371	255884	32 00

*For right hand mounting a copper connection is provided for connecting overload and underload coil studs.

Inverse-Time-Limit Attachments

One inverse-time-limit attachment required for each overload trip mechanism.

Approx. Wt.—Lbs. Net	Boxed	Style No.	List Price
4	5	240498	$16 00

Note—Specify on order one-third pint can of oil. P.S. 115233, is required for each attachment.

Cutout Contacts

Throw	Approx. Wt.—Lbs. Net	Boxed	Style No. Front Connection	Rear Connection	List Price
Single	¼	½	196019	196020	$ 5 70
Double	¼	½	196021	196022	10 00

TYPE CD CARBON CIRCUIT-BREAKERS—Continued

Special Bases for Type CD Breakers

No. of Poles	Current Rating of Breakers	Voltage Rating of Breakers	Approx. Wt. Lbs. Net Base Only	Approx. Wt. Lbs. Boxed	Style No. Front Connection	Style No. Rear Connection	List Price
			For Use with Underload Trip				
1	5 to 100	600	25	30	168372	.....	$ 7 00
1	150 to 300	600	25	30	168373	.....	8 25
2	5 to 100	300	25	30	168374	.....	10 80
2	150 to 300	300	25	30	168375	.....	12 00
2	5 to 100	600	30	35	168380	.....	12 00
2	150 to 300	600	30	35	168381	.....	14 00
3	5 to 100	300	35	45	168376	.....	15 00
3	150 to 300	300	35	45	168377	.....	15 00
3	5 to 100	600	45	55	168382	.....	15 00
3	150 to 300	600	45	55	168383	.....	17 80
4	5 to 100	300	45	55	168378	.....	20 00
4	150 to 300	300	45	55	168379	.....	22 50
			For Use with Undervoltage Trip				
1	5 to 100	600	25	30	168384	271458	12 00
1	150 to 300	600	25	30	168385	271459	12 00
2	5 to 100	300	25	30	168386	271460	14 00
2	150 to 300	300	25	30	168387	271461	15 00
2	5 to 100	600	30	35	168392	271462	20 00
2	150 to 300	600	30	35	168393	271463	20 00
3	5 to 100	300	35	45	168388	271464	21 00
3	150 to 300	300	35	45	168389	271465	22 00
3	5 to 100	600	45	55	168394	271466	22 00
3	150 to 300	600	45	55	168395	271467	22 00
4	5 to 100	300	45	55	168390	271468	25 00
4	150 to 300	300	45	55	168391	271469	25 00
4	5 to 100	600	..	..	271456	271470	25 00
4	150 to 300	600	..	..	271457	271471	25 00
			For Use With Shunt Trip*				
1	5 to 100	600	25	30	271486	271472	10 00
1	150 to 300	600	25	30	271487	271473	10 00
2	5 to 100	300	25	30	271488	271474	12 00
2	150 to 300	300	30	35	271489	271475	12 00
2	5 to 100	600	30	35	271490	271476	20 00
2	150 to 300	600	30	35	271491	271477	22 00
3	5 to 100	300	35	45	271492	271478	16 50
3	150 to 300	300	35	45	271493	271479	16 50
3	5 to 100	600	45	55	271494	271480	21 00
3	150 to 300	600	45	55	271495	271481	21 00
4	5 to 100	300	45	55	271496	271482	24 00
4	150 to 300	300	45	55	271497	271483	24 00
4	5 to 100	600	45	55	271498	271484	24 00
4	150 to 300	600	45	55	271499	271485	29 50

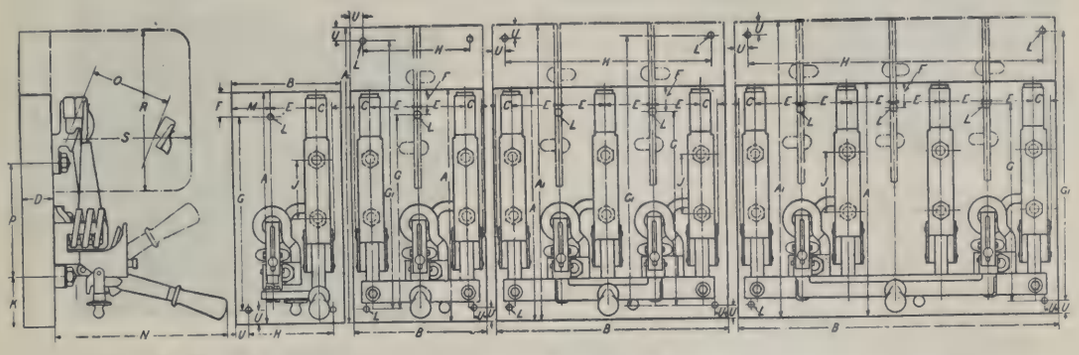
*When ordering bases for breaker with shunt trip only, specify whether single or double-throw auxiliary switch is required and give style number of switch.

For information as to what material is furnished with these breakers, see "Instructions for Ordering Carbon Circuit-Breakers" on a previous page.

Order by Style Number

TYPE CD CARBON CIRCUIT-BREAKERS—Continued

OUTLINE DIMENSIONS
Front-Connected

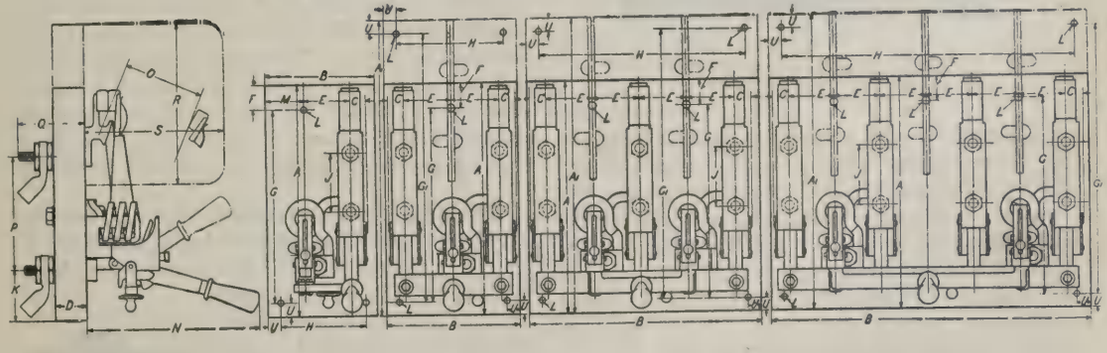


DIMENSIONS IN INCHES

Amperes	A	A¹	B* 1P.	C	D	E	F	G	G¹	H† 1P.	J	K	L	M 1P.	N§ 1P.	O	P	Q	R	S	U	APPROX. WEIGHT, POUNDS 0 to 300 Volts 1P.	2P.	3P.	4P.	301 to 600 Volts 1P.	2P.	3P.	4P.
4 to 100	15	19	8	1	1¼	3	1½	12½	17	6	4⅛	‡3 $\frac{9}{16}$	$\frac{1}{16}$	2½	11⅛	5⅜	7¼	...	10	8	1	30	50	65	100	35	55	75	110—Net
150-200-300	15	19	8	1	1¼	3	1½	12½	17	6	3 $\frac{13}{16}$	+3 $\frac{1}{16}$	$\frac{1}{16}$	2½	11⅛	5⅜	7¼	...	10	8	1	45	70	95	140	50	75	105	150—Gross

*For 2-pole breakers, dimension B is 11; for 3-pole, 17; for 4-pole, 23.
†For 2-pole breakers, dimension H is 9; for 3-pole, 15; for 4-pole, 21.
‡For 2, 3, and 4-pole, 600-volt breakers, dimension K is 3 $\frac{13}{16}$.
+For 2, 3, and 4-pole, 600-volt breakers, dimension K is 3 $\frac{13}{16}$.
§For 2-pole breakers, dimension N is 11¾; for 3-pole and 4-pole, 12½.
The dimensions of breakers with special bases will be the same as for standard breakers with the exception of dimensions B and H which will be increased three inches. The distance from center of breaker jaw to center of trip will be three inches. These dimensions are for reference only. For official dimensions apply to the nearest district office.

Rear-Connected



DIMENSIONS IN INCHES

Amperes	A	A¹	B* 1P.	C	D	E	F	G	G¹	H† 1P.	J	K	L	M 1P.	N§ 1P.	O	P	Q	R	S	U	Dia. Stud	APPROX. WEIGHT, POUNDS 0 to 300 Volts 1P.	2P.	3P.	4P.	301 to 600 Volts 1P.	2P.	3P.	4P.
4 to 100	15	19	8	1	1¼	3	1½	12½	17	6	4⅛	‡3 $\frac{9}{16}$	$\frac{1}{16}$	2½	11 $\frac{1}{16}$	5⅜	7¼	2⅞	10	8	1	⅜	30	50	65	100	35	55	75	110—Net
150-200-300	15	19	8	1	1¼	3	1½	12½	17	6	3 $\frac{13}{16}$	+3 $\frac{1}{16}$	$\frac{1}{16}$	2½	11 $\frac{1}{16}$	5⅜	7¼	4	10	8	1	⅝	45	70	95	140	50	75	105	150—Gross

*For 2-pole breakers, dimension B is 11; for 3-pole, 17; for 4-pole, 23.
†For 2-pole breakers, dimension H is 9; for 3-pole, 15; for 4-pole, 21.
‡For 2, 3, and 4-pole, 600-volt breakers, dimension K is 3 $\frac{13}{16}$.
+For 2, 3, and 4-pole, 600-volt breakers, dimension K is 3 $\frac{13}{16}$.
§For 2-pole breakers, dimension N is 11¾; for 3-pole and 4-pole, 12½.
The dimensions of breakers with special bases will be the same as for standard breakers with the exception of dimensions B and H which will be increased three inches. The distance from center of breaker jaw to center of trip will be three inches. These dimensions are for reference only. For official dimensions apply to the nearest district office.

TYPE CC CARBON CIRCUIT-BREAKERS

The type CC carbon circuit-breakers meet the demand for protection of alternating-current and direct-current circuits of moderate capacities, such as lighting circuits and so forth, the voltages of which do not exceed the rated voltage of the breakers.

Capacity—These breakers are supplied for voltages of 750 or less and for capacities up to 800 amperes.

Calibration—Type CC circuit-breakers are calibrated as follows: single and double-pole breakers on direct current; three-pole and four-pole breakers on 25-cycle alternating current. If other calibration is desired, it should be specified on the order.

If immediate delivery is desired and a maximum error of 10 per cent in calibration is permissible, standard circuit-breakers should be ordered for use on either alternating current or direct-current circuits, thus eliminating the necessity for special calibration and the consequent delay in shipment.

Operating Mechanism—These breakers are manually operated and are closed by pulling down on

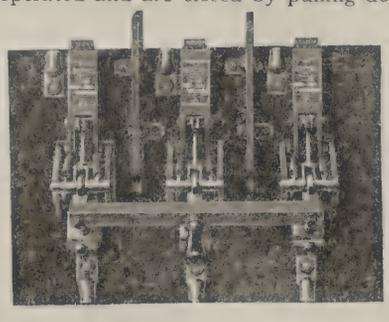


FIG. 2—THREE-POLE, FRONT-CONNECTED BREAKER, WITH BARRIERS, CLOSED POSITION

the operating handle, and may be tripped manually by pushing upwards on the handle or back on the calibrating thumb knob. In closing a breaker, the brush is forced against the contact plates by means of a toggle-joint lever. A small steel roller engages a locking catch, places the two releasing springs under tension, and holds the breaker in the closed position.

Friction clips, which engage a projection on the handle eliminate any destructive effects of jarring due to the opening of the breaker.

Overload Adjustment is obtained by turning a thumb screw which moves a weight that acts against the magnetic pull on the armature.

Main Contacts—See pages on "Carbon Circuit-Breakers, General".

Secondary Contacts—Attached to the upper end of each movable contact is a phosphor-bronze secondary contact that bears on the main stationary contact when the breaker is closed, and opens after the main brush has entirely left the contact plate. By this means, the opening of the circuit is transferred from the main contacts and, in case of any possible failure of the carbon arcing contacts, the main contacts are protected from the arc.

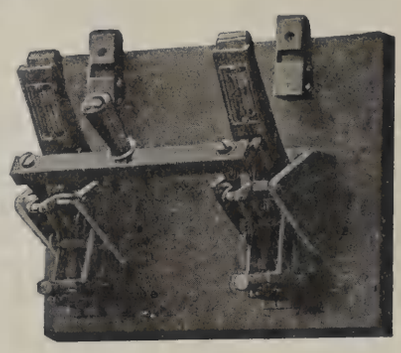


FIG. 1—TWO-POLE, REAR-CONNECTED BREAKER, WITHOUT BARRIERS, OPEN POSITION

Carbon Contacts—Each breaker is also provided with auxiliary carbon arcing contacts which finally interrupt the circuit, thereby preventing any burning of the main contacts when the breaker opens. The stationary carbon contact is securely fastened to the stud immediately above the upper stationary main contact. The movable carbon contact is mounted immediately above the movable main contact to which it is connected by a shunt composed of braided flexible copper. This contact is so mounted that the main and secondary contacts are open about one-quarter inch before the carbons separate, thus eliminating any possibility of the metallic contacts being blistered by the arc. The movable carbon contact is pivoted on the supporting frame in such a manner that it is in perfect alignment with the stationary contact whenever the breaker is closed. These carbon contacts are inexpensive and readily renewable.

Mounting—These breakers are furnished mounted on black Marine finished slate bases, which are included in the list prices and style numbers. When desired for use on switchboards, circuit-breakers can be removed from the slate bases and mounted directly on the panels. If breakers are desired without bases for switchboard work, they can be supplied mounted on wooden templates, without handles or terminals; when so desired, the order should read: "Furnish breaker similar to Style No. ....., except to be mounted on a wood template, without handles or terminals, the handles and terminals to be furnished separately, for switchboard work."

FIG. 3—BREAKER WITH SHUNT TRIP ATTACHMENT

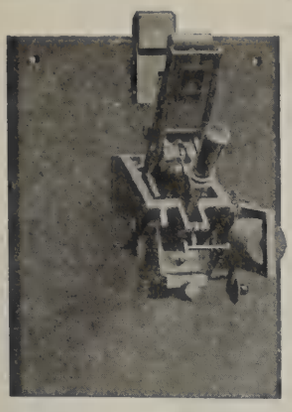


FIG. 4—BREAKER WITH UNDERVOLTAGE RELEASE ATTACHMENT

Multipole Circuit-Breakers—Separate closing handles for each pole with common trip can be supplied at an increased price; prices on request. (See "Double-Arm Attachment" in pages on Carbon Circuit-breakers, General.)

Barriers—Barriers are included with the standard breakers where specified. If barriers are desired with breakers, not so equipped, they should be ordered separately from the pages listing carbon circuit-breaker accessories.

Auxiliary Tripping Attachments

The following auxiliary-tripping attachments can be supplied with type CC carbon circuit-breakers.

Shunt Trip—A shunt trip cutout, consisting of a contact pin mounted on the panel under the circuit breaker brush in such a way that the tripping-coil circuit is opened when the breaker opens, is also furnished with the tripping device. The current required to operate this device is from .1 to .9 amperes at the ratings given.

The shunt trip is mounted on the left-hand side of the circuit-breaker frame. It is necessary to drill and tap two small holes in the frame for mounting screws. Two $\frac{3}{16}$-inch holes must also be drilled in the circuit-breaker panel for the leads to the coil, and another hole for the shunt trip cutout. In adjusting this attachment, it is necessary to fit the trigger and lever to suit the dimensions of the circuit-breaker to which it is applied. Drawings showing the method of adjustment and drilling plan will be furnished with the attachment.

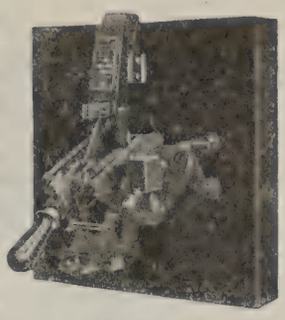


FIG. 5—BREAKER WITH UNDERLOAD ATTACHMENT

Automatic Undervoltage Trip—The undervoltage trip attachment is mounted on the panel beside the circuit-breaker and requires but a small amount of space. No modification of the circuit-breaker is necessary except the riveting of a pin to the trigger. Drilling plans for mounting this attachment will be furnished on request.

Automatic Underload Trip—This attachment is for rear-connected breakers only.

The underload-trip attachment is mounted on the right-hand side of the circuit-breaker frame, and it is necessary to drill and tap two holes in the frame for this purpose. The current coil is supported by its studs, for which two holes must be drilled in the panel. The coil is connected in series with the lower circuit-breaker stud by means of a strap on the back of the panel. A small pin must also be riveted to the trigger of the circuit-breaker. Drilling plans and drawings showing the method of adjustment will be furnished with the attachment.

MANUALLY-OPERATED CARBON-CIRCUIT BREAKERS

Separate Mounting—For A.C. and D.C.

Rear Connected—Round Studs—Automatic

Number Poles	Max Amperes 30° Rating	Max Amperes 20° Rating	Max Volts	Type	Approx. Shipping Wt. Lbs.	Style No.	List Price
1	400	400	600	CC	80	65942	$102 00
1	600	600	600	CC	85	65943	126 00
1	800	800	600	CC	85	65944	138 50
2	400	400	250	CC	125	65952	204 00
2	400	400	600	CC	140	155805	220 00
2	600	600	250	CC	130	65953	252 00
2	600	600	600	CC	140	101473	267 50
2	800	800	250	CC	130	65954	277 50
2	800	800	600	CC	130	101474	292 50
3	400	400	250*	CC	235	65962	306 00
3	600	600	250*	CC	250	65963	378 00
3	800	800	250*	CC	250	65964	415 00
4	400	400	250*	CC	285	74598	408 00
4	600	600	250*	CC	300	74599	504 00
4	800	800	250*	CC	300	74600	555 00

*The three-pole and four-pole type CC breakers listed above may be used on circuits up to 600 volts by the addition of barriers. For these barriers add to the list prices, $10.00 for the three-pole breakers and $15.00 for the four-pole breakers.

ACCESSORIES FOR TYPE CC CARBON CIRCUIT-BREAKERS

Style number and list price include attachment complete. Where resistors are specified below, they are included in the list price but not in the style number, and must be called for separately in the order.

Shunt-Trip Attachments

Volts D.C.	Volts A.C. 25 Cycles	Volts A.C. 60 Cycles	Approx. Net Wt., Pounds*	Style Number Shunt Trip	Style Number Series Resistor	List Price
10– 70	90–250	180–500	2¼	112535	None	$15 00
71–150	251–600	.....	2¼	112536	None	15 00
151–300	.....	.....	4½	112536	186465	15 00
301–600	.....	.....	4½	112536	186467	15 00

*Weight includes resistance where required.

Undervoltage Release Attachments

Style number includes the mechanism complete without coils, which must be specified on order by style number from table below. List price includes mechanism with coil and with resistor when required.

Capacity Amperes D.C	Connection	Kind of Current	Wt., Pounds Net	Wt., Pounds Boxed	Style No.	List Price
300–400	Rear	Direct	3	5	269652	$22 00
300–400	Front	Direct	3	5	269653	22 00
300–400	Rear	Alternating	3	5	269654	22 00
300–400	Front	Alternating	3	5	269655	22 00
600–800	Rear	Direct	3	5	269656	22 00
600–800	Front	Direct	3	5	269657	22 00
600–800	Rear	Alternating	3	5	269658	22 00
600–800	Front	Alternating	3	5	269659	22 00

Coils for Undervoltage Release Attachments

The coils listed below are for use with the above undervoltage mechanisms and must be ordered separately.

Volts 60 Cycles	Volts 25 Cycles	Volts D.C.	External Resistor Style No.	Wt., Pounds Net	Wt., Pounds Boxed	Style No
110	....	...	.....	1	1½	141527
220	110	...	.....	1	1½	141531
440–600	220	50	.....	1	1½	141529
...	440	...	.....	1	1½	141532
...	550	110	.....	1	1½	141530
...	...	250	186469	1	1½	141530
...	...	600	186474	1	1½	141530

For information as to what material is furnished with these breakers, see "Instructions for Ordering Carbon Circuit-Breakers" on a previous page.

Order by Style Number

TYPE CC CARBON CIRCUIT-BREAKERS—Continued

Underload-Trip Attachments

Style number and list price include the mechanism complete with coils.

Capacity, Amperes	Approx. Net Weight, Pounds	Style No.	List Price
400	3½	115122	$31 00
600	4	115123	35 00
800	5	115124	41 50

Double-Arm Attachments and Three-Pole Common Trip

Style number and list price include the device complete with insulating cross bar and mounting screw sand all parts necessary to mount them, but does not include the circuit-breaker.

Amperes	Volts, A. C. or D. C. With Barriers	Without Barriers	Spacing Inches Ctr. to Ctr.	Approx. Wt. —Lbs. Net	Boxed	Style No.	List Price
Double-Pole Attachment*							
400	750	250	7	1½	3	133973	$16 50
600–800	750	250	7	1¾	3½	133974	16 50
600–800	750	250	8	2	4	133975	16 50
Three-Pole Common Trip							
400	750	250	7	2½	5	269650	$20 00
600–800	750	250	7	3	6	269651	20 00

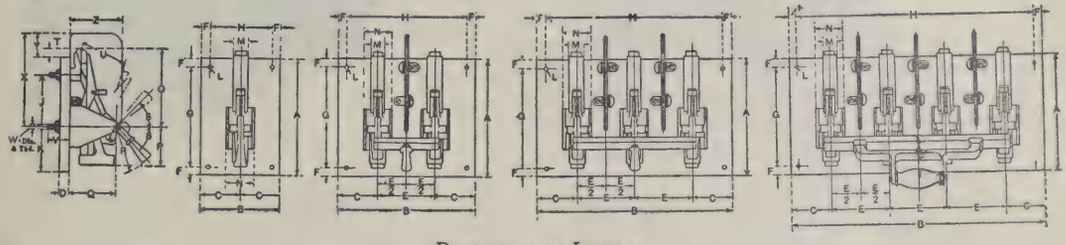
*Two single-pole breakers, if ordered mounted on one base complete with double-arm attachment will be supplied at the price of two separate single-pole breakers.

Barriers with Brackets

Capacity Breaker Amps.	Approx. Wt.—Lbs. Net	Boxed	Style No.	List Price
400	1¼	2½	99829	$4 50
600–800	1¾	3½	99830	5 50

OUTLINE DIMENSIONS

250 Volts D. C. or 440 Volts A. C. (Without Barriers), or 750 Volts D. C. or A. C. (With Barriers)



Dimensions in Inches

Capacity Amperes	A	B 1P.	B 2P.	B 3P.	B 4P.	C	D	E	F	G	H 1P.	H 2P.	H 3P.	H 4P.	J	K	L 1P.	L 2P.	L 3P.	L 4P.
400	13¾	9	16	23	30	4½	1¼	7	¾	12¼	7½	14½	21½	28½	7⅞	3½	5/16	7/16	7/16	9/16
600	16	10	17	24	31	5	1¼	7	¾	14½	8½	15½	22½	29½	9¼	4	5/16	7/16	7/16	9/16
800	16	10	17	24	31	5	1¼	7	¾	14½	8½	15½	22½	29½	9¼	4	5/16	7/16	7/16	9/16

Capacity Amperes	M	N	O	P	Q	R 1P.	R 2P.	R 3P.	R 4P.	S	T	U	V	W Dia.	W Th'd	X	Y	Z	*Approx. Net Wt. Per Pole Pounds
400	1⅞	3¾	9⅛	4 5/16	5¼	5⅜	6⅛	7¼	7¾	41°	⅞	6	4¼	¾	16	12⅜	2⅛	6¼	15
600	2¾	4⅝	10 1/16	5 5/16	6¼	6½	7⅜	8 1/16	8⅜	45°	1⅛	6½	5⅛	1	14	14⅜	2⅜	7¼	30
800	2¾	4⅝	10 1/16	5 5/16	6¼	6½	7⅜	8 1/16	8⅜	45°	1⅛	6½	5½	1¼	14	14⅜	2⅜	7¼	30

*Weights do not include bases.

The above dimensions are for reference only. For official dimensions and drilling plans apply to nearest district office of this Company.

TYPE CA CARBON CIRCUIT-BREAKERS

Manually or Electrically Operated—for D.C. or A.C. Circuits

FIG. 1—MANUALLY OPERATED DIRECT-CONTROL SINGLE-POLE 2000-AMPERE, OPEN AND CLOSED POSITIONS

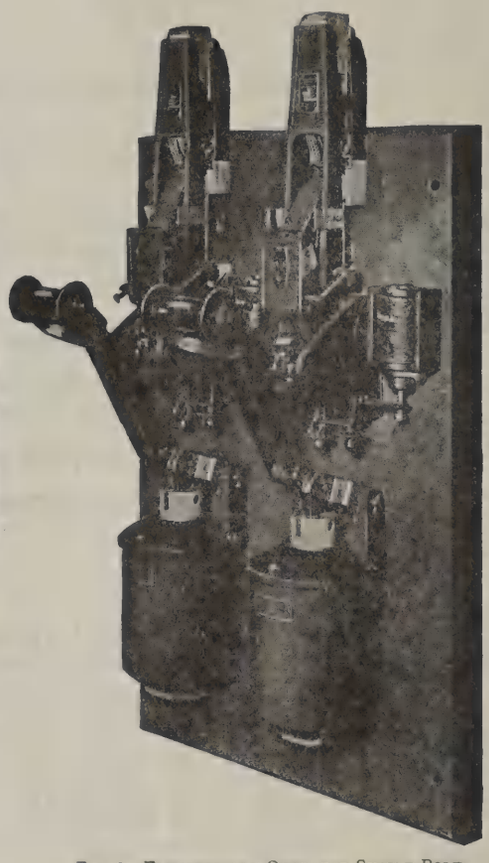


FIG. 2—ELECTRICALLY OPERATED SINGLE-POLE 1000-AMPERE, CLOSED POSITION

APPLICATION

Type CA carbon circuit-breakers are designed particularly for the severe current-carrying and interrupting conditions found in operating low-voltage direct and alternating-current systems. They are made in the following capacities, based on 30 degrees Centigrade rise:

——FOR CIRCUIT——			——MAXIMUM AMPERES——		
Current	Frequency Cycles	Max. Volts	Manually Operated Direct-Control	Manually Operated Remote-Control	Electrically Operated
Direct	....	750	24,000	....	24,000
		1500	....	2500	8,000
Alternating	25	750	10,000	....	10,000
	60	750	7,000	....	7,000

When conditions make it desirable to operate carbon circuit-breakers from a distance, the electrically operated form or the manually operated remote-control, within its limited application, is furnished. This makes it possible to install the circuit-breaker near the apparatus to be connected, like the equalizer connection of a direct-current generator, and to retain the control at the switchboard. Another common application of the electrically operated form is for remote-control feeder tie-switches on distributing systems. Such arrangements effect a saving in wiring, as a light control cable takes the place of the heavy power cable otherwise required.

CONSTRUCTION

Type CA circuit-breakers are more compact, except in the overall length, than any other type of carbon circuit-breaker on the market, of equal conducting and interrupting capacity. The added length is due wholly to the longer break distance and greater length of carbon arm, which experience in heavy railway service has shown to be desirable.

The automatic-overload tripping attachment is contained in the circuit-breaker and forms an integral part of it.

The simple form of toggle mechanism used throughout is especially worthy of note. This toggle on all sizes, from 3,000 to 24,000 amperes, consists of but a single link member connecting the handle lever and main contact arm, but is so shaped and related to the lever members as to form an eccentric toggle of exceptional power. In the sizes below 3,000 amperes the toggle is of the roller type, formed by means of a roller on the inner end of the handle lever acting directly on a plane surface on the brush-arm or main-contact lever. Both forms are best adapted to the particular sizes of breaker and form the simplest mechanism known to be used for the purpose.

TYPE CA CARBON CIRCUIT-BREAKERS—Continued

Main Contacts—In larger capacities, where the moving contact is subdivided in order to obtain a better average distribution of contact pressure, large ventilating spaces are allowed between the individual laminated main-contact members—an exclusive feature of the type CA carbon circuit-breakers. This reduces the temperature rise very materially under any given conditions of load and increases the capacity on alternating-current service by reducing the skin effect. When the breaker is tripped, the main contacts are opened first and the current is shunted upward through copper secondary and tertiary contacts to the carbon arcing contacts where the break takes place. (See Fig. 3).

Secondary Contacts—Directly over the brush contacts the secondary contacts are located. The secondary stationary contact has a surface inclined to the vertical and practically parallel to the plane of support of the moving contact spring, thus preventing buckling of the spring in case the contact is roughened by repeated opening under short-circuit conditions. The moving contact spring is held under initial pressure until just before the contacts separate. The secondary contacts open next after the main or brush contacts open, protecting the latter from arcing under severe short-circuit conditions.

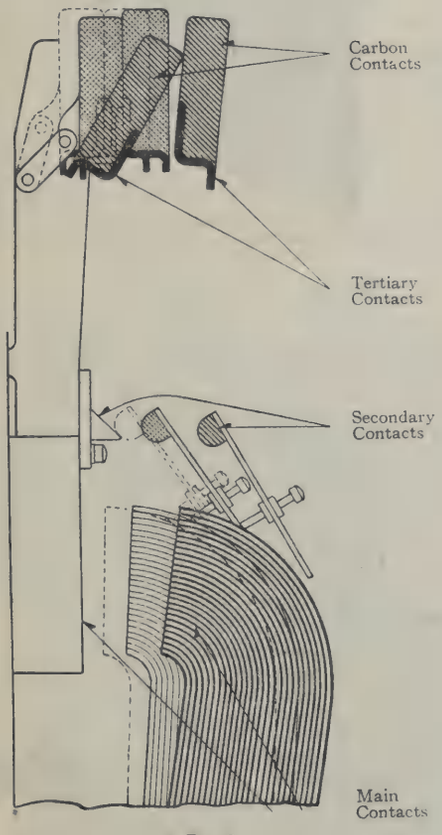


FIG. 3

This diagram shows the shape and relative position of each of the contacts in the three important stages of breaking the circuit as follows:

1. Contacts outlined by dotted lines show main brush opened, secondary contact on point of opening, aand tertiary and carbon contacts not changed from closed position.

2. Contacts shown by light shading show main and secondary contacts open, tertiary and carbon contacts still closed, but one set of contacts has slid down on the other set.

3. Contacts shown by heavy shading show the tertiary contact open and carbon tips about to finally break the circuit.

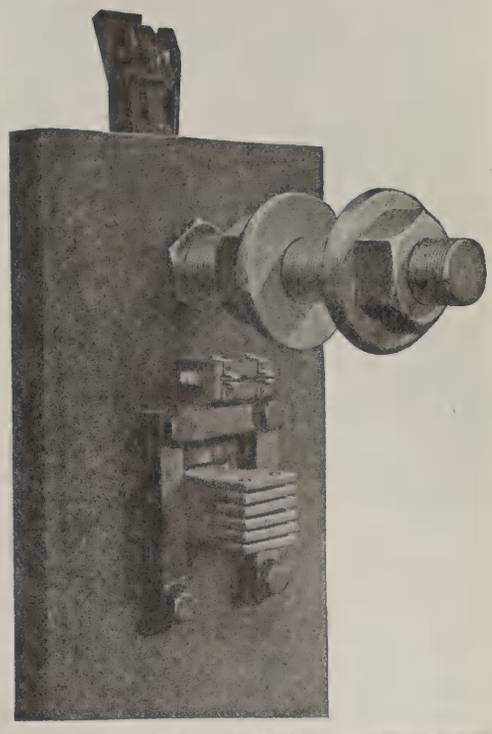


FIG. 4—SHOWING 4000-AMPERE MILL-SLOTTED STUD, ROUND STUD, AND SIGNAL SWITCH OF TYPE CA CIRCUIT-BREAKER

An adjusting screw on the moving contact allows an adjustment of the relation of the opening of the main and secondary contacts.

Tertiary Contacts—The tertiary contacts are attached to the lower end of the carbon contacts of which they appear to be a part. They are made of copper and are connected to the main or brush contacts by heavy copper shunts. They open immediately before the carbon contacts open and fully protect the secondary contacts except under extreme conditions of repeated short circuit without proper maintenance.

Carbon Contacts—The carbon or final contacts, except where exposed to the arc, are heavily copper coated or filled, thus insuring lowest-resistance contact with the tertiary-contact copper plates and the shunts to the main contacts. They are self-aligning and have a self-wiping action, thus making them self-cleaning.

The carbon arms are of ample length and open far enough to insure breaking the heaviest arc incident to short-circuit, as in heavy railway service.

TYPE CA CARBON CIRCUIT-BREAKERS—Continued

Connections—All standard type CA circuit-breakers are arranged for rear connection. The main contact blocks form part of the terminal studs. Front-connected type CA breakers up to 2000 amperes, direct-current, can be supplied on special order.

Handles—The manually operated direct-control type CA carbon circuit-breakers have an insulated spade-grip handle.

Contactor-Type—A line of breakers known as the type CA "contactor-type" circuit-breaker (see Fig.5) is available in capacities from 1000 amperes to 8000 amperes direct-current, inclusive, and in intermediate capacities corresponding to the regular type CA single-pole line. The term "contactor-type" means a breaker that is electrically operated, but held in the closed position by the presence of a small amount of closing current on the operating magnet and not by a mechanical latch, as is usual with the standard manually or electrically operated type CA breakers. The breaker drops to the open position on the absence of voltage in the control circuit. The contactor type of electrically operated breaker is much more simple than the standard electrically operated form, which has all of the parts of the regular manually operated breaker and the electric operating mechanism in addition. However, they are made only in the single-pole non-automatic form, which accounts for part of the simplicity.

The contactor breaker is made automatic by the addition of overload or reverse-power relays arranged to open the closing-coil circuit or to short-circuit the closing coil with resistance in series. The latter relay scheme permits the use of standard contact-closing relays.

The contactor breaker is adapted for use as an automatic feeder tie-switch in conjunction with appropriate relays and connections. In this service

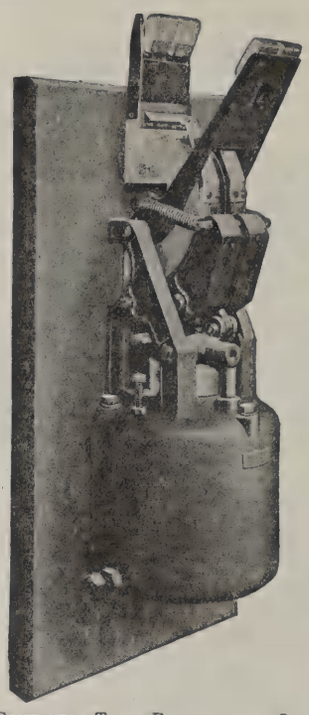


FIG. 5—CONTACTOR-TYPE, ELECTRICALLY OPERATED SINGLE-POLE, 3000-AMPERE

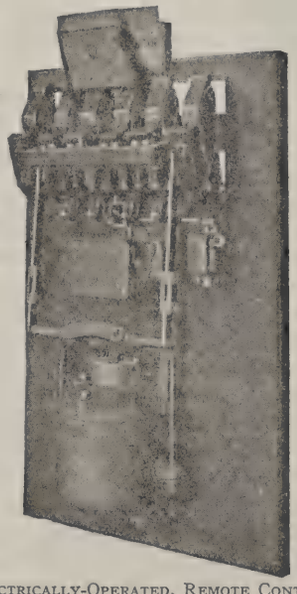


FIG. 6—ELECTRICALLY-OPERATED, REMOTE CONTROL, SINGLE-POLE, 20,000 AMPERE, WITH REVERSE-CURRENT-TRIP ATTACHMENT

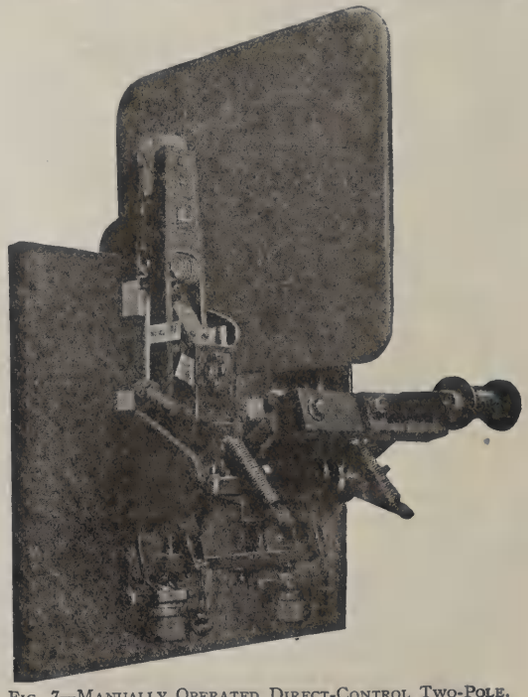


FIG. 7—MANUALLY OPERATED DIRECT-CONTROL TWO-POLE, 600-AMPERE, WITH BARRIER, INVERSE-TIME-LIMIT AND COMMON TRIP

TYPE CA CARBON CIRCUIT-BREAKERS—Continued

it is adjusted to open when the voltage drops below a certain predetermined limit, as would be caused by an excessive overload or short-circuit in the vicinity. The breaker will then remain open until some predetermined voltage exists on both feeders that it is arranged to tie, and then automatically close.

Multipole contactor breakers are made by using several single-pole units controlled by a single control switch or relay, or both.

Field Discharge Breakers—A combined shunt-trip and field-discharge contact is available on all capacities up to 2500 amperes direct-current for either manual or electrical operation.

Manually Operated Remote-Control Breakers—For service up to 1500 volts direct-current and capacities up to 2500 amperes, single-pole type CA manually operated breakers are supplied for mounting away from the switchboard panels, but operated from a handle mounted on the panel in the usual location for the knife switch (see Fig. 10).

Multipole Circuit-Breakers—Each multipole breaker is provided with a common trip; that is, an overload on any one pole trips all poles. The manually operated breakers (two, three or four-pole), up to and including 2500 amperes capacity, can be provided with a single closing-handle and cross-bar for closing all poles together (all poles tripped together). This form of handle is arranged, by springs, to retrieve independently of the breaker pole units so as not to retard the operation of the breaker on opening.

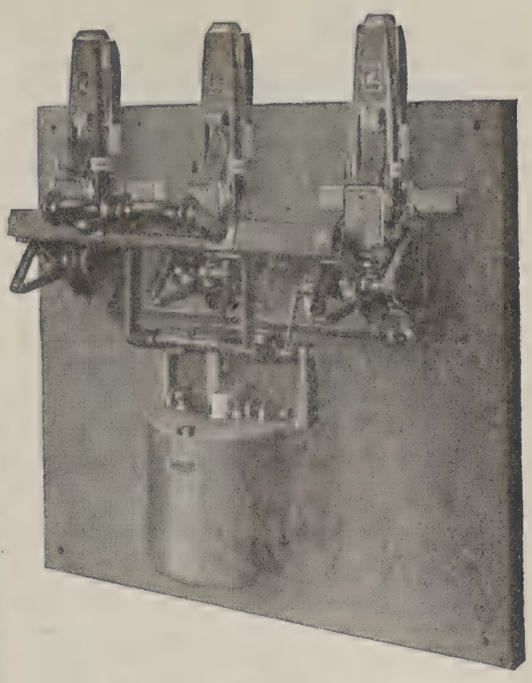


FIG. 8—ELECTRICALLY OPERATED THREE-POLE 3000-AMPERE, WITH EQUALIZER CONTACTS

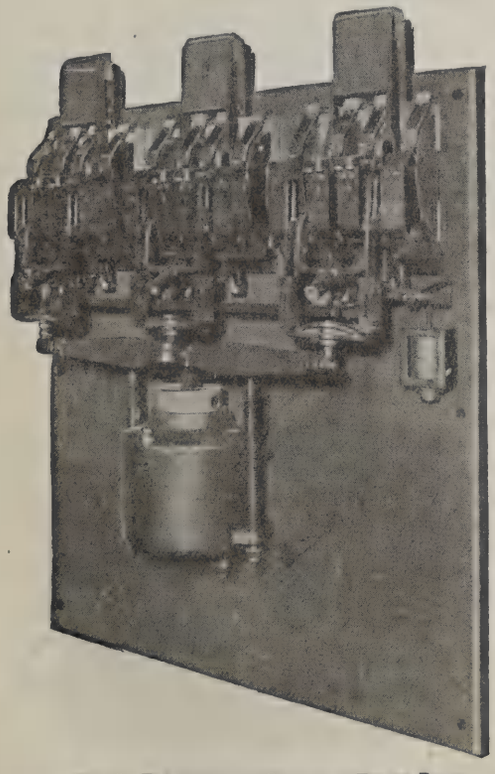


FIG. 9—ELECTRICALLY OPERATED THREE-POLE 12,000-AMPERE

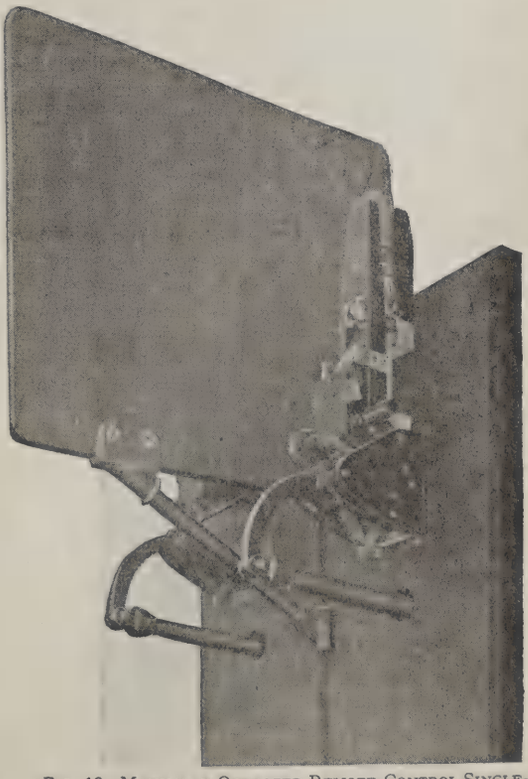


FIG. 10—MANUALLY OPERATED REMOTE-CONTROL SINGLE-POLE 400-AMPERE 1500-VOLT, WITH BARRIER

The electrically operated multipole breakers are supplied in any standard number of poles and in any standard ampere capacity in which the type CA line is listed. They have a separate electro-magnet for closing each pole and a single shunt-trip magnet acting through a common trip mechanism for tripping all poles of the breaker together.

Single electro-magnets are supplied on special order for closing all capacities of breakers up to 8000 amperes four poles, 14,000 amperes three poles, and 20,000 amperes two poles.

Type CA Multipole Circuit-Breaker Standard Mounting Centers (Distance Between Center Lines of Individual Poles)

Amperes Direct-Current	300 AND 750-VOLT SERVICE Standard Distance With or Without Barriers, Inches	Minimum Distance With Barriers, Inches
150 to 2500	10	7
3000 to 4000	13	10
6000	16	13
8000	18	15
10000	20	17
14000	24	20

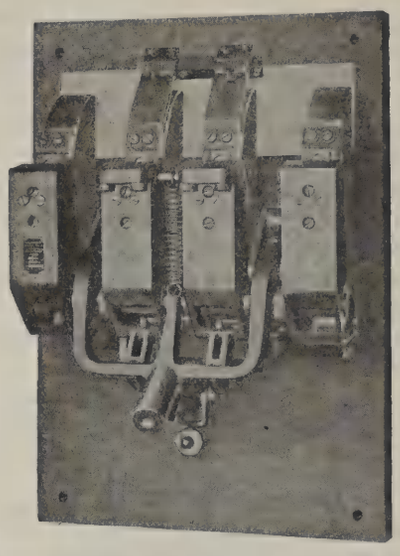


FIG. 11—MANUALLY OPERATED DIRECT-CONTROL SINGLE-POLE 14,000-AMPERE WITHOUT CONTACT ARMS

ACCESSORIES

Auxiliary Tripping Attachments

Attachments Applied—Any single auxiliary trip attachment is arranged to trip all poles of a multipole type CA carbon circuit-breaker, and therefore one attachment can be used for all poles. If proper space between poles (or pole centers) is allowed, one attachment per pole can be used, if desired. The usual location for the shunt-trip is on the right side of the breaker when facing the front of the panel, the undervoltage trip on the left side, the inverse-time-limit below the breaker; the reverse-current-trip is also located below the breaker and below the time-limit attachment if used; the equalizer contacts on and behind, but insulated from and supported by the main contact brush or bridge; and the signal-contact attachment behind the panel, between the contact terminal studs of the breaker. The electric operating solenoid magnet is mounted below the breaker proper at various distances as required by the presence or absence of any of the attachments that are mounted below the breaker.

Shunt-Trip Attachment—Direct-current shunt-trip attachments arranged for mounting on the front of the panel are listed for all capacities of manually operated type CA breakers.

Automatic Undervoltage-Trip Attachment—A direct-current automatic undervoltage-trip attach-

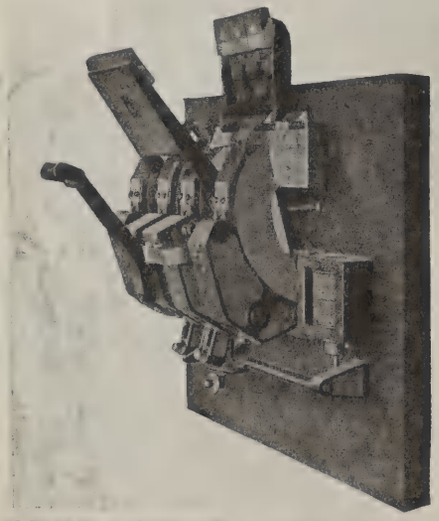


FIG. 12—MANUALLY OPERATED DIRECT-CONTROL SINGLE-POLE 10,000-AMPERE, WITH SHUNT-TRIP ATTACHMENT

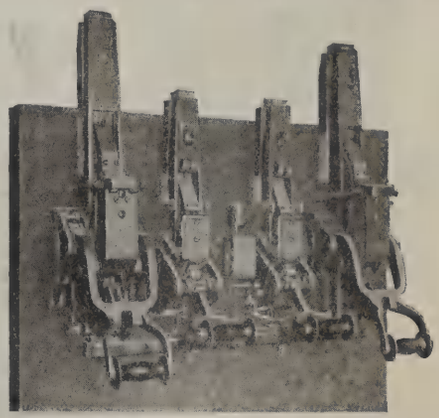


FIG. 13—MANUALLY OPERATED DIRECT-CONTROL SPECIAL FOUR-POLE EQUALIZER BREAKER WITH UNDERVOLTAGE ATTACHMENT AND COMMON TRIP

TYPE CA CARBON CIRCUIT-BREAKERS—Continued

ment is listed for the several capacities of type CA breaker. This attachment is reset automatically by the opening of the circuit-breaker.

An alternating-current undervoltage-trip attachment similar to the direct-current attachment can be supplied on special order.

Inverse-Time-Limit Attachment—An inverse-time-limit dashpot with an adjustable time feature is listed for all sizes of type CA breakers up to and including 2500 amperes direct-current and 1600 amperes alternating-current, in any number of poles up to four poles, and for both manually or electrically operated breakers. A similar attachment for the larger capacity breakers can be supplied on special order.

Reverse-Current-Trip Attachment—An attachment for tripping the type CA carbon circuit-breaker on reversal of current in direct-current service is listed to be applied to any regular type CA carbon circuit-breakers of capacities up to 20,000 amperes.

Equalizer Contacts

Equalizer contacts are listed and can be provided on type CA breakers in capacities up to 2500 direct-current, but are not provided with overload protection in the equalizer circuit. Equalizer contacts are not usually supplied above 2500 amperes capacity, direct current. Either standard multipole breakers or special multipole breakers having equalizer poles of lower capacity than the main poles can be used.

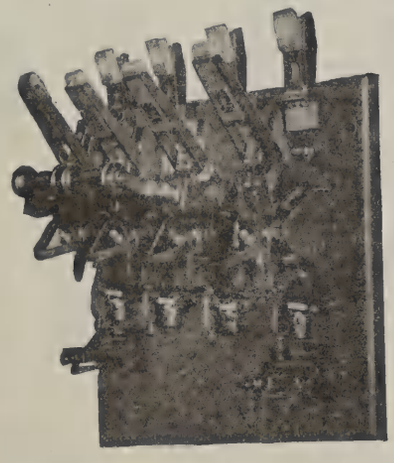


FIG. 15—MANUALLY OPERATED DIRECT CONTROL FOUR-POLE 1000-AMPERE, WITH INVERSE-TIME-LIMIT AND AUTOMATIC-REVERSE-CURRENT-TRIP ATTACHMENTS

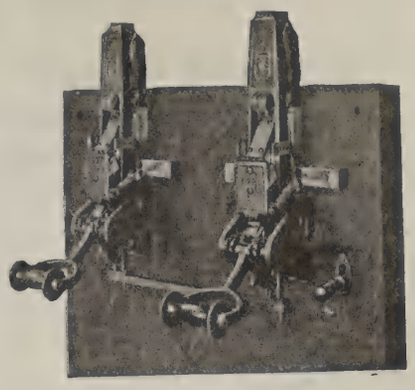


FIG. 14—MANUALLY OPERATED DIRECT-CONTROL TWO-POLE 2500-AMPERE WITH EQUALIZER CONTACTS, UNDERVOLTAGE AND COMMON TRIPS

Barriers

Barriers are not included with the standard breakers and where needed should be ordered separately from pages listing Accessories.

Bases

Bases are included with the standard separate mounting breakers as listed in the tables on following pages.

The style number of the separate mounting round stud single-pole manually operated breakers include a black-marine slate base of the following sizes with $\frac{9}{16}$-inch mounting holes, 3 inches from top, $2\frac{1}{2}$ inches from bottom and $1\frac{3}{8}$ inches from sides, with all front edges beveled $\frac{1}{2}$-inch by $\frac{1}{2}$-inch.

Slate

Breaker Capacity Amperes	Size of Panel or Base, Inches		
	Width	Length	Thickness
2500 and less	20	20	2
3500 to 4000	20	25	2
4500 to 8000	24	25	$2\frac{1}{2}$

Marble

2500 and less	20	16	2
3500 to 4000	20	25	$2\frac{1}{2}$
4500 to 8000	24	25	$2\frac{1}{2}$

For special bases see pages listing Type CA Accessories

TYPE CA CARBON CIRCUIT-BREAKERS—Continued

TABLE I

MANUALLY OPERATED CARBON CIRCUIT-BREAKERS

Separate Mounting—Direct-Current—Single-Pole

Rear-Connected—Round Studs—Automatic

Max. Amperes 30° Rating	Max. Amperes 20° Rating	Max. Volts	Type	Approx. Shipping Wt. Lbs.	Style No.	List Price
150	150	750	CA	125	189038	$197 00
200	200	750	CA	125	188530	197 00
300	300	750	CA	130	261070	200 00
400	400	750	CA	130	286961	200 00
600	600	750	CA	130	261071	210 00
800	800	750	CA	130	271966	210 00
1200	1000	750	CA	135	271968	240 00

TABLE II

MANUALLY OPERATED CARBON CIRCUIT-BREAKERS

Panel Mounting—For Direct Current

Single-Pole

Rear-Connected—Automatic

Max. Amperes 30° Rating	Max. Amperes 20° Rating	Max. Volts	Type	Studs † Top	Studs † Bottom	Approx Shipping Wt. Lb.	Style No.	List Price	Black Marine Slate Base Style No.‡
150	150	750	CA	Round	Round	125	189030	$ 172 00	.....
200	200	750	CA	Round	Round	125	169826	172 00	.....
300	300	750	CA	Round	Round	130	261066	175 00	.....
400	400	750	CA	Round	Round	130	262561	175 00	.....
600	600	750	CA	Round	Round	135	261067	186 00	.....
800	800	750	CA	Round	Round	140	271971	186 00	.....
1200	1000	750	CA	Round	Round	150	271973	217 50	.....
1600	1200	750	CA	Hor.	Vert.	145	261087	255 00	.....
2000	1600	750	CA	Hor.	Vert.	150	233102	285 00	267821
3000	2400	750	CA	Hor.	Vert.	250	229553	400 00	267824
4000	3000	750	CA	Hor.	Vert.	325	233106	510 00	267826
6000	5000	750	CA	Hor.	Vert	450	198466	750 00	267828
8000	6000	750	CA	Hor.	Vert.	*	198467	980 00	267830
10000	9000	750	CA	Hor.	Vert.	*	198468	1210 00	267832
14000	12000	750	CA	Hor.	Vert.	*	198469	1800 00	267834

*Approximate shipping weights will be furnished on application.
†Vert. indicates studs vertically laminated; hor., horizontally laminated.
‡For list prices refer to pages on Type CA Carbon Circuit-Breaker Accessories.
For information as to what material is furnished with these breakers, see "Instructions for Ordering Carbon Circuit-Breakers," on ■ previous page.

Order by Style Number

TYPE CA CARBON CIRCUIT-BREAKERS—Continued

TABLE III

MANUALLY OPERATED CARBON CIRCUIT-BREAKERS

Panel Mounting—For Direct-Current

Single-Pole

Rear-Connected—Non-Automatic

Max. Amperes 30° Rating	Max. Amperes 20° Rating	Max. Volts	Type	Studs† Top	Studs† Bottom	Approx. Shipping Wt.,Lb.	Style No.	List Price	Black Marine Slate Base Style No.‡
200	200	750	CA	Round	Round	125	225440	$172 00	267793
300	300	750	CA	Round	Round	130	261068	175 00	267794
400	400	750	CA	Round	Round	130	286960	175 00	267794
600	600	750	CA	Round	Round	135	261069	186 00	267795
800	800	750	CA	Round	Round	140	225448	186 00	267796
1200	1000	750	CA	Round	Round	140	225452	217 50	267798
1600	1200	750	CA	Hor.	Vert.	145	261107	255 00	267817
2000	1600	750	CA	Hor.	Vert.	150	233108	285 00	267821
3000	2400	750	CA	Hor.	Vert.	250	233110	400 00	267825
4000	3000	750	CA	Hor.	Vert.	325	233112	510 00	267827
6000	5000	750	CA	Hor.	Vert.	400	198495	750 00	267829
8000	6000	750	CA	Hor.	Vert.	500	198496	980 00	267831
10000	9000	750	CA	Hor.	Vert.	*	198497	1210 00	267833
14000	12000	750	CA	Hor.	Vert.	*	198498	1800 00	267835

TABLE IV

MANUALLY OPERATED CARBON CIRCUIT-BREAKERS

Panel Mountings—For 25-Cycle Alternating Current

Single-Pole

Rear-Connected—Automatic

Max. Amperes 30° Rating	Max. Amperes 20° Rating	Max. Volts	Type	Studs† Top	Studs† Bottom	Approx. Shipping Wt.,Lb.	Style No.	List Price	Black Marine Slate Base Style No.‡
150	150	750	CA	Round	Round	125	249407	$172 00	267793
200	200	750	CA	Round	Round	125	249408	172 00	267793
300	300	750	CA	Round	Round	130	261074	175 00	267794
400	400	750	CA	Round	Round	130	286963	175 00	267794
600	...	750	CA	Round	Round	135	261075	186 00	267795
800	800	750	CA	Round	Round	140	249412	186 00	267796
1200	1000	750	CA	Round	Round	140	249414	217 50	267798
1500	1200	750	CA	Hor.	Vert.	145	261183	255 00	267817
1800	1400	750	CA	Hor.	Vert.	150	261184	285 00	267821
2750	2400	750	CA	Hor.	Vert.	250	247618	400 00	267824
3500	3000	750	CA	Hor.	Vert.	325	247619	510 00	267826
4500	4000	750	CA	Hor.	Vert.	400	247620	750 00	267828
6000	5000	750	CA	Hor.	Vert.	500	247621	980 00	267830
8000	6000	750	CA	Hor.	Vert.	*	247622	1210 00	267832
10000	8000	750	CA	Hor.	Vert.	*	247623	1800 00	267834

*Approximate shipping weights will be furnished on application..
†Vert. indicates studs vertically laminated; hor., horizontally laminated.
‡For list prices refer to pages on Type CA Carbon Circuit-Breaker accessories.
For information as to what material is furnished with these breakers, see "Instructions for Ordering Carbon Circuit-Breakers" on a previous page.

Order by Style Number

TYPE CA CARBON CIRCUIT-BREAKERS—Continued

TABLE V

MANUALLY OPERATED CARBON CIRCUIT-BREAKERS

Panel Mounting—For 25-Cycle Alternating Current

Single-Pole

Rear-connected—Non-automatic

Max. Amperes 30° Rating	Max. Amperes 20° Rating	Max. Volts	Type	Studs† Top	Studs† Bottom	Approx. Shipping Wt.,Lb.	Style No.	List Price	Black Marine Slate Base Style No.‡
200	200	750	CA	Round	Round	125	225440	$172 00	267793
300	300	750	CA	Round	Round	130	261068	175 00	267794
400	400	750	CA	Round	Round	130	286960	175 00	267794
600	600	750	CA	Round	Round	135	261069	186 00	267795
800	800	750	CA	Round	Round	140	225448	186 00	267796
1200	1000	750	CA	Round	Round	140	225452	217 50	267798
1500	1200	750	CA	Hor.	Vert.	145	261107	255 00	267817
1800	1400	750	CA	Hor.	Vert.	150	233108	285 00	267821
2750	2400	750	CA	Hor.	Vert.	250	233110	400 00	267825
3500	3000	750	CA	Hor.	Vert.	325	233112	510 00	267827
4500	4000	750	CA	Hor.	Vert.	400	198495	750 00	267829
6000	5000	750	CA	Hor.	Vert.	500	198496	980 00	267831
8000	6000	750	CA	Hor.	Vert.	*	198497	1210 00	267833
10000	8000	750	CA	Hor.	Vert.	*	198498	1800 00	267835

TABLE VI

MANUALLY OPERATED CARBON CIRCUIT-BREAKERS

Panel Mounting —For 60-Cycle Alternating Current

Single-Pole

Rear-connected—Automatic

Max. Amperes 30° Rating	Max. Amperes 20° Rating	Max. Volts	Type	Studs† Top	Studs† Bottom	Approx. Shipping Wt.,Lb.	Style No.	List Price	Black Marine Slate Base Style No.‡
150	150	750	CA	Round	Round	125	249418	$172 00	267793
200	200	750	CA	Round	Round	125	249419	172 00	267793
300	300	750	CA	Round	Round	130	261076	175 00	267794
400	400	750	CA	Round	Round	130	286964	175 00	267794
600	600	750	CA	Round	Round	135	261077	186 00	267795
800	800	750	CA	Round	Round	140	249423	186 00	267797
1000	900	750	CA	Round	Round	140	249424	217 50	267798
1200	1000	750	CA	Hor.	Vert.	145	261194	255 00	267817
1600	1200	750	CA	Hor.	Vert.	150	261195	285 00	267821
2400	2000	750	CA	Hor.	Vert.	150	247642	400 00	267824
3000	2400	750	CA	Hor.	Vert.	325	247643	510 00	267826
4000	3000	750	CA	Hor.	Vert.	400	247644	750 00	267828
5000	4000	750	CA	Hor.	Vert.	500	247645	980 00	267830
6000	5000	750	CA	Hor.	Vert.	650	247646	1210 00	267832
7000	6000	750	CA	Hor.	Vert.	*	247647	1800 00	267834

TABLE VII

MANUALLY OPERATED CARBON CIRCUIT-BREAKERS

Panel Mounting—For 60-Cycle Alternating Current

Single-Pole

Rear-connected—Non-automatic

Max. Amperes 30° Rating	Max. Amperes 20° Rating	Max. Volts	Type	Studs† Top	Studs† Bottom	Approx. Shipping Wt., Lb.	Style No.	List Price	Black Marine Slate Base Style No.‡
200	200	750	CA	Round	Round	125	225440	$172 00	267793
300	300	750	CA	Round	Round	130	261068	175 00	267794
400	400	750	CA	Round	Round	130	286960	175 00	267794
600	600	750	CA	Round	Round	135	261069	186 00	267795
800	800	750	CA	Round	Round	140	225448	186 00	267796
1000	900	750	CA	Round	Round	150	222452	217 50	267798
1200	1000	750	CA	Hor.	Vert.	145	261107	255 00	267817
1600	1200	750	CA	Hor.	Vert.	150	233108	285 00	267821
2400	2000	750	CA	Hor.	Vert.	250	233110	400 00	267825
3000	2400	750	CA	Hor.	Vert.	325	233112	510 00	267827
4000	3000	750	CA	Hor.	Vert.	400	198495	750 00	267829
5000	4000	750	CA	Hor.	Vert.	500	198496	980 00	267835
6000	5000	750	CA	Hor.	Vert.	*	198497	1210 00	267833
7000	6000	750	CA	Hor.	Vert.	*	198498	1800 00	267831

*Approximate shipping weights will be furnished on application.
†Vert. indicates studs vertically laminated; hor., horizontally laminated.
‡For list prices refer to pages on Type CA Carbon Circuit-Breaker Accessories.
For information as to what material is furnished with these breakers, see "Instructions for Ordering Carbon Circuit-Breakers" on a previous page.

Order by Style Number

TABLE VIII

ELECTRICALLY OPERATED TYPE CA CARBON CIRCUIT-BREAKERS

Rear Connected—Single-Pole—750 Volts

The single-pole, electrically operated, type CA carbon circuit-breakers listed below will have a total list price equal to the list price of the corresponding manually operated panel-mounting breakers, plus the list price of the proper electric mechanism indicated below.

ELECTRIC MECHANISM

AMPERE CAPACITY OF BREAKERS*			
Direct Current	Alternating Current		List Price
	25-cycle	60-cycle	
150 to 2000	150 to 2000	150 to 1600	$136 00
3000 to 4000†	2750 to 3500	2400 to 3000	205 00
6000 to 8000	4500 to 6000	4000 to 5000	295 00
10000 to 14000	8000 to 10000	6000 to 7000	380 00

*30° basis of rating.

†3500 and 4500-ampere breakers are not supplied electrically operated.

‡The prices shown are not for the parts themselves but are additional prices covering breaker and mechanism on the same order.

TABLE IX

CONTACTOR-TYPE ELECTRICALLY OPERATED CARBON CIRCUIT-BREAKERS

Single-Pole—750 Volts

AMPERE CAPACITY OF BREAKERS*				
Direct Current	Alternating Current		Studs	List Price
	25-cycle	60-cycle		
1200	1200	1000	Round	†
1600	1500	1200	Round	†
2000	1800	1600	Round	†
3000	2750	2400	Laminated	†
4000	3500	3000	Laminated	†
6000	4500	4000	Laminated	†

*30° basis of rating.

†The list price of the contactor-type circuit-breaker is the same as that for the corresponding single-pole electrically operated breaker. These circuit-breakers are made only in the capacities given.

TABLE X

MANUALLY OPERATED REMOTE-CONTROL CARBON CIRCUIT-BREAKERS

Single-Pole—1500 Volts—For Direct Current

Automatic—Round-Stud

Amperes	List Price	Amperes	List Price
150	†	1600	†
200	†	2000	†
300	†		
400	†		
600	†		
800	†		
1200	†		

†The manually operated, remote-control, automatic single-pole, round-stud breakers will have a total list price equal to the list price of the corresponding manually operated panel-mounting breaker plus a list price of $90.00

For information as to what material is furnished with these breakers, see "Instructions for Ordering Carbon Circuit-Breakers" on a previous page.

Order by Style Number

TABLE XI

MULTIPOLE MANUALLY OPERATED CARBON CIRCUIT-BREAKERS
750 Volts

Multipole manually operated breakers with separate closing handles per pole and common trip, up to and including 8000 amperes* capacity direct-current, 6000 amperes* capacity 25-cycle alternating-current, and 5000 amperes* capacity 60-cycle alternating-current, will have a total list price equal to the sum of the list prices of the corresponding single-pole panel-mounting breakers.

Multipole manually operated breakers with single closing handle, cross-bar, and common trip will be supplied on breakers up to and including 2500 amperes* capacity direct-current, 2000 amperes* capacity 25-cycle alternating-current, and 1600 amperes* capacity 60-cycle alternating-current, at the same price as the sum of the list prices of the corresponding single-pole panel-mounting breakers, making up the multipole breaker.

TABLE XII

MULTIPOLE ELECTRICALLY OPERATED CARBON CIRCUIT-BREAKERS
750 Volts

Multipole electrically operated circuit-breakers with separate electric mechanisms for each pole and with common trip will be supplied at a total list price equal to the sum of the list prices of the corresponding single-pole manually operated panel-mounting circuit-breakers plus the list price of the proper electric mechanism for capacities indicated in table XI.

Multipole electrically operated circuit-breakers with single or common electric mechanisms for all poles will be supplied at a total list price equal to the sum of the list prices of the corresponding single-pole manually operated panel-mounting circuit-breakers, plus the list price of the proper electric mechanism for the capacities indicated below.

ELECTRIC MECHANISM

AMPERE CAPACITY OF BREAKERS*			
Direct Current	Alternating Current		List Price†
	25-cycle	60-cycle	
Two-Pole Circuit-Breaker			
150 to 2500	150 to 2000	150 to 1600	$230 00
3000 to 4000	2700 to 3500	2400 to 3000	365 00
6000 to 14000	4500 to 10000	4000 to 7000	670 00
Three-Pole Circuit-Breaker			
150 to 2500	150 to 2000	150 to 1600	295 00
3000 to 4000	2750 to 3500	2400 to 3000	350 00
6000 to 8000	4500 to 6000	4000 to 5000	670 00
10000 to 14000	8000 to 10000	6000 to 7000	835 00

*30° basis of rating.

†The prices shown are not for the parts themselves but are additional prices covering breaker and mechanism on the same order.

TABLE XIII

TYPE CA FIELD DISCHARGE CIRCUIT-BREAKERS
Manually and Electrically Operated
250 Volts—Direct Current

MANUALLY OPERATED BREAKERS

Max. Amps.	Single-Pole		Two-Pole		List Price
	Without Shunt Trip	With Shunt Trip and Auxiliary Switch	Without Shunt Trip	With Shunt Trip and Auxiliary Switch	
800	268174	268179	268184	268189	*
1200	268175	268180	268185	268190	*
1600	268176	268181	268186	269191	*
2000	268177	268182	268187	268192	*

ELECTRICALLY OPERATED BREAKERS
Electric Operating Mechanism for Voltages of 93 to 143 Volts

Max. Amps.	Single-Pole	Two-Pole	List Price
800	268194	268199	*
1200	268195	268200	*
1600	268196	268201	*
2000	268197	258202	*

*Prices will be furnished on request.

For information as to what material is furnished with these breakers, see "Instructions for Ordering Carbon Circuit-Breakers" on a previous page.

ACCESSORIES FOR TYPE CA CARBON CIRCUIT-BREAKERS

The list prices given for the following accessories cover assembly with the breaker at the Works and are additional to the list price of the breaker.

Shunt-Trip Attachments

Style number does not include coil or cutout, which must be specified on order by style number from table below. List price includes mechanism with coil but without cutout which is priced below.

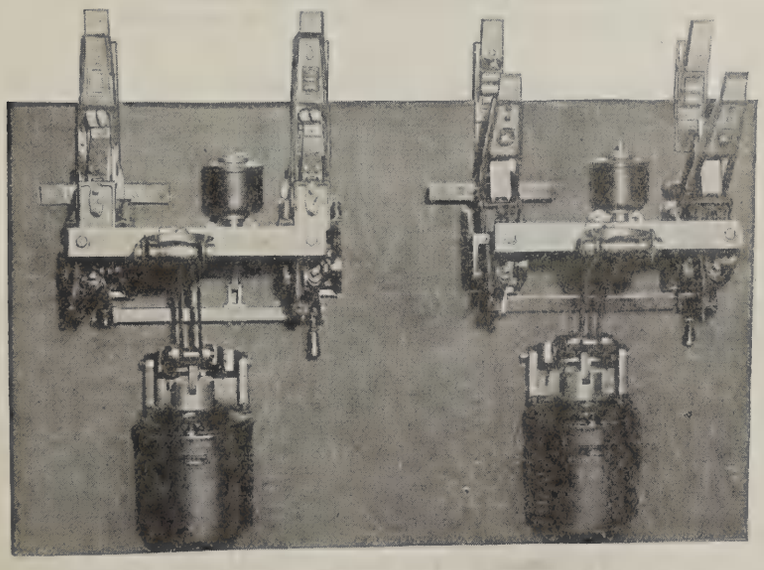
Breakers: Capacity Amperes D.C.	Poles	Overload	Wt., Pounds Net	Wt., Pounds Boxed	Style No.	List Price
150 to 2000	Single-pole	*	6	8	235877	$15 00
150 to 2000	Multipole	*	6	8	235878	15 00
3000	Single-pole and Multipole	*	8	12	235881	15 00
4000	Single-pole and Multipole	*	8	12	235881	15 00
6000	Single-pole and Multipole	Auto.	8	12	235882	15 00
6000	Single-pole and Multipole	Non-auto.	8	12	235883	15 00
8000	Single-pole and Multipole	Auto.	8	12	235884	15 00
8000	Single-pole and Multipole	Non-auto.	8	12	235885	15 00
10000	Single-pole and Multipole	Auto.	11	17	240488	15 00
10000	Single-pole and Multipole	Non-auto.	11	17	240489	15 00
14000	Single-pole and Multipole	Auto.	11	17	240490	15 00
14000	Single-pole and Multipole	Non-auto.	11	17	240491	15 00

*For either automatic or non-automatic breakers.

Coils for Shunt-Trip Attachments

The coils listed below are for use with the above shunt-trip attachments and must be ordered separately.

Breaker Capacity Amperes, D. C.	Volts D. C.	Weight, Pounds Net	Weight, Pounds Boxed	Style No.
150 to 2000	110	1½	2½	272861
150 to 2000	125	1½	2½	235879
150 to 2000	220	1½	2½	272862
150 to 2000	250	1½	2½	235887
150 to 2000	500 and 600	1½	2½	220619
3000 to 8000	110 and 125	2½	4	272931
3000 to 8000	220 and 250	2½	4	272932
3000 to 8000	440 and 500	2½	4	272933
3000 to 8000	600	2½	4	272934
3000 to 8000	750	2½	4	201397
10000 to 14000	110 and 125	3½	5	240485
10000 to 14000	220 and 250	3½	5	240486
10000 to 14000	440, 500 and 600	3½	5	240487



TYPE CA FIELD-DISCHARGE CIRCUIT-BREAKER, ELECTRICALLY-OPERATED REMOTE-CONTROL, TWO-POLE, WITH EQUALIZER CONTACT ON LEFT-HAND POLE

TYPE CA CARBON CIRCUIT-BREAKERS—Continued

ACCESSORIES FOR TYPE CA BREAKERS—Continued

Undervoltage Release Attachments

Style number includes mechanism complete without coil. List price includes mechanism complete with coil which must be specified from table below.

Breaker Capacity Amperes, D. C.	Poles	Overload	Weight, Pounds Net	Weight, Pounds Boxed	Style No.	List Price
150 to 2000	Single	*	9	11	240492	$22 00
150 to 2000	Multiple	*	9	11	240493	22 00
3000 and 4000	Single	*	12	16	241168	22 00
3000 and 4000	Multiple	*	12	16	241173	22 00
6000	Single	Auto	12	16	241169	22 00
6000	Single	Non-auto	12	16	241170	22 00
6000	Multiple	Auto	12	16	241174	22 00
6000	Multiple	Non-auto	12	16	241175	22 00
8000	Single	Auto	12	16	241171	22 00
8000	Single	Non-auto	12	16	241172	22 00
8000	Multiple	Auto	12	16	241176	22 00
8000	Multiple	Non-auto	12	16	241177	22 00
10000	Single	Auto	20	26	272863	22 00
10000	Single	Non-auto	20	26	272864	22 00
10000	Multiple	Auto	20	26	272867	22 00
10000	Multiple	Non-auto	20	26	272868	22 00
14000	Single	Auto	20	26	272865	22 00
14000	Single	Non-auto	20	26	272866	22 00
14000	Multiple	Auto	20	26	272869	22 00
14000	Multiple	Non-auto	20	26	272870	22 00
For Breakers with Equalizer Contacts						
	Single	*	12	17	272880	$22 00
	Multiple	*	12	17	272881	22 00

*For either automatic or non-automatic breakers.

Coils for Undervoltage Release Attachments

The coils listed below are for use with the above undervoltage mechanisms and must be ordered separately.

Breaker Capacity Amperes D. C.	Volts D. C.	Weight, Pounds Net	Weight, Pounds Boxed	Style No.
150 to 2000	125	1½	2½	240494
3000 to 8000	125	2½	4	272860
10000 to 14000	125	3½	5	241190
For Breaker with Equalizer Contacts				
150 to 4500	125	1½	2½	201480

Inverse-Time-Limit Attachments

One inverse-time-limit attachment required for each overload trip mechanism.

Breaker Capacity Amperes, D. C.	With Reverse Current Trip	Poles	Weight, Pounds Net	Weight, Pounds Boxed	Style No.	List Price
150 to 2000	No	Multiple	4	6	233066	$54 50
150 to 2000	Yes	Multiple	4	6	233067	54 50
150 to 2000	No	Single	4	6	272884	54 50
150 to 2000	Yes	Single	4	6	272885	54 50
3000 and 4000	No	Single or Multiple	12	12	272886	61 00
6000	No	Single or Multiple	15	22	272887	61 00
8000	No	Single or Multiple	15	22	272888	61 00
10000	No	Single or Multiple	15	22	272889	61 00
14000	No	Single or Multiple	15	22	272890	61 00

Reverse-Current-Trip Attachments

Style number and list price include mechanism complete without shunt coils. List price includes mechanism complete with coils which must be specified on order from table below.

Breaker Capacity Amperes D. C.	Weight, Pounds Net	Weight, Pounds Boxed	Style No.	List Price
For Breaker without Inverse-Time-Limit				
150 and 200	15	20	241430	$150 00
300 and 400	15	20	241431	150 00
600 and 800	15	20	241432	150 00
1000 to 2000	15	20	241433	182 00
3000 and 4000 (auto)	15	20	241436	230 00
3000 and 4000 (non-auto)	15	20	241435	230 00
For Breaker with Inverse-Time-Limit				
150 and 200	15	20	241437	152 00
300 and 400	15	20	241438	152 00
600 and 800	15	20	241439	152 00
1000 to 2000	15	20	270452	184 00
3000 and 4000	15	20	270466	242 50

ACCESSORIES FOR TYPE CA BREAKERS—Continued

Coils for Reverse-Current-Trip Attachments

The coils listed below are for use with the Reverse-Current Trip Attachments listed on the preceding page and must be ordered separately. Four coils are required with each trip mechanism.

Volts	Weight, Pounds Net	Boxed	Style No.
125	1½	2½	241442
250	1½	2½	241443
600	1½	2½	241445

Equalizer Contacts

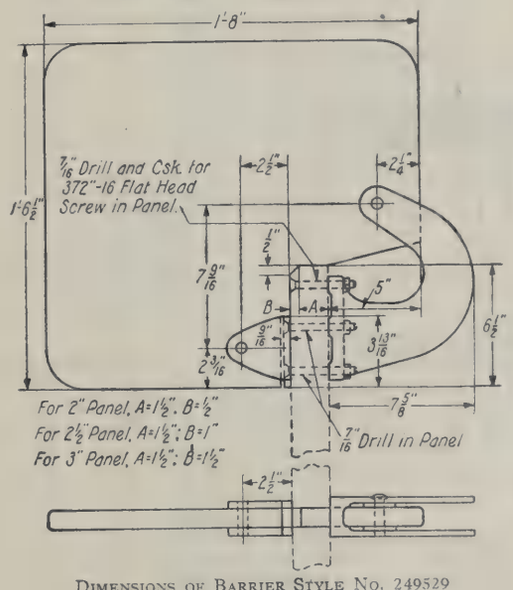
Breaker Capacity Amperes D. C.	Weight, Pounds Net	Boxed	Style No.	List Price
150 to 400	5	8	272891	$81 00
600 and 800	8	12	272892	81 00
1000 to 2000	11	16	272893	95 00

Barriers with Brackets

Style number and list price include barrier complete with brackets for mounting on panel.

Description	Style No.	List Price
Black Marine-finished Slate	249529	$48 00
Monson Slate	*	50 00
Blue Vermont Marble	*	56 50
Black Marine-finished Marble	*	52 50

*Order by description.



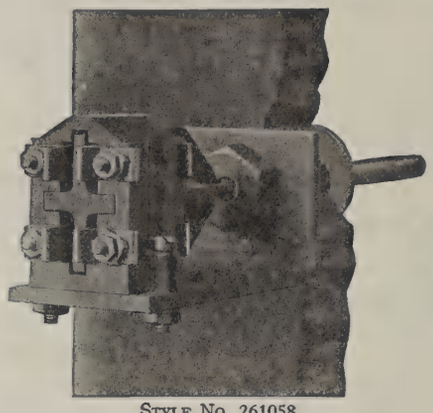
Dimensions of Barrier Style No. 249529 With Brackets

ACCESSORIES FOR TYPE CA BREAKERS—Continued

Signal and Auxiliary-Circuit Switches

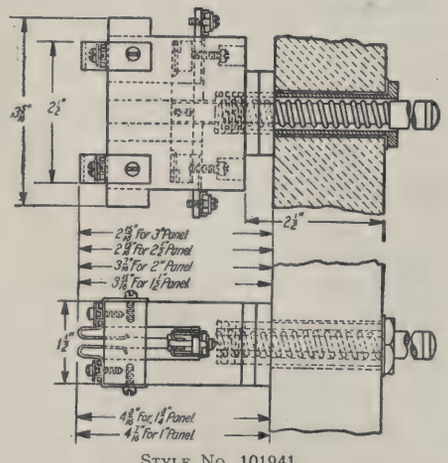
Two forms of signal and auxiliary circuit switches are listed. The only practical difference in the switches is in the method of mounting and construction. Both forms of switches are made from a bakelite compound, but Style No. 261058 is of heavier construction than the others.

In both forms, one set of contacts is normally closed while the other set is normally open; pushing the button opens the first set of contacts and then closes the second set. The contacts are of the sliding type, which insures good electrical connection regardless of side thrust in the operation of the plunger. The first form of switch is single-pole, double-throw, and the second form double-pole, double-throw.

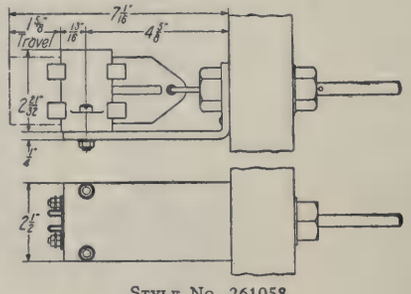


STYLE No. 261058

Both forms of switches are adapted for use in auxiliary circuits for such purposes as ringing alarm bells, operating shunt trip or no-voltage release for electrically-operated circuit-breakers, interlocking circuits, etc. Style No. 261058 is frequently used in connection with knife switches, in which case it is mounted in such a position that closing the knife switch pushes in the button and opening the knife switch releases the button.



STYLE No. 101941



STYLE No. 261058

Used with Capacity of Breakers	Capacity Amperes	Maximum Volts	Amperes Interrupt'g Capacity	Number Contacts	Panel Thickness Inches	Style No.	List Price Each
Up to 2500 amperes	10 at 250 V. 5 at 600 V.	600	10 at 250 V. 5 at 600 V.	.....	2½	101941	$10 00
3000 amperes and higher	5 at 600 V.	600	5 at 600 V.	.....	2½	248981	15 75
3000 amperes and higher	5 at 600 V.	600	5 at 600 V.	.....	3	248982	15 75
3000 amperes and higher	5 at 600 V.	600	5 at 600 V.	.....	3½	248983	15 75
Any capacity	15	250	5 at 250 V. 10 at 125 V.	Double	2	261058	15 75
Spacer for use with style Nos. 101941 and 248981 for each one-quarter inch panel that is thinner than 2½ inches.	.....	...	.....	.....	...	270305	15

Control Switches and Control Relays

For the prices, weights and dimensions of control switches (drum control switches) and control relays, refer to Section 2-B on Switchboard Accessories.

ACCESSORIES FOR TYPE CA REAR-CONNECTED CARBON CIRCUIT-BREAKERS

Black Marine-Finished Slate Bases

(Refer to Price Table for Application of Bases)

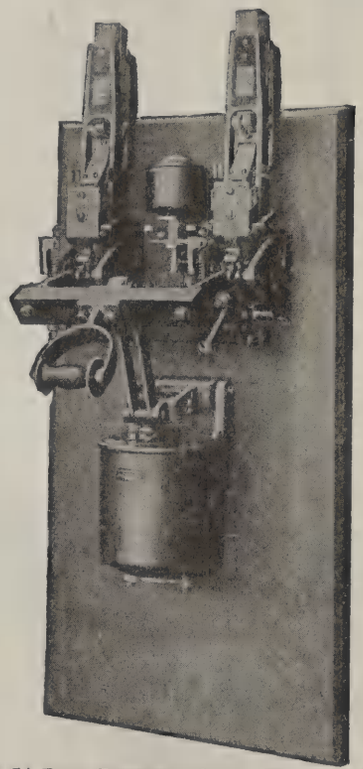
Style No.	Size in Inches Height	Width	Thickness	Approx. Wt., Lbs. Net	Boxed	List Price
267793	20	16	2	145	179	$16 50
267794	20	16	2	145	179	16 75
267795	20	16	2	145	179	17 00
267796	20	16	2	145	179	17 00
267797	20	16	2	145	179	18 25
267798	20	16	2	145	179	19 25
267799	20	16	2	145	179	19 25
267800	20	16	2	145	179	20 00
267801	20	16	2	145	179	22 00
267802	20	36	2	145	179	22 00
267803	25	20	2	100	130	26 00
267804	25	20	2	100	130	26 00
267806	25	20	2	100	130	26 00
267808	25	24	2½	155	190	31 25
267810	25	24	2½	155	190	36 50
267811	20	16	2	65	89	20 75
267812	20	16	2	65	89	20 75
267813	20	16	2	65	89	20 75
267814	20	16	2	65	89	20 75
267815	20	16	2	65	89	22 00
267816	20	16	2	65	89	22 75
267817	20	16	2	65	89	22 75
267818	20	16	2	65	89	23 75
267819	20	16	2	65	89	23 75
267820	20	16	2	65	89	23 75
267821	20	16	2	65	89	23 75
267822	20	16	2	65	89	24 75
267823	20	16	2	65	89	24 75
267824	25	20	2	100	130	33 00
267825	25	20	2	100	130	33 00
267826	25	20	2	100	130	34 00
267827	25	20	2	100	130	34 50
267828	25	24	2½	155	190	42 00
267829	25	24	2½	155	190	42 00
267830	25	24	2½	155	190	45 00
267831	25	24	2½	155	190	45 00
267832	25	32	3	245	286	80 00
267833	25	32	3	245	286	80 00
267834	25	32	3	245	286	80 00
267835	25	32	3	245	286	80 00
*267846	20	24	2	100	132	30 00
*267847	20	24	2	100	132	30 50
*267848	20	24	2	100	132	31 25
*267849	20	24	2	100	132	31 25
*267850	20	24	2	100	132	33 00
*267851	20	24	2	100	132	35 00
*267852	20	24	2	100	132	35 00
*267853	20	24	2	100	132	36 75
*267854	20	24	2	100	132	38 50
*267855	20	24	2	100	132	38 50
*267866	20	36	2	65	89	46 50
*267867	20	36	2	65	89	47 50
*267868	20	36	2	65	89	48 75
*267869	20	36	2	65	89	49 00
*267870	20	36	2	65	89	52 00
*267871	20	36	2	65	89	55 00
*267872	20	36	2	65	89	55 00
*267873	20	36	2	65	89	58 00
*267874	20	36	2	65	89	61 00
*267875	20	36	2	65	89	61 00
*267889	20	24	2	100	132	38 25
*267890	20	24	2	100	132	38 25
*267891	20	24	2	100	132	38 25
*267892	20	24	2	100	132	38 25
*267893	20	24	2	100	132	40 00
*267894	20	24	2	100	132	42 00
*267895	20	24	2	100	132	42 00
*267896	20	24	2	100	132	43 50
*267897	20	24	2	100	132	43 50
*267898	20	24	2	100	132	43 50
*267899	20	24	2	100	132	43 50
*267900	20	24	2	100	132	47 25
*267901	20	24	2	100	132	45 50
*267915	20	36	2	145	179	60 00
*267916	20	36	2	145	179	60 00
*267917	20	36	2	145	179	60 00
*267918	20	36	2	145	179	60 00
*267919	20	36	2	145	179	$63 00
*267920	20	36	2	145	179	65 50
*267921	20	36	2	145	179	65 50
*267922	20	36	2	145	179	67 50
*267923	20	36	2	145	179	67 50
*267924	20	36	2	145	179	67 50
*267925	20	36	2	145	179	67 50
*267926	20	36	2	145	179	67 50
*267927	20	36	2	145	179	69 50
*267928	32	16	2	105	136	29 00
*267929	32	16	2	105	136	29 50
*267930	32	16	2	105	136	30 75
*267931	32	16	2	105	136	30 75
*267932	32	16	2	105	136	32 75
*267933	32	16	2	105	136	33 75
*267934	32	16	2	105	136	33 75
*267935	32	16	2	105	136	34 50
*267936	32	16	2	105	136	36 50
*267937	32	16	2	105	136	36 50
*267938	20	45	2	185	228	43 50
*267939	20	45	2	185	228	43 50
*267940	20	45	2	185	228	43 50
*267941	20	45	2	185	228	43 50
*267942	45	24	2½	275	422	51 50
*267943	45	24	2½	275	422	52 00
*267944	45	24	2½	275	422	55 50
*267945	45	24	2½	275	422	55 50
*267946	32	16	2	105	136	34 00
*267947	32	16	2	105	136	34 00
*267948	32	16	2	105	136	34 00
*267949	32	16	2	105	136	34 00
*267950	32	16	2	105	136	36 00
*267951	32	16	2	105	136	36 50
*267952	32	16	2	105	136	36 50
*267953	32	16	2	105	136	37 50
*267954	32	16	2	105	136	37 50
*267955	32	16	2	105	136	37 50
*267956	32	16	2	105	136	37 50
*267957	32	16	2	105	136	38 50
*267958	32	16	2	105	136	38 50
*267959	45	20	2	185	228	50 00
*267960	45	20	2	185	228	50 00
*267961	45	20	2	185	228	50 00
*267962	45	20	2	185	228	50 00
*267963	45	20	2	185	228	65 50
*267964	45	20	2	185	228	59 50
*267965	45	20	2	185	228	70 00
*267966	45	20	2	185	228	65 50
*267967	45	32	3	440	497	90 00
*267968	45	32	3	440	497	86 50
*267969	45	32	3	440	497	95 00
*267970	45	32	3	440	497	87 00
*267985	36	24	2	175	217	48 50
*267986	36	24	2	175	217	49 00
*267987	36	24	2	175	217	51 00
*267988	36	24	2	175	217	51 00
*267989	36	24	2	175	217	53 50
*267990	36	24	2	175	217	55 50
*267991	36	24	2	175	217	55 50
*267992	36	24	2	175	217	56 50
*267993	36	24	2	175	217	55 00
*267994	36	24	2	175	217	53 50
*267995	45	32	2½	365	422	62 50
*267996	45	32	2½	365	422	62 50
*267997	45	32	2½	365	422	66 50
*267998	45	32	2½	365	422	66 50
*268016	36	24	2	175	217	58 00
*268017	36	24	2	175	217	58 00
*268018	36	24	2	175	217	58 00
*268019	36	24	2	175	217	58 00
*268020	36	24	2	175	217	60 50
*268021	36	24	2	175	217	62 00
*268022	36	24	2	175	217	62 00
*268023	36	24	2	175	217	64 00
*268024	36	24	2	175	217	64 00
*268025	36	24	2	175	217	64 00
*268026	36	24	2	175	217	64 00

*For application of these bases apply to nearest district office.

TYPE CA CARBON CIRCUIT-BREAKERS—Continued

Style No.	Size in Inches Height	Width	Thick-ness	Approx. Wt., Lbs. Net	Boxed	List Price
*268027	36	24	2	175	217	68 00
*268028	36	24	2	175	217	68 00
*268029	45	32	2½	365	422	67 00
*268030	45	32	2½	365	422	67 00
*268031	45	32	2½	365	422	71 50
*268032	45	32	2½	365	422	62 50
*268047	36	36	2	265	321	69 00
*268048	36	36	2	265	321	70 00
*268049	36	36	2	265	321	70 00
*268050	36	36	2	265	321	70 00
*268051	36	36	2	265	321	76 50
*268052	36	36	2	265	321	79 00
*268053	36	36	2	265	321	79 00
*268054	36	36	2	265	321	81 50
*268055	36	36	2	265	321	82 00
*268056	36	36	2	265	321	87 50
*268057	45	40	2½	460	548	100 00
*268058	45	40	2½	460	548	94 00
*268059	45	40	2½	460	548	109 00
*268060	45	40	2½	460	548	100 00
*268078	36	36	2	265	321	86 00
*268079	36	36	2	265	321	86 00
*268080	36	36	2	265	321	86 00
*268081	36	36	2	265	321	86 00
*268082	36	36	2	265	321	90 00
*268083	36	36	2	265	321	92 50
*268084	36	36	2	265	321	92 50
*268085	36	36	2	265	321	90 00
*268086	36	36	2	265	321	95 00
*268087	36	36	2	265	321	95 00
*268088	36	36	2	265	321	95 00
*268089	36	36	2	265	321	98 50
*268090	36	36	2	265	321	98 50
*268091	45	40	2½	460	548	115 00
*268092	45	40	2½	460	548	115 00
*268093	45	40	2½	460	548	125 00
*268094	45	40	2½	460	548	125 00

*For application of these bases apply to nearest district office.



TYPE CA FIELD DISCHARGE CIRCUIT-BREAKER—ELECTRICALLY OPERATED, 1000 TO 2500 AMPERES—CLOSING COIL ENERGIZED TO HOLD DOWN CORE AND HANDLE

TYPE CA CARBON CIRCUIT-BREAKERS—Continued

OUTLINE DIMENSIONS

Manually Operated—Automatic—Single-Pole—750 Volts

Capacities based on 30-degree rating

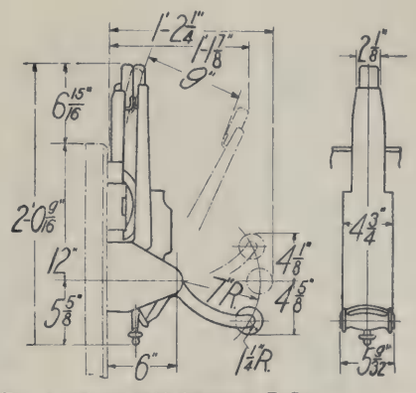


FIG. 1—150 TO 2500 AMPERES, D.C.
150 TO 2000 AMPERES, 25 CYCLES, A.C.
150 TO 1600 AMPERES, 60 CYCLES, A.C.

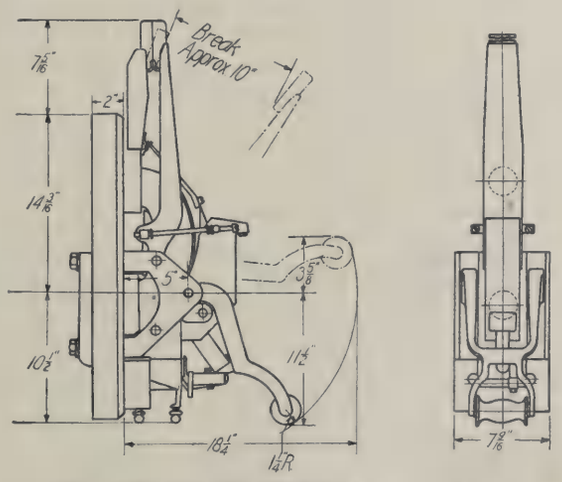


FIG. 2—3000 AND 4000 AMPERES, D.C.
2750 AND 3500 AMPERES, 25 CYCLES, A.C.
2400 AND 3000 AMPERES, 60 CYCLES, A.C

TYPE CA CARBON CIRCUIT-BREAKERS—Continued

OUTLINE DIMENSIONS

Manually Operated—Automatic—Single-Pole—750 Volts

Capacities based on 30-degree rating

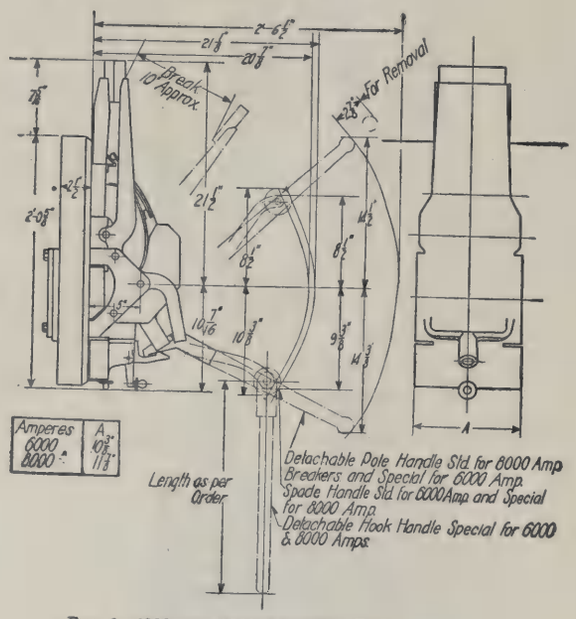


FIG. 3—6000 AND 8000 AMPERES, D.C.
4500 AND 6000 AMPERES, 25 CYCLES, A.C.
4000 AND 5000 AMPERES, 60 CYCLES, A.C.

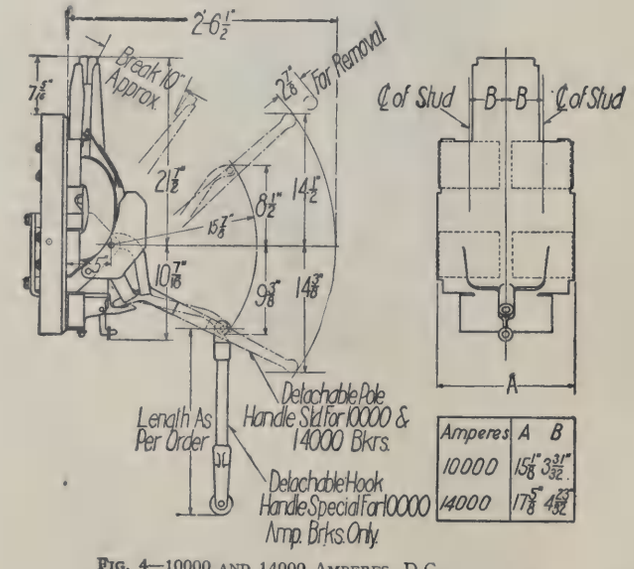


FIG. 4—10000 AND 14000 AMPERES, D.C.
8000 AND 10000 AMPERES, 25 CYCLES, A.C.
6000 AND 7000 AMPERES, 60 CYCLES, A.C.

TYPE CA CARBON CIRCUIT-BREAKERS—Continued

OUTLINE DIMENSIONS

Electrically Operated—Automatic—Single-Pole—750 Volts

Capacities based on 30-degree rating

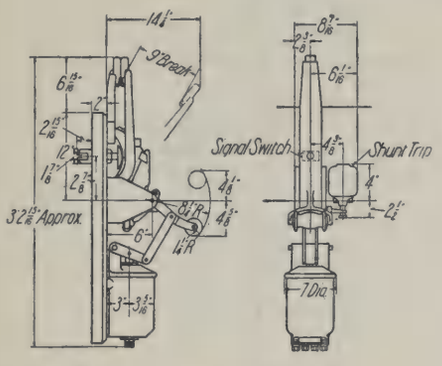


FIG. 5—150 TO 2500 AMPERES, D.C.
150 TO 2000 AMPERES, 25 CYCLES, A.C.
150 TO 1600 AMPERES, 60 CYCLES, A.C.

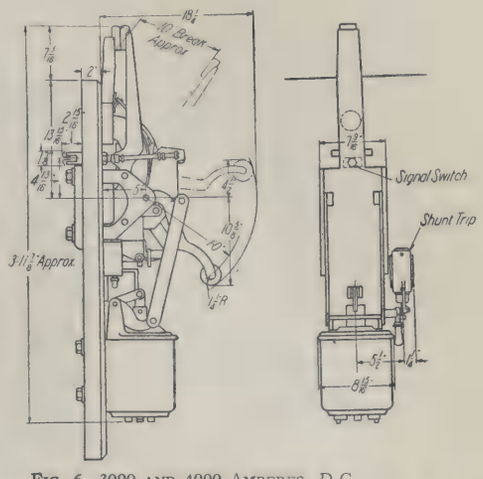
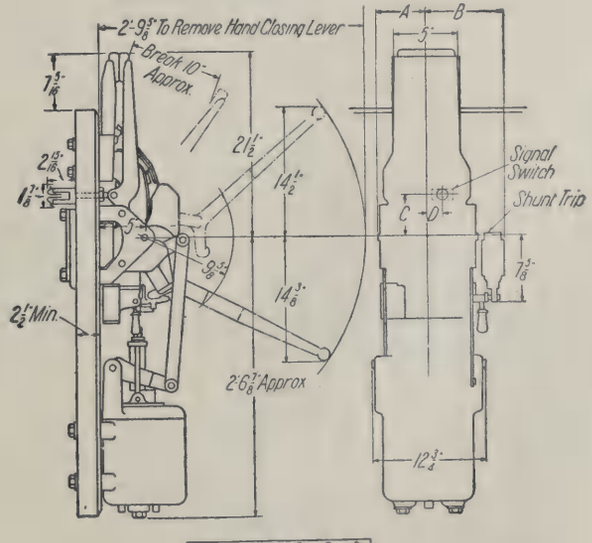


FIG. 6—3000 AND 4000 AMPERES, D.C.
2750 AND 3500 AMPERES, 25 CYCLES, A.C.
2400 AND 3000 AMPERES, 60 CYCLES, A.C.



Amperes	A	B	C	D
6000	5⅛	8⅛	5¹¹⁄₁₆	1⅛
8000	6⅛	8¹³⁄₁₆	5¹⁵⁄₁₆	2¹⁄₁₆

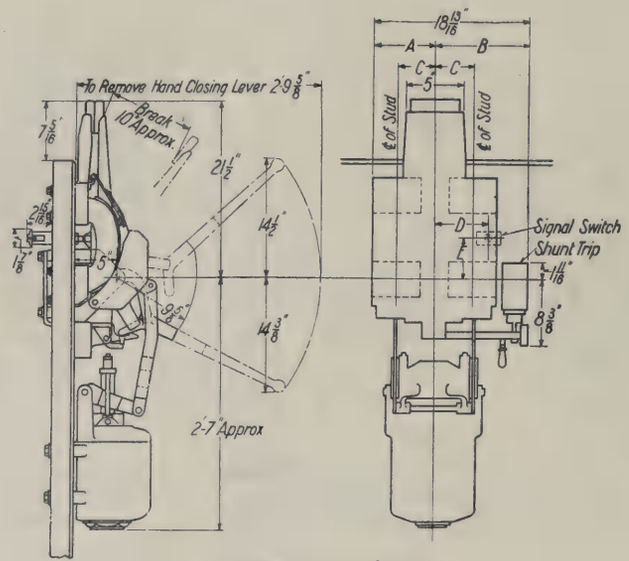
FIG. 7—6000 AND 8000 AMPERES, D.C.
4500 AND 6000 AMPERES, 25 CYCLES, A.C.
4000 AND 5000 AMPERES, 60 CYCLES, A.C.

TYPE CA CARBON CIRCUIT-BREAKERS—Continued

OUTLINE DIMENSIONS

Electrically Operated—Automatic—Single-Pole—750 Volts

Capacities based on 30-degree rating



Amperes	A	B	C	D	E
10000	7 9/16"	11/4"	3 31/32"	6 3/8"	4 13/16"
14000	8 3/16"	12 5/8"	4 23/32"	7 3/8"	4 13/16"

FIG. 8—10000 AND 14000 AMPERES, D.C.
8000 AND 10000 AMPERES, 25 CYCLES, A.C.
6000 AND 7000 AMPERES, 60 CYCLES, A.C.

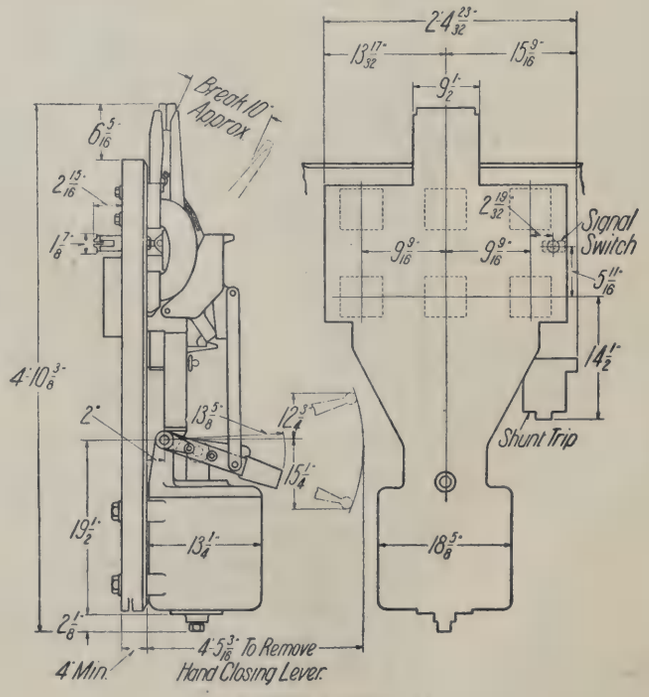


FIG. 9—20000 AMPERES, D.C.

TYPE CA CARBON CIRCUIT-BREAKERS—Continued

OUTLINE DIMENSIONS

Electrically Operated—Automatic—Multipole—750 Volts

Capacities based on 30-degree rating

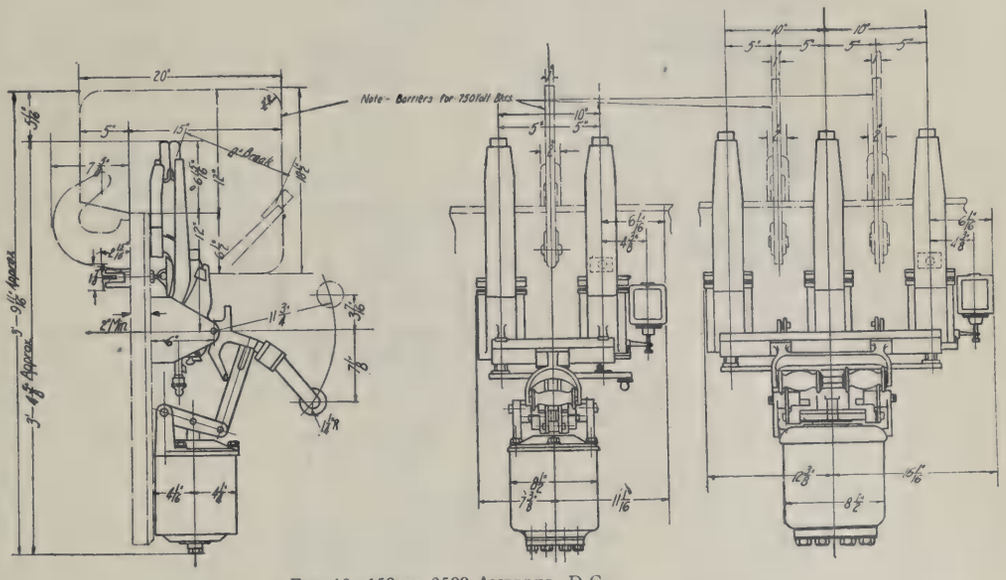


FIG. 10—150 TO 2500 AMPERES, D.C.
150 TO 2000 AMPERES, 25 CYCLES, A.C.
150 TO 1600 AMPERES, 60 CYCLES, A.C.

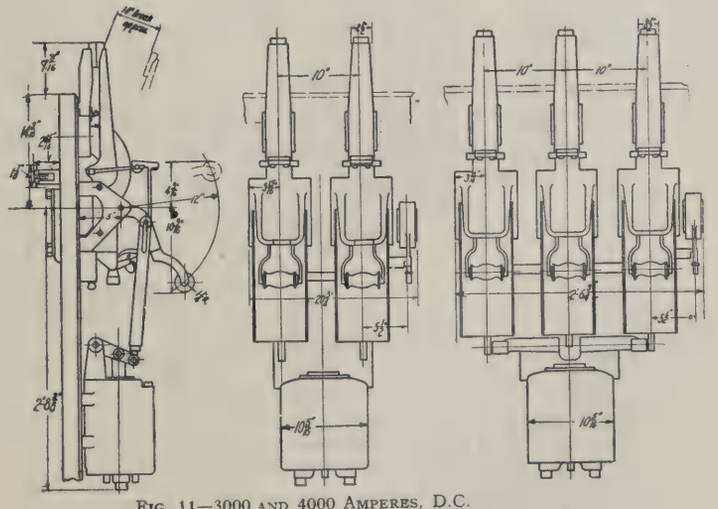


FIG. 11—3000 AND 4000 AMPERES, D.C.
2750 AND 3500 AMPERES, 25 CYCLES, A.C.
2400 AND 3000 AMPERES, 60 CYCLES, A.C.

TYPE CA CARBON CIRCUIT-BREAKERS—Continued

OUTLINE DIMENSIONS

Electrically Operated—Automatic—Multipole—750 Volts

Capacities based on 30-degree rating

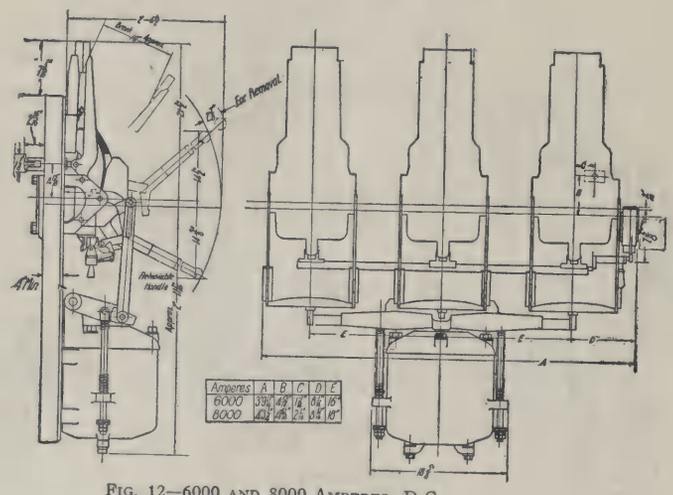


FIG. 12—6000 AND 8000 AMPERES, D.C.
4500 AND 6000 AMPERES, 25 CYCLES, A.C.
4000 AND 5000 AMPERES, 60 CYCLES, A.C.

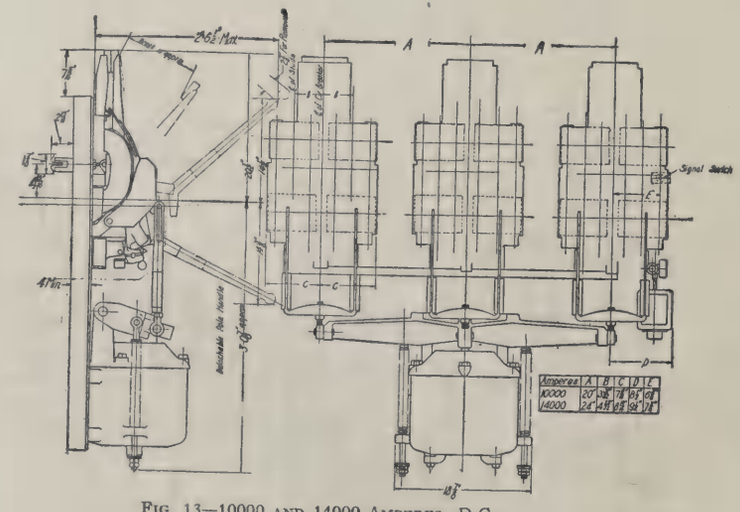


FIG. 13—10000 AND 14000 AMPERES, D.C.
8000 AND 10000 AMPERES, 25 CYCLES, A.C.
6000 AND 7000 AMPERES, 60 CYCLES A.C.

TYPE CA CARBON CIRCUIT-BREAKERS—Continued

OUTLINE DIMENSIONS
Manually Operated—Automatic—Single-Pole
Round and Laminated Studs

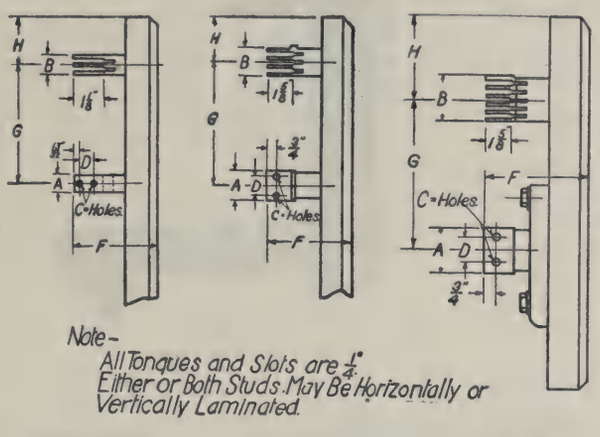


FIG. 14 FIG. 15 FIG. 16

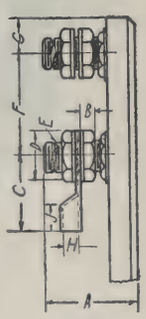


FIG. 17

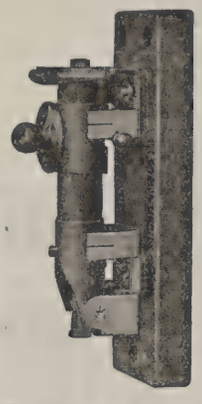
D.C. Amperes§	Fig.	Dimensions in Inches A	B	C	D	E‡	F	G	H	J
150–200	17	5½	1/16	1 13/16	1 3/32	½–13	6 5/8	2 3/8	.558	7/8
300	17	5½	1/2	2 1/16	1 1/16	5/8–11	6 5/8	2 3/8	.87	1 1/16
400	17	5½	1/2	2 3/16	1 1/16	5/8–11	6 5/8	2 3/8	.918	1 3/8
600	17	5½	5/8	3 1/16	1 5/8	¾–16	6 7/16	2 1/16	1.28	1 11/16
800	17	5½	5/8	2 7/8	1 7/8	1 –14	6 7/16	2 1/16	†.918	1 5/8
1000	17	5½	5/8	...	1 7/8	1 –14	8	3	.....	...
1200	17	5½	¾	...	2 1/16	1¼–14	8	3	.....	...
1600	17	6¼	⅞	...	2½	1½–14	8	3	.....	...
2000	17	6½	⅞	...	3	1¾–12	8	3	.....	...

†Two terminals per stud.
‡Diameter in inches and number of thread per inch.
§Capacities based on 30-degree rating.

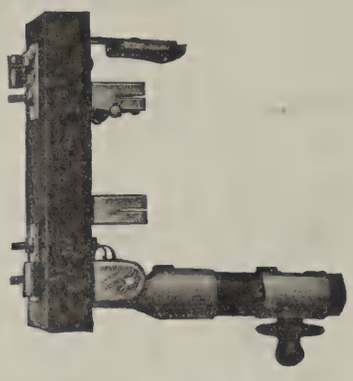
D.C. Amperes§	Fig.	Dimensions in Inches A	B	C	D	E*	F	G	H	I†
1600	14	1¼	1¼	7/16	11/16	3	5½	7 21/32	3 1/32	1
2000	14	1¾	1¼	7/16	11/16	3	5½	7 21/32	3 1/32	1
2500	14	2	1¾	7/16	1 1/16	4	5½	8	3	1
3000	14	2½	2¼	7/16	1½		6½	9¾	5 1/16	1
4000	14	3	2¾	7/16	1¾	6	6½	9¾	5 1/16	1
6000	14	4	2¾	11/16	2	8	7½	9¾	5 1/16	1
8000	14	4½	4¼	11/16	2½	9	7½	9¾	5 1/16	1
10000	15	4	3¾	11/16	2	8	8½	9¾	8 1/16	1
14000	15	4½	4¼	11/16	2½	9	8½	9¾	5 1/16	1
20000	16	4½	4¼	11/16	2½	9	8½	9¾	8 1/16	3

*Number of tongues. (Number of slots is one less than the number of tongues.)
†Number of studs.
§Capacities based on 30-degree rating.

TYPE F CARBON CIRCUIT-BREAKERS



Front-Connected, Closed



Rear-Connected, Open

TYPE F CARBON CIRCUIT-BREAKERS WITH AUTOMATIC OVERLOAD TRIP

The type F are small and compact single-pole carbon breakers. They readily take the place of switches and fuses and occupy about the same space as a fuse block and fuse. They are designed to fulfill a demand for a protective device to be used with small motor and lighting installations, and have a cost commensurate with those of such systems.

By installing a type F breaker for each wire of the circuit the line switch may be dispensed with and the circuit operated by means of the breakers alone. In this case the breakers cannot be closed on overloads, the breaker on one side of the circuit opening when an attempt is made to close the breaker on the other side of the circuit. The cost of such an installation is about the same as that of the switch and fuses for the same service, and there is no maintenance cost for replacing fuses. The circuit-breaker can be reset instantly, and at no cost.

Limitations—The type F carbon breakers are not satisfactory for use with polyphase motors, as they cannot be mechanically inter-connected and, therefore, would not afford full protection to such motors. For such service, interlocked three-pole or four-pole breakers, as required, should be selected.

These breakers are not satisfactory for mounting directly on machinery or in any other location where they will be subjected to considerable vibration, or for any service where they will be subjected to rough usage.

Capacities—These breakers are supplied for voltages up to 250 and normal current capacities of 12½, 25, 50, and 75 amperes.

TYPE F BREAKER WITH AUTOMATIC OVERLOAD TRIP AND SHUNT TRIP

Distinctive Features

Among the features that make the type F carbon circuit-breakers especially adapted to their class of service are compactness, neatness, simplicity, self cleaning contacts and use of carbon secondary or arcing contacts.

Construction

Operating Mechanism—The overload-operating solenoid is inside of a fibre tube forming the lever arm. The tripping point may be set for any current within the tripping range by a little knurled thumb screw located below the pivot. A small insulating knob at the right controls the tripping device and offers a means of opening the breaker by hand.

The current-carrying contacts are copper and the arcing contacts are carbon and are readily renewable. The lever arm is operated by a spring and the copper contacts are of a shape to assist in opening the breaker.

Automatic Overload With Shunt Trip—By the addition of a shunt-trip coil, the type F circuit-breaker can be tripped electrically. The shunt trip does not interfere with the overload trip and the one circuit-breaker affords protection from overloads and in addition permits opening the circuit from a distance or by an automatic device. This type of breaker is shipped mounted on a slate base.

TYPE F CARBON CIRCUIT-BREAKERS—Continued

These breakers are applicable to any installation where it is desired to open the circuit by means of a push button, a contact-making relay, a contact-making volt-meter, a speed-limit mechanism, a tank float, or, in fact, any equivalent contact-making device.

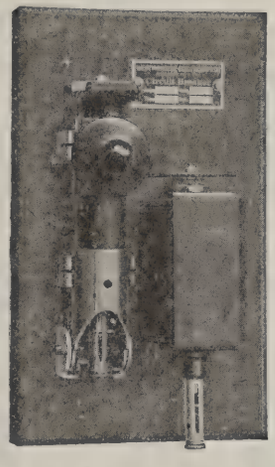
Non-Automatic With Shunt Trip—In construction and general appearance these breakers are similar to the standard automatic-overload-trip breakers, with the exception that a spring cutout is added for the purpose of opening the trip-coil circuit when the breaker opens. This cutout is located behind the main barrel or tube of the circuit-breaker and its action eliminates any possibility of a burn-out of the trip coil.

Auxiliary Tripping Attachments

Automatic overvoltage-trip, and automatic reverse-current-and-underload-trip attachments may be applied to any standard type F carbon circuit-breaker, either front or rear-connected. These attachments may also be applied, without interference with existing mechanism, to type F breakers equipped with standard shunt-trip attachments.

Mounting—When these attachments are mounted with a breaker on a front-connected base, it will be necessary to supply a wider base than is furnished with the standard breaker. When the breaker and attachment are mounted on a switchboard, no base is supplied and the apparatus is mounted directly on the panel. Drilling plan will be supplied on request.

TYPE F NON-AUTOMATIC BREAKER WITH SHUNT TRIP



TYPE F AUTOMATIC BREAKER WITH OVERLOAD AND REVERSE CURRENT TRIP, 75 AMPERES

OVERVOLTAGE TRIP MECHANISM

PRICES

Circuit-Breakers

Style number and list price include breaker complete with base and terminals.

With Automatic Overload Release

Capacity Amperes	Range of Overload Adjustment Amperes	Approx. Wt., Lbs. Net	Approx. Wt., Lbs. Boxed	Front-Connected Style No.	Front-Connected List Price	Rear-Connected Style No.	Rear-Connected List Price
5	4– 8	2	4	154713	$23 50	154714	$24 50
12.5	10–20	2	4	43670	23 50	88823	24 50
25	20–40	2	4	43671	23 50	88824	24 50
50	40–80	2	4	43672	23 50	88825	24 50
75	60–120	2	4	43673	23 50	88826	24 50

With Automatic Overload Release and Shunt Trip

Capacity Amperes	Range of Overload Adjustment Amperes	Approx. Wt., Lbs. Net	Approx. Wt., Lbs. Boxed	Style No. (Front-Connected.) 110 Volts D. C.	Style No. (Front-Connected.) 220 Volts D. C.	List Price
5	4– 8	5	8	154715	154716	$59 00
12.5	10–20	5	8	101292	101296	59 00
25	40–80	5	8	101293	101297	59 00
50	40–80	5	8	101294	101298	59 00
75	60–120	5	8	101295	101299	59 00

Order by Style Number

TYPE F CARBON CIRCUIT-BREAKERS—Continued

PRICES—Continued

Non-Automatic Breaker With Shunt Trip

Capacity Amperes	Range of Tripping Voltage D. C.	A. C. 25 to 60 Cycles	Approx. Wt., Lbs. Net	Boxed	Style No. Front-Connected*	List Price
75 or Less	20– 50	30– 80	2½	4½	133892	$52 50
75 or Less	50–130	80–230	2½	4½	129224	52 50
75 or Less	130–250	230–440	2½	4½	133893	52 50

*Furnished at same price rear-connected for remounting on a 1 to 1½-inch panel, if so specified in order.

Electrically Operated Accessories

Style number of the mechanism includes the device complete with the necessary contact nuts, terminals, mounting screws for 1-inch to 1½-inch panel and necessary terminal clips, resistance (when required) and spring cut-out for opening the shunt coil circuit when the breaker is tripped. The style number, however **does not include** the base or breaker proper, which must be ordered separately.

Overvoltage Trip

Tripping Range Volts	Approx. Wt., Lbs. Net	Shipping	Style No.	List Price
10 to 20	2¾	3½	133738	$57 00
20 to 40	2¾	3½	133739	54 00
35 to 70	2¾	3½	133740	47 50
65 to 130	2¾	3½	133741	57 00
125 to 250	5	6 (with resistance)	133742	57 00

Note—If desired for use on alternating-current circuits, the voltage and frequency of the tripping coil circuit must be specified on the order.

Reverse-Current and Underload Trip for Direct-Current Circuits

Rated Amperes of Circuit-Breaker	Rated Voltage of Trip Mechanism	No. of 2-Volt Cells in Series	Approx. Weight, Lbs. Net	Shipping	Style No.	Style No. of Resistance	List Price
12½	32	16	3¼	4	129225	None	$40 00
25	32	16	3¼	4	129226	None	40 00
50	32	16	3¼	4	129227	None	40 00
75	32	16	3¼	4	129228	None	40 00
12½	55	28	3¼	4	133407	None	41 50
25	55	28	3¼	4	133408	None	41 50
50	55	28	3¼	4	133409	None	41 50
75	55	28	3¼	4	133410	None	41 50
12½	110	56	3¼	4	129229	None	45 00
25	110	56	3¼	4	129230	None	45 00
50	110	56	3¼	4	129231	None	45 00
75	110	56	3¼	4	129232	None	45 00
12½	220–110	..	5½	6½	129229	186470	49 50
25	220–110	..	5½	6½	129230	186470	49 50
50	220–110	..	5½	6½	129231	186470	49 50
75	220–110	..	5½	6½	129232	186470	49 50

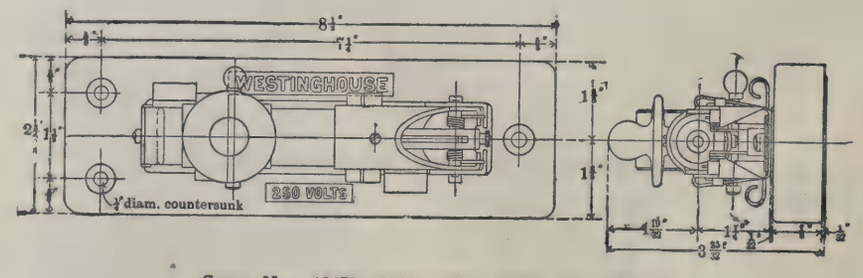
For any given value of current at any special voltage under 150 use the list price of next higher voltage unless ordered in quantities of 25 or more at one time, in which case the additional charge may be omitted.

Base

Description	Approx. Wt., Lbs. Net	Shipping	Style No.	List Price
One-inch black marine slate base for any type F carbon circuit-breaker and auxiliary attachments	5	5½	133743	$5 25

Order by Style Number

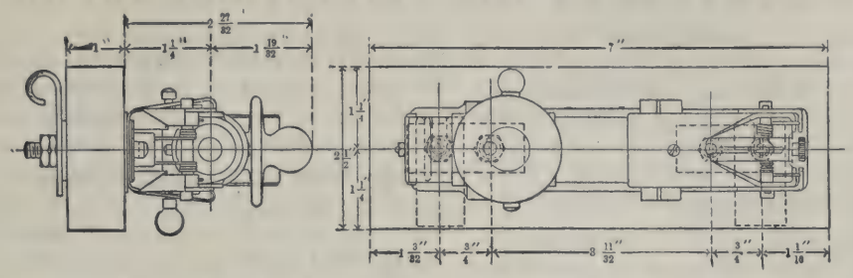
OUTLINE DIMENSIONS



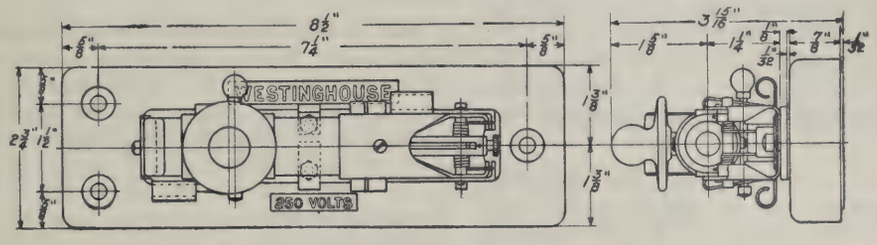
Style Nos. 43670, 43671, 43672, 43673, and 154713-A

TYPE F CARBON CIRCUIT-BREAKERS—Continued

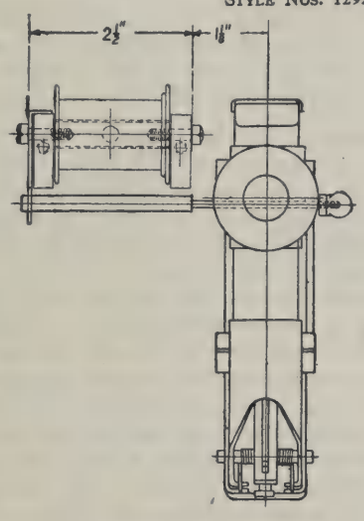
OUTLINE DIMENSIONS



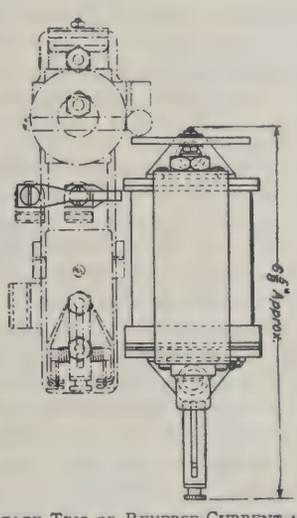
STYLE NOS. 88823, 88824, 88825, 88826, AND 154714



STYLE NOS. 129224 133892, AND 133893

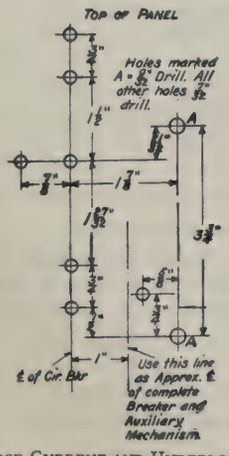


SHUNT TRIP ATTACHMENT

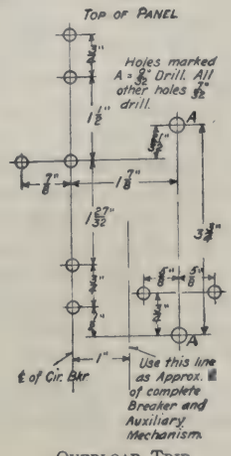


OVERVOLTAGE TRIP OR REVERSE-CURRENT-AND-UNDERLOAD TRIP ATTACHMENT

DRILLING PLANS



REVERSE-CURRENT-AND-UNDERLOAD TRIP



OVERLOAD TRIP

APPLICATION OF OIL CIRCUIT-BREAKERS

The selection of an oil circuit-breaker for application to an electrical system or circuit requires a knowledge of the characteristics of the breaker and the characteristics of the system or circuit. Breakers are usually classified according to their rated voltage, rated current, rated frequency, interrupting capacity, and instantaneous-current capacity.

Systems may be classified according to their normal operating voltage, normal current, normal frequency, and current transients. The following data gives a short description of the method of applying the information given in the following tables. For a complete description and examples of the application of oil circuit-breakers and the determination of short-circuit currents see "Switchboard Data Book".

The tables of short-circuit characteristics, as published herein, may be used to determine the application of oil circuit-breakers under average conditions.

TABLE A shows factors based on the total reactance of a system. The product of these factors times the normal current of the synchronous apparatus connected to the circuit gives the probable short-circuit current under average conditions.

TABLE B directly states the greatest current in amperes that can be delivered by the secondary of transformers of 3 per cent reactance; a rule is given for changing these values where transformers of other than 3 per cent reactance are used. These are safe values that may be used in the ready application of circuit-breakers, regardless of the amount of power behind the transformers. Where a transformer has relatively high kilovolt-ampere capacity, or is applied at the end of a considerable length of line so that the equivalent reactance of the transformer is small compared to the total equivalent reactance of the system, the maximum short-circuit current in amperes may be much less than the figures given in Table B, thus allowing the application of a smaller breaker. In such cases, or in any case where close figuring is desired, the short-circuit current should be figured by the use of Table A.

THE CURVES OF FIGS. 1 AND 2 may be used in place of Table A, the factors of which are based on these curves.

Single-Phase Short Circuits on Three-Phase Systems—The factors in Table A and the values of curves, Figs. 1 and 2, are high enough to cover both single-phase and three-phase short circuits on three-phase ungrounded neutral systems; or where the neutral is grounded through only one machine of several feeding the system; or where the neutral is grounded through a limiting resistance.

For single-phase short circuits on solidly grounded neutral three-phase systems, the initial current is slightly higher and the sustained current is approximately 100 per cent to 150 per cent higher than the values indicated in these tables and curves. For full protection, allowance should be made accordingly in choosing a breaker for such a system.

Single-Phase and Two-Phase Systems will have essentially the same short-circuit characteristics as those indicated in Table A for three-phase systems and the same factors may be used with the modification stated above for solidly grounded neutral systems.

Short circuits in cables are not instantaneous in nature but develop gradually into dead short-circuits. On such a short, a current may pass sufficient to actuate the breaker relay and develop into a dead short-circuit at the time the breaker contacts open. Where full protection is required for such cases, a breaker good for the initial value of short-circuit current shown on curves, Figs. 1 and 2, must be used.

Tables C and D state the interrupting capacities of the various oil circuit-breakers listed in this catalogue in terms of the maximum amperes per pole which they should be called upon to break in the arc.

Greatest Carrying Capacity—The values of greatest carrying capacity in Tables C and D represent the greatest current in amperes that the breaker can carry continuously for five seconds or less. In applying a breaker, after selecting one with current interrupting capacity equal to or greater than the system-short-circuit amperes as determined from Table A, care should be taken to see that the greatest five-second carrying capacity of the breaker is also equal to or greater than the initial rush of current in the system as indicated by calculation, or by the highest point of such curve in Figs. 1 and 2 as represents the reactance of the system in question. Where application is made by the use of Table A the five-second limitation need not be considered.

Applications of non-automatic breakers should be based on the breaker interrupting capacity ratings in Tables C and D and the two-second system short-circuit characteristics in Table A, or the transformer short-circuit-ampere values in Table B. In the use of the two-second values from Table A, it is assumed that a non-automatic breaker will not be opened in less than two seconds after the occurrence of a short circuit. For quicker opening the system characteristics should be figured accordingly.

When two-pole breakers are used between line and solidly grounded neutral, without limiting resistance, they should have a voltage rating equal to the voltage between lines (delta voltage), but their interrupting capacity when so applied will be the amperes given in tables C and D under the voltage heading equivalent to the voltage between line and neutral (58 per cent of delta voltage).

APPLICATION OF OIL CIRCUIT-BREAKERS—Continued

Series-trip breakers with or without inverse-time element should be applied so that the short-circuit current to which they may be subjected will not exceed either the ampere values in the columns of interrupting-capacity, or the one-second greatest-carrying-capacity values.

When definite-time element of more than one second is applied to these breakers the short-circuit current must not exceed the five-second greatest-carrying-capacity values.

In series-trip breakers, the breaker itself has considerable reactance which limits the short-circuit current that can pass through it. The table below gives these reactances in hms for type H and type F-1 breakers.

Breaker Rating, Amperes	Reactance of Breaker in Ohms		Breaker Rating, Amperes	Reactance of Breaker in Ohms	
	25-Cycle	60-Cycle		25-Cycle	60-Cycle
2	6.75	13.45	25	0.0413	0.0818
3	2.87	5.77	30	0.0252	0.0521
5	0.972	2.08	50	0.0094	0.0196
■	0.385	0.800	70, 75	0.00518	0.0104
10	0.246	0.503	100	0.00261	0.00537
12	0.157	0.322	150	0.000912	0.00171
15	0.108	0.226	200	0.000445	0.000336
20	0.0582	0.120	300	0.000250	0.000440

When using a series-trip breaker on the secondary of a transformer this reactance should be added to the transformer reactance, and the reactance of line from transformer to breaker, as shown in the following formula.

$$\text{Short-Circuit line Amperes} = \frac{.58 \times \text{line voltage}}{\dfrac{.58 \times \text{line voltage}}{\text{Transformer short-circuit amperes}} + \left\{\text{Reactance in ohms of breaker}\right\} + \left\{\text{Reactance per wire of line in ohms}\right\}}$$

For example, take a 25-ampere type H 750-volt series-trip breaker feeding a motor from the secondary of a 100-Kva. 2200—220-volt 60-cycle transformer having 3 percent reactance. The short-circuit current of the transformer from table B is 8770 amperes at 220 volts. Assume the wires connecting the breaker to the transformer are No. 6 gauge and are 30 feet long with conductors spaced 2 inches apart. The reactance per wire is approximately 0.079 ohms per 1000 feet or 0.0023 ohms for 30 feet. The breaker reactance from above table is 0.0818 ohms. Substituting in above formula we have

$$\text{Short-circuit line amperes} = \frac{.58 \times 220}{\dfrac{.58 \times 220}{8770} + 0.0818 + 0.0023} = 1295 \text{ amperes}$$

As the 25-ampere 750-volt type H circuit-breaker interrupting capacity from Table C is 4500 amperes at 440 volts and less, this breaker may be applied; whereas had the reactance of the breaker not been considered the value of 8770 amperes capable of being delivered from the transformer would indicate that this particular breaker could not be applied to the system.

All **doubtful or unusual problems** regarding the application of oil circuit-breakers should be referred to the Company for recommendations. Each inquiry or request for special recommendations should give information regarding the problem as follows:

1—Rating and number of synchronous-alternator, synchronous-motor, synchronous-condenser, and synchronous-converter units.

2—Rating and number of transformers and reactors.

3—Reactance of each unit on basis stated below under "percentage reactance".

4—Resistance, reactance, and capacitance of each portion of the system in ohms, or size, length, relation, and spacing of the conductors of the system.

5—Complete diagram of connections of the system.

6—Normal operating frequency of system.

7—Normal operating voltage of system.

8—Maximum permissible time between the instant the short circuit is made and the instant the short circuit must be cleared from the system.

9—Complete details of the proposed application.

The **percentage reactance** of any leg of a circuit is the reactance drop in that leg of the circuit at normal current expressed as a per cent of the voltage to the neutral of that circuit. The values listed are initial values based on a symmetrical sine wave and on the normal rating of the machines connected to the bus. The percentage reactance of alternators varies from about 5 per cent to 30 per cent. The percentage reactance of transformers varies from about 3 per cent to 20 per cent.

APPLICATION OF OIL CIRCUIT-BREAKERS—Continued

TABLE A—SHORT-CIRCUIT CURRENT FACTORS FOR THREE-PHASE SYSTEMS

Method of Tripping Breaker Corresponding To Time Elapsed		Elapsed time in seconds from time of short Circuit ‡	*Reactance Based on Total Kva. Rating of Synchronous Machines											
			8%	10%	12%	15%	20%	30%	40%	50%	60%	75%	100%	125%	150%
			†Current Factors Expressed as Number of Times Full-Load Current												
No Relay	A. C. Series Trip Coil	.05	13.91	11.16	9.59	7.68	6.04	4.03	3.01	2.40	2.00	1.58	1.17	0.92	0.77
	Cur. Trans. with A.C. Trip Coil	.08	11.78	9.54	8.25	6.66	5.27	3.59	2.74	2.21	1.86	1.50	1.13	0.90	0.76
Solenoid or Motor Relay	Cur. Trans. with A.C. Trip Coil	.10	10.94	8.89	7.68	6.23	4.97	3.41	2.63	2.13	1.81	1.46	1.11	0.89	0.76
	Cur. Trans with D.C. Trip Coil	.15	9.16	7.54	6.57	5.40	4.38	3.08	2.42	2.00	1.71	1.41	1.09	0.89	0.76
Induction Relay	Cur. Trans. with A.C. Trip Coil	.20	8.24	6.80	5.97	4.95	4.06	2.92	2.30	1.92	1.66	1.38	1.08	0.88	0.76
	Cur. Trans. with D.C. Trip Coil	.25	7.55	6.28	5.54	4.63	3.82	2.79	2.23	1.87	1.63	1.36	1.07	0.88	0.76
Circuit-Breakers Having A. C. or D. C. Trip With Definite-Time Setting		.30	7.03	5.88	5.19	4.39	3.67	2.70	2.18	1.84	1.60	1.34	1.06	0.88	0.76
		.40	6.27	5.30	4.74	4.03	3.40	2.57	2.10	1.79	1.57	1.32	1.06	0.87	0.76
		.50	5.74	4.91	4.40	3.80	3.23	2.48	2.04	1.75	1.54	1.31	1.05	0.87	0.76
		.70	4.99	4.34	3.93	3.45	2.98	2.34	1.96	1.70	1.51	1.29	1.04	0.87	0.76
		1.00	4.25	3.77	3.47	3.11	2.73	2.21	1.88	1.65	1.48	1.27	1.04	0.87	0.76
		1.50	3.63	3.31	3.08	2.82	2.53	2.10	1.81	1.61	1.45	1.25	1.03	0.87	0.76
		2.00	3.20	2.98	2.82	2.63	2.39	2.03	1.77	1.58	1.43	1.24	1.02	0.87	0.76

*This includes both internal reactance of machines and reactance of external circuit reduced to the above basis. For reactance values not shown use the next lower listed reactance.

†Rated full-load current based on maximum continuous kilovoltampere rating of synchronous machines. When the equivalent reactance of line, reactor, transformer, or combination of these, expressed in percent based on the total synchronous machine rating, exceeds 150 percent, the current to be interrupted may be determined directly from that reactance. This is due to the fact that under these conditions, the generator reactance and time of opening of the breaker may be neglected.

‡If breakers are equipped with under voltage release mechanisms use time value of .08 seconds unless such mechanism is provided with a definite-time adjustment that can be set the same as an overload relay.

TABLE B—TRANSFORMER CHARACTERISTICS

Three-Phase Current in Secondary on Short Circuit

Primary Pressure Assumed to be Sustained

5 to 200 Kilovolt-Amperes **3%* Reactance**

Secondary Volts	110	220	330	440	550	660	1100	2200	3300	4400	6600	11000	13200	22000	33000	44000	55000	66000	88000	110000
Transformer Bank Rating In Kva.	Secondary Short-Circuit Current In Amperes																			
5	877	438	292	219	175	146														
7.5	1313	656	438	329	263	219	131													
10	1750	877	584	438	350	292	175	88												
15	2625	1313	877	657	525	438	263	131	88											
20	3500	1750	1167	877	700	584	350	175	117	88										
25	4375	2190	1460	1095	877	730	438	219	146	110	73									
37.5	6560	3280	2190	1645	1313	1095	656	328	219	165	110									
50	8770	4375	2920	2190	1750	1460	877	438	292	219	146	88	73							
75	13130	6560	4375	3290	2625	2190	1313	656	438	329	219	131	110							
100	17500	8770	5835	4375	3500	2920	1750	877	584	438	292	175	146	88						
125	21880	10950	7300	5475	4375	3650	2188	1095	730	548	365	219	183	110						
150	26250	13130	8770	6570	5250	4375	2625	1313	877	657	438	263	219	131	88					
200	35000	17500	11670	8770	7000	5835	3500	1750	1167	877	584	350	292	175	117	88				
200	35000	17500	11670	8770	7000	5835	3500	1750	1167	877	584	350	292	175	117	88				
250	43750	21900	14600	10950	8770	7300	4375	2190	1460	1095	730	438	365	219	146	110	88			
300	52500	26250	17500	13130	10500	8770	5250	2625	1750	1313	877	525	438	263	175	131	105	88		
400	70000	35000	23350	17530	14000	11670	7000	3500	2335	1753	1167	700	584	350	234	175	140	117	88	
500	87700	43750	29200	21900	17500	14600	8770	4375	2920	2190	1460	877	730	438	292	219	175	146	110	88
750		65600	43750	32850	26250	21900	13130	6560	4375	3285	2188	1313	1095	656	438	329	263	219	164	131
1000		87700	58350	43750	35000	29200	17500	8770	5835	4375	2920	1750	1460	877	584	438	350	292	219	175
1500			87700	65700	52500	43750	26250	13130	8770	6570	4375	2625	2190	1313	877	657	525	438	328	263
2000				87700	70000	58350	35000	17500	11670	8770	5835	3500	2920	1750	1167	877	700	584	438	350
2500					87700	73000	43750	21880	14600	10950	7300	4375	3650	2188	1460	1095	877	730	547	438
3000						87700	52500	26250	17500	13130	8770	5250	4375	2625	1750	1313	1050	877	656	525
4000							70000	35000	23350	17530	11670	7000	5835	3500	2335	1753	1400	1167	877	700
5000							87700	43750	29200	21900	14600	8770	7300	4375	2920	2190	1750	1460	1095	877

*For transformers of other than 3% reactance, multiply the amperes given in the table above by 3 and divide the product by the percent reactance of the transformer used.

TABLE C—AUTOMATIC SERIES-TRIP OIL CIRCUIT-BREAKERS

Rated Amperes	Rated Volts	¶Method of Control	Greatest Carrying Capacity Amperes 0.2 Second	1 Second	5 Seconds	Maximum Interrupting Capacity in Amperes at Service Voltages* of 750 V.	2500 V.	4500 V.	6000 V.	7500 V.	12000 V.	15000 V.
Type H Manually-Operated Single-Throw Indoor and Outdoor												
5–100	2500	D.	100†	50	25†	5000	2900	....	....	....	....	....
5–100	750	D.	100†	50	25†	4500	.....	....	....	....	....	....
Type F-1 Manually-Operated Single-Throw Indoor Panel Mounting												
10–200	2500	D.	100†	50†	25†	10000	5700	....	....	....	....	....
Type F-2 Manually-Operated Single-Throw Indoor Panel Mounting												
10–200	2500	D.	100†	50†	25†	10000	6100	....	....	....	....	....
Type F-2 Manually-Operated Double-Throw Indoor Panel Mounting												
10–200	2500	D.	100†	50†	25†	10000	6800	....	....	....	....	....
Type F-1 Manually-Operated Single-Throw Weatherproof and Subway												
10–200	7500	D.	100†	50†	25†	10000	3400	1800	1270	960	....	....
300	7500	D.	100†	50†	25†	15000	3400	1800	1270	960	....	....
5–200	4500	D.	100†	50†	25†	10000	3300	1600	....	....	....	....
5–200	750	D.	100†	50†	25†	10000	.....	....	....	....	....	....
300	750	D.	100†	50†	25†	15000	.....	....	....	....	....	....
Type F-2 Electrically-Operated Single-Throw Subway												
5–200	7500	E.	100†	50†	25†	10000	6100	3200	2250	1700	....	....
300	7500	E.	100†	50†	25†	15000	6100	3200	2250	1700	....	....
Type F-3 Manually-Operated Single-Throw Weatherproof												
5–200	15000	D.	100†	50†	25†	10000	10000	5600	4130	3200	1850	1400
10–200	7500	D.	100†	50†	25†	10000	10000	5400	3950	2900	....	....
300	7500	D.	100†	50†	25†	15000	10400	5400	3950	2900	....	....
500§	7500§	D.	25000‡	25000‡	..	25000	10400	5400	3950	2900	....	....
600§	7500§	D.	30000‡	30000‡	..	30000	10400	5400	3950	2900	....	....
800§	4500§	D.	40000‡	40000‡	..	35900	9800	4800	....	....	....	....

TABLE D—NON-AUTOMATIC AND AUTOMATIC TRANSFORMER-TRIP OIL CIRCUIT-BREAKERS

			5-Seconds	750 volts	2500 volts	4500 volts	6000 volts	7500 volts	12000 volts	13200 volts
Type 1 Manually-Operated Single and Double-Throw Non-Automatic Indoor										
60	4500	D.	2000	1000	610	300	....	....	....	....
Type D Manually-Operated Single and Double-Throw Non-Automatic Indoor and Outdoor										
200	4500	D. & R.	5000	5000	1630	800	....	....	....	....
300	7500	D. & R.	10000	5000	2500	1300	940	700	....	....
200	15000	D.	5000	5000	5000	2840	2060	1600	940	700
Type F-1 Manually-Operated Single-Throw Automatic Indoor										
200	4500	D.	10000	10000	5700	2800	....	....	....	....
200	4500	R.	10000	10000	7300	3600	....	....	....	....
300	4500	D.	15000	15000	5700	2800	....	....	....	....
300	4500	R.	15000	15000	7300	3600	....	....	....	....
Type F-2 Manually and Electrically-Operated Single-Throw Automatic Indoor										
300	7500	D. & E.	15000	15000	6100	3200	2250	1700	....	....
300	7500	R.	15000	15000	7700	4000	2850	2150	....	....
500	7500	D. & E.	25000	21500	6100	3200	2250	1700	....	....
500	7500	R.	25000	25000	7700	4000	2850	2150	....	....
600	4500	D. & E.	25000	21500	6100	3200	....	....	....	....
600	4500	R.	25000	25000	7700	4000	....	....	....	....
Type F-2 Manually and Electrically-Operated Multiple Single-Pole Single-Throw Automatic										
300	7500	R. & E.	15000	15000	10400	5400	3850	2900	....	....
500	7500	R. & E.	25000	25000	10400	5400	3850	2900	....	....
600	4500	R. & E.	25000	25000	10400	5400	....	....	....	....
Types F-2 and QF Manually-Operated and Double-Throw Automatic Indoor										
300	7500	D.	15000	15000	6800	3500	2500	1900	....	....
300	7500	R.	15000	15000	8600	4500	3200	2400	....	....
500	7500	D.	25000	24100	6800	3500	2500	1900	....	....
500	7500	R.	25000	25000	8600	4500	3200	2400	....	....
600	4500	D.	25000	24100	6800	3500	....	....	....	....
600	4500	R.	25000	25000	8600	4500	....	....	....	....
Type F-3 Manually and Electrically-Operated Single-Throw Automatic Indoor										
500	13200	D. & E.	25000	25000	8100	4400	3200	2500	1400	1250
500	13200	R.	25000	25000	9800	5300	3800	3000	1700	1500
800	4500	D. & E.	40000	26900	7300	3600	....	....	....	....
800	4500	R.	40000	32900	9000	4400	....	....	....	....
Type F-3 Manually and Electrically-Operated Multiple-Multipole Single-Throw Automatic Indoor										
1200	13200	R. & E.	50000	50000	17000	9200	6600	5300	2940	2600
1600	13200	R. & E.	65000	65000	22700	12300	8900	7000	3950	3500
2000	4500	R. & E.	80000	56500	15300	7600	....	....	....	....
2400	4500	R. & E.	100000	75300	20400	10100	....	....	....	....

*To obtain interrupting capacity at any intermediate service voltage:

Let A=Service voltage proposed.
B=Next higher service voltage in table.
C=Amperes interrupting capacity in table at voltage "B."
D=Amperes interrupting capacity at voltage "A."
E=Amperes interrupting capacity at the lowest voltage at which the breaker is rated in the table.
F=Limit of current to be admitted to series trip coils as given in the table.

Then $D = \frac{B \times C}{A}$ (See Note 1)

NOTE 1:—If value so calculated for "D" exceeds that given for "E" or "F," then "E" or "F" must be used as interrupting capacity of breaker at "A" or any lower voltage.

The carrying capacity of series trip coils may prevent taking full advantage of interrupting capacity of breaker. (See also application rules for series-trip breakers on previous page.)

†Number of times coil rating. ‡Amperes.

§These are transformer-trip breakers with self-contained transformers.

¶D=Direct-control panel or panel-frame mounting, R.=Remote-control manually-operated. E=Remote-control electrically-operated. Non-automatic manually-operated remote-control breaker ratings are the same as the direct-control breaker ratings.

APPLICATION OF OIL CIRCUIT-BREAKERS—Continued

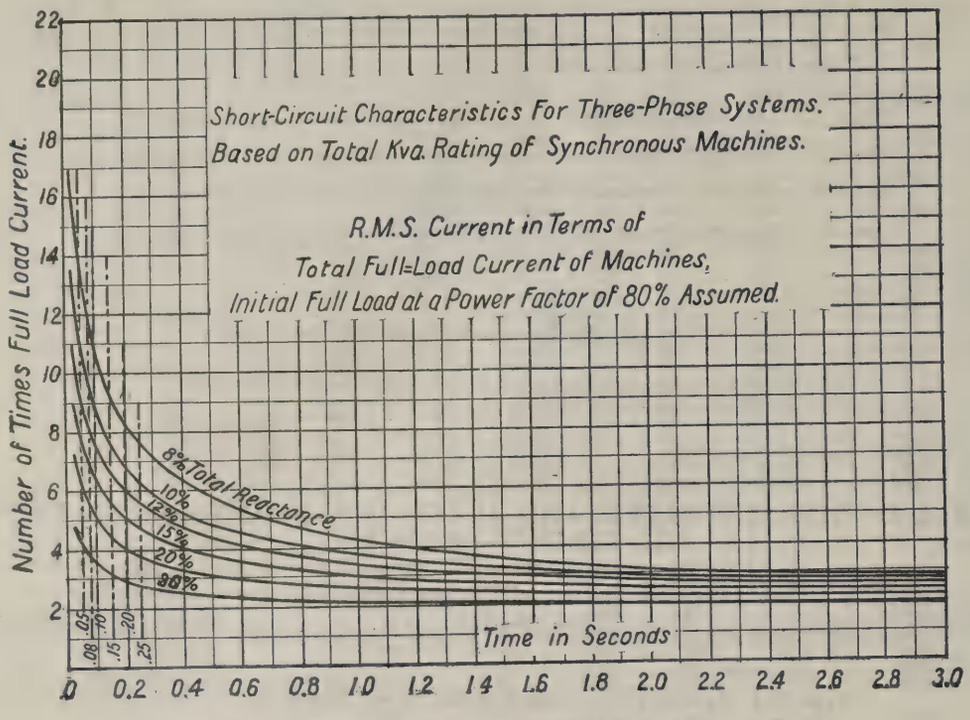


FIG. 1—SHORT-CIRCUIT CHARACTERISTICS FOR THREE-PHASE SYSTEMS BASED ON TOTAL KILOVOLT-AMPERE RATING OF SYNCHRONOUS MACHINES

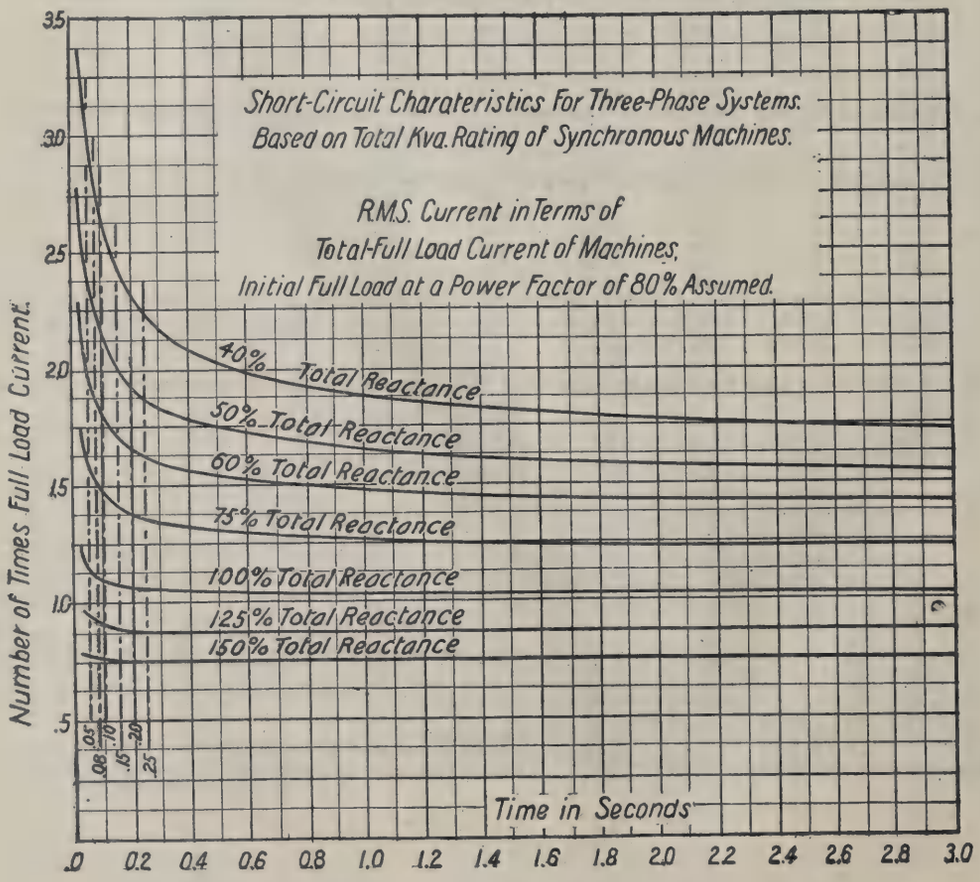


FIG. 2—SHORT-CIRCUIT CHARACTERISTICS FOR THREE-PHASE SYSTEMS BASED ON TOTAL KILOVOLT-AMPERE RATING OF SYNCHRONOUS MACHINES

OIL CIRCUIT-BREAKERS—GENERAL INFORMATION

The oil circuit-breaker affords the best insurance against costly interruption of service. The breaker operation is positive, but, in the case of automatic overload breakers, can be adjusted to trip between wide limits of either breaker or relay calibration.

Single-Throw

The data given in this section, unless otherwise specified, apply to single-throw breakers.

Double-Throw

Double-throw breakers, where not listed, can be supplied on special orders, as follows: (Prices will be quoted on request).

Manually-operated double-throw circuit-breakers (downward-pull wall or pipe-mounting remote-control with bell cranks above or below the floor) are made up of any combination of two separate single-throw circuit-breakers operated from one two-handle cover-plate. The two-handle cover-plate is supplied with a simple interlocking device so that only one throw can be closed at a time. The interlocking device can be omitted on special order, thus permitting the transfer of a circuit without opening. Either or both throws of the double-throw circuit-breaker can be made automatic or non-automatic, as ordered, and when automatic can be equipped with under-voltage, underload or inverse-time-element attachment. All of the accessories specified for use with single-throw circuit-breakers (except triple-coil cover-plates) can be used on the double-throw circuit-breakers.

For **electrically-operated** double-throw circuit breakers, two single-throw breakers are used with wiring interlocked. The electrical interlocking of the control wiring should be made by means of a special five-point drum control switch.

Special Breakers

It is desirable to make projects covering circuit-breakers differing from standard as described and listed, the subject of special negotiation and correspondence with the Company.

CURRENT RATING AND TEMPERATURE

The rated current of a circuit-breaker is the greatest current in r. m. s. amperes which it will carry continuously at a specified frequency without any essential part having its temperature raised more than a specified number of degrees above an ambient temperature, or above a fixed temperature.

The American Institute of Electrical Engineers has established heating standards for oil circuits-breakers. These are given in Sections 376 to 379, 392, and 721 of the supplement to the Standardization Rules dated November 8, 1918. They limit the maximum permissible temperature rise of coils and insulating materials of oil circuit-breakers to 65 degrees Centigrade, based on an ambient temperature of 40 degrees Centigrade, and the rise of other parts whose temperature does not effect the temperature of the insulating material to be such as not to be injurious in other respects. They also limit the maximum temperature of oil and contacts in oil to 70 degrees Centigrade. For an ambien temperature of 40 degrees Centigrade, this permits a temperature rise of 30 degrees Centigrade for oil and for contacts in oil. Where, however, the ambient temperature is less than 40 degrees Centigrade, advantage may be taken of the condition to operate the parts at a higher temperature rise if the maximum temperatures specified are not exceeded. The breakers listed herein are rated on ambient temperatures of 40 degrees Centigrade and comply with the standards adopted by the American Institute of Electrical Engineers.

To determine the ambient temperature of reference for breakers mounted in cells or other places when the temperature about the breaker varies considerably, take the average of the following three thermometer readings: one reading one foot below the breaker tanks, one reading one foot above the breakers terminals and a third reading midway vertically between the first two, and one foot away from the breaker frame.

Altitude—Standard ratings of Westinghouse oil circuit-breakers apply for altitudes of 3300 feet above sea level and less. For higher altitudes standard listed breakers must be used on voltages less than their rated voltage, the amount of derating depending on the altitude. For operation above 3300 feet the voltage ratings given must be multiplied by the following factors.

Distance above sea level	Voltage Rating Factor
4000 feet	0.97
6000 feet	0.90
8000 feet	0.84
10000 feet	0.79
12000 feet	0.72
14000 feet	0.66

METHODS OF OPERATION

Manual Operation

Manual closing from a coverplate lever or handle on a panel or frame bracket is the ordinary method of closing small or medium sized circuit-breakers both panel-mounting and remote-control. With very large circuit-breakers, manual operation becomes impossible or undesirable, owing to the inability of a man to throw a large breaker fast enough for synchronizing purposes, and to escape possible injury incurred in closing a breaker slowly on a short circuit, or even to close the circuit-breakers at all without excessive mechanical leverage, which is wasteful of space. Stresses in manually-operated remote-control parts and the mechanical complication necessary to connect breakers located in positions inaccessible from the switchboard or control position, often preclude the use of manually-operated remote-control.

In the smaller sizes of manually-operated remote-control circuit-breakers, the automatic details are mounted directly in the cover-plate, while in larger sizes the automatic latching details are located in a special operating mechanism mounted at the circuit-breaker, thus taking the strain of the latch load off the panel and remote-control bell cranks and levers.

All Westinghouse automatic overload-trip manually-operated remote-control circuit-breakers are known as full-automatic (trip free on overload); the tripping details being so designed that it is impossible to latch the circuit-breaker closed when excessive overload or short circuit exists on any phase of the line. To accomplish this, two levers are provided, one being placed within the other. The outer lever is fastened to the operating handle; the inner lever is connected to the mechanism of the circuit-breaker proper. Under normal conditions, the levers move together due to a trigger on the outer lever engaged with the inner lever The trigger is directly acted upon by the tripping coil plungers. If an overload or short circuit should come on the line the tripping coil core releases the trigger allowing the inner lever to return to the upper position,

thus opening the breaker. It is necessary for the operating handle to be returned to the upper position for latching with the inner lever before the circuit-breaker can again be closed.

The **manual remote-control** method of operation is subject to the following limitations:

(a) With bell cranks mounted either above or below the floor, the distance between the handle and the breaker units should not exceed 50 feet.

(b) With horizontal remote control without bell cranks, that is, with the pull rod extending directly from the coverplate to the circuit-breaker units, the distance between the circuit-breaker and the switchboard should not be over 4 feet.

(c) The friction interposed by a complicated system of bell cranks and rods must not be such as to prohibit the quick operation of the circuit-breaker.

The control or operating rods should be of three-quarter-inch gas pipe and, except in lengths of two feet or less, should be operated in tension during the closing operation of the breaker. Vertical rods should be so arranged, if possible, that the weights are balanced.

When distances are too great (in general when the total length of the operating rods exceeds 50 feet) the weight of the rods and the friction in the standard mechanism may offer so much resistance to the proper operation that it will be necessary to install special operating devices. Such cases should be referred to the Company.

Where distance between switchboards and switching devices makes the application of hand-operated breakers questionable, electrically-operated breakers should be supplied. Doubtful cases should be referred to the Company.

Electric Operation

In the field of power-operated circuit-breakers the Westinghouse Electric and Manufacturing Company has long maintained as standard, the electrical-solenoid method of closing, which is now used almost universally to the exclusion of various other methods, such as motor, hydraulic, and pneumatic power. The electric solenoid type of operation is very flexible and permits mounting the operating mechanism on cell walls, on pipe frames, or on the floor above or below, or behind the circuit-breaker. Each type of breaker will, however, regularly employ one or more arrangements that will be standard. *Special arrangements will involve increased costs and time of delivery.* The individual mechanism arrangements are shown in Figs. 171 to 175.

Electric-operating mechanisms are usually provided with combined **accelerating and dashpot attachments,** the former to insure speedy opening of the contacts on tripping, the latter to dissipate the kinetic energy of moving parts on the end of the opening stroke. They are also usually equipped with dashpots under the closing cores to absorb shocks of moving parts on closing. The action of these dashpots is regulated by adjusting screws which determine the extent of the valve opening.

Control Circuit—Standard electric-operating (closing and tripping) mechanisms are made for direct-current operation. This form, besides utilizing simpler construction, being more reliable in operation and more easily kept in repair, is much more economical of space and power than alternating-current mechanisms. For special applications such as for alternating-current electrically-operated railway sectionalizing circuit-breakers and other installations where no auxiliary source of direct-current power is available, special alternating-current operating mechanisms can be supplied; prices on request. Their evident disadvantages, however, make their general use undesirable.

With inquiries, contemplating alternating-current control, submit full details for the installation contemplated, particularly the characteristics of the circuits supplying the power for the control circuits.

Mechanism—The standard electric mechanism closes the breaker by a direct-current magnet and holds it closed by a latch and trigger which engage automatically. The tripping mechanism consists of a direct-current trip magnet acting on a trigger, which releases the latch, permitting the breaker to open.

The closing and tripping mechanism is operated by a **control switch,** with or without control relays (switches) in the closing circuit, and usually with **signal lamps** as described on pages on "Switchboard Accessories."

All electric operating mechanisms have a small **double-throw switch** to open the shunt-trip coil circuit when the circuit-breaker opens and to operate the signal circuit (lamps). See Figs. 112 to 120 for diagrams.

The standard electric mechanisms are regularly supplied with **closing solenoids** wound for 70 to 140 volts (110 volts nominal) direct current. The time required to close a breaker from the time of the closing of the control-switch contacts until the arcing contacts in the breaker touch, is 3/10 to 6/10 seconds. Coils for other than the aforementioned standard voltages, or of greater operating range, can be supplied upon special order; prices on request.

The electric mechanisms are equipped with **tripping coils,** as standard, to operate at from 50 to 140 volts direct current.

Electric operating mechanisms can be furnished at the same price as those described but with closing coils to operate at from 140 to 280 volts, direct current, or to trip at from 100 to 280 volts, direct current.

Trip coils of other than the standard voltage, or of greater operating range, or mechanisms for operation on 110, 220, 440, or 550 volts, 25 or 60-cycle alternating current, can be supplied on special order; prices on request.

Manual closing—The electrically-operated breakers can be closed manually by a handle inserted in a socket on the electric operating mechanism or breaker mechanism.

Summary of Methods of Operation Available

Type of Breaker	Direct Control Manual	Remote Control	
		Manual	Electrical
I	Yes	No	No
D	Yes	Yes	No
H	Yes	No	No
QF	Yes	Yes	No
F	Yes	Yes	Yes

Acceleration

One of the prime necessities in oil circuit-breaker operation is that when the contacts have commenced to separate they shall travel rapidly, especially during the first part of the stroke. Speed of operation reduces the duration of the arc, reduces the amount of energy expended in the arc, reduces the volatilization of metal parts and oil, and, consequently, reduces the tank pressure which is a determining factor in the ultimate capacity rating of a breaker. All small automatic circuit-breakers are provided with accelerating springs in the breaker itself; this insures speedy operation when the switch is unlatched. Automatic overload-trip remote-control circuit-breakers in smaller sizes are provided with accelerating devices mounted on one of the remote control bell cranks. This device precludes any possibility of the sticking of the circuit-breakers, when tripped, in case the system of remote-control rods and cranks is arranged so that they overbalance the weight of the circuit-breaker contacts; it also insures a rate of acceleration of moving parts greater than that due to unassisted gravity. Where the weight of the moving contact parts is large and there would be danger of breakage if they were suddenly arrested, the accelerating device is equipped with an air cylinder and an adjustable valve to regulate the rate of stopping the moving contact.

The beneficial effect on the operation of a circuit-breaker by this accelerating device is such that a remote-control circuit-breaker can be rated at a higher breaking capacity than the corresponding panel-mounting circuit-breaker. (See tables S, C and D of "Interrupting Capacities at various Service Voltages" on pages on "Application of Oil Circuit-Breakers.")

METHODS OF TRIPPING

See schematic diagrams on following pages

Non-Automatic Trip

Manually-operated circuit-breakers supplied for non-automatic operation are tripped by hand from the face-plate or breaker mechanism.

Electrically-operated circuit-breakers supplied for non-automatic operation are supplied with a direct-current shunt tripping magnet acting on a trigger that releases the latch. The shunt-tripping magnet is usually energized by a circuit controlled from some central point, or it may be connected to a relay circuit, thus giving automatic features through the relays.

When direct current is not available for operating the standard shunt-tripping magnet, special magnets usually can be supplied for using alternating current; price on request.

Automatic Overload Trip

Plain-automatic overload-trip circuit-breakers when closed with an overload on the line will remain closed as long as the closing coil (of electrically-operated breakers) is energized, or the manually operated mechanism is held in the closed position. With electrically-operated breakers, when the closing-coil circuit is opened, the breaker will not remain closed on overloads. Electrically-operated circuit-breakers, only, are regularly supplied plain-automatic.

Full-automatic overload trip circuit-breakers have a mechanism as described under the heading "Methods of Operation," making it impossible to hold the breaker in a closed position while a continuous overload condition or short-circuit exists on the circuit.

Tripping from Current Transformers—For manually-operated circuit-breakers, direct tripping from the secondary of current transformers is the most common method of automatic-overload tripping where no time element feature is necessary. (See Figs. 12 to 25 and 60 to 87). For some low-voltage indoor circuit-breakers, series-trip overload coils can be used, mounted directly on the circuit-breaker. (See heading "Tripping from Series Coils" and Figs. 1 to 11).

Where time-limit features are wanted, inverse time-limit dashpots are supplied on some types of Westinghouse circuit-breakers, or relays having this feature may be used.

For electrically-operated circuit-breakers, tripping from the secondary of current transformers is most common. This tripping can be accomplished by connecting the secondaries directly to the current trip coils of the circuit-breaker, or by connecting them to relays which operate the current trip coils or shunt trip coils. Series automatic-overload trip coils can also be used on some of the Westinghouse electrically operated circuit-breakers.

The coils for current-transformer automatic-overload trip are mounted on the cover-plate or on the breaker mechanism of the manually-operated circuit-breakers, and on the operating mechanism of electrically-operated circuit-breakers. A single 5-ampere coil is regularly used on single-pole and two-pole circuit-breakers, and two 5-ampere coils on three-pole and four-pole double-coil circuit-breakers.

On two- and three-phase ungrounded systems, two current transformers connected to two 5-ampere coils (Figs. 17 and 22) are recommended for overload protection.

On four-wire three-phase grounded-neutral circuits, three current transformers connected in

"Z" to two 5-ampere coils are recommended for automatic overload protection. (See Fig. 19.)

On balanced ungrounded two- or three-phase circuits one current transformer and one 5-ampere trip coil can be used for automatic overload protection. (See Figs. 16 and 21).

For three-phase reverse-power protection, three current transformers are necessary, and, when these are connected through reverse-current relays directly to current trip coils, three 5-ampere coils are necessary. (See paragraphs on "Direct-Trip Attachment," on a following page, also under the heading "Oil Circuit-Breaker Accessories.") Triple-coil overload tripping can usually be supplied on special order; price on request.

Ordinarily, where current transformers are used for instruments and watthour meters, the trip coils can be connected to the same transformers, if great accuracy is not required. Where not required for instruments or meters, lower priced transformers of good accuracy are available for connection directly to the circuit-breaker trip coils or to relays. For descriptions of current transformers see Section 3-B on "Westinghouse Instruments and Relays" and data under the heading "Oil Circuit-Breaker Accessories."

Tripping from Series Coils—The coils for series automatic-overload trip are either dry insulated, mounted on the switchboard coverplate, or they are contained in the circuit-breaker oil tank. In the former case, the main connections to the series trip coils are made through holes in the panel; these holes being covered by the coverplate. This method of trip is recommended to be applied only to small low-capacity installations, not having current transformers for meters. (See Figs. 1 to 11 for connections.)

Tripping Calibration—Breakers automatically operated from current transformers and current-transformer trip coils or from series trip coils are calibrated to function through a range of from 80 to 160 percent of the normal current rating of the current transformer or of the series trip coil, unless otherwise specified. The tripping coils can be set to function at any current within the range given on the scale by means of an adjusting screw at the bottom of the coil. Since the transformer trip coils are energized by power from the secondaries of series transformers in the main circuit, the high voltage is removed from the coverplate (and therefore from the front of switchboard panel or other operating station).

Inverse Time Limit—When inverse time limit is required to prevent the circuit-breaker coming out unnecessarily on short overloads, an adjustable inverse-time-limit dashpot can be applied to the standard coverplate of some breakers. With various mixtures of oil, the time limit can be varied considerably. For time characteristics using oil furnished with the attachment, see information under general heading "Oil Circuit-Breaker Accessories."

With other breakers the inverse-time-limit dash pots are located in the breaker tank and operate in the breaker oil thus eliminating the possibility of using various oil mixtures.

Relays—Where a more reliable time limit is required for selective operation of circuit-breakers than can be provided by the type of dashpot described above, protective relays should be used in connection with the circuit-breaker trip coils. For description and connection diagrams of the selective protection possible with relays, see Section 3-B on "Westinghouse Instruments and Relays." The use of relays and transformers in connection with an auxiliary source of direct current for tripping obviates the use of overload coils and the dashpot time-limit feature on circuit-breaker or cover-plate.

Direct-Trip Attachment—The direct-trip attachment is a retaining coil which prevents the tripping plunger from acting to trip the circuit-breaker until the relay (contact-closing type) operates. This device requires no shunt-trip circuit and is applicable where no reliable direct-current or alternating-current shunt-trip power is available. For lists of direct-trip attachments see pages on "Oil Circuit-Breaker Accessories." Connection diagrams will be furnished on request.

Tripping Attachments

The tripping arrangements described in the following paragraphs can usually be provided.

Automatic Undervoltage—Where automatic undervoltage protection is required, or where tripping is desired upon failure of power rather than from an auxiliary circuit, an automatic undervoltage trip can be supplied. Up to 600 volts alternating current the coil of this attachment is shunted directly across the line, but on higher voltages the coil is connected in the secondary of a voltage transformer as shown in Figs. 158 to 162.

To prevent the burning out of the coil, due to open magnetic circuit, the standard arrangement of the automatic-undervoltage mechanism provides for the automatic retrieving of the plunger to its original position upon the opening of the circuit-breaker. With this arrangement, the coil must be connected on the incoming line, for otherwise the circuit-breaker cannot be closed, as the undervoltage attachment will trip the circuit-breaker before the contacts come together. When, however, a hand-operated circuit-breaker controls a high-voltage line, and excitation for the undervoltage coil is obtained from the low-voltage side, then the plunger must be retrieved by hand, or automatically when closing the circuit-breaker, as the closing of the circuit-breaker is necessary to put voltage on the coil. When electrically-operated circuit-breakers are used for this kind of service, a separate automatic retrieving mechanism is used, operating jointly with the circuit-breaker closing operation for returning the undervoltage plunger to its normally closed position.

Automatic Underload—The automatic undervoltage trip attachment as described above can be supplied with a 5-ampere coil and then used as an automatic underload-trip device in connection with appropriate current transformers to trip the circuit-breakers upon the load decreasing below a predetermined amount. These are of the manual-reset form.

Automatic Overvoltage trip coils can be used on Westinghouse circuit-breakers to trip the breaker in case the voltage of the circuit increases to a certain predetermined setting.

Tripping Combinations

On most hand-operated Westinghouse circuit breakers, when a double-coil, or a triple-coil coverplate is used, either a shunt trip or an overvoltage-trip coil, or both, can be added on special order in the place ordinarily occupied by one or more of the overload coils. This is possible with or without an underload or undervoltage attachment.

The following standard combinations can be supplied. For other than these combinations, special inquiry should be made to the Company to determine the feasibility of the proposed combination.

On double-coil automatic standard single-handle coverplate of the current-transformer-trip breakers:

2 overload coils and 1 undervoltage attachment.
2 overload coils and 1 underload attachment.
2 overvoltage coils and 1 undervoltage attachment.
2 overvoltage coils and 1 underload attachment.
1 overload coil, 1 shunt coil, and 1 undervoltage attachment.
1 overload coil, 1 shunt coil, and 1 underload attachment.
1 overload coil, 1 overvoltage coil, and 1 undervoltage attachment.
1 overload coil, 1 overvoltage coil, and 1 underload attachment.
1 shunt coil, 1 overvoltage coil, and 1 undervoltage attachment.
1 shunt coil, 1 overvoltage coil, and 1 underload attachment.

On the double-coil automatic standard single-handle coverplate of the series-trip breakers:

1 overload coil and 1 shunt coil.
1 overload coil and 1 overvoltage coil.

On the triple-coil automatic special single-handle coverplate of the transformer-trip breakers (prices for this coverplate on request):

3 overload coils and 1 undervoltage attachment.
3 overload coils and 1 underload attachment.
2 overload coils, 1 overvoltage coil, and 1 undervoltage attachment.
2 overload coils, 1 overvoltage coil, and 1 underload attachment.
2 overload coils, 1 shunt coil, and 1 undervoltage attachment.
2 overload coils, 1 shunt coil, and 1 underload attachment.
1 overload coil, 1 overvoltage coil, 1 shunt coil, and 1 undervoltage attachment.
1 overload coil, 1 overvoltage coil, 1 shunt coil, and 1 undervoltage attachment.
2 overvoltage coils, 1 shunt coil, and 1 undervoltage attachment.
2 overvoltage coils, 1 shunt coil, and 1 underload attachment.
3 overvoltage coils, and 1 undervoltage attachment.
3 overvoltage coils and 1 underload attachment.

On the double-coil automatic standard double-handle (D. T.) coverplate of the transformer-trip breakers (double-coil coverplates are used on double-throw breakers listed as single-coil as well as double-coil):

2 overload coils and 2 undervoltage attachments.
2 overload coils and 2 overload attachments.
2 overload coils, 1 undervoltage attachment, and 1 underload attachment.
1 overload coil, 1 overvoltage coil, 1 undervoltage attachment, and 1 underload attachment.
1 overload coil, 1 shunt coil, 1 undervoltage attachment, and 1 underload attachment.
1 overvoltage coil, 1 shunt coil, 1 undervoltage attachment and 1 underload attachment.
2 overvoltage coils, 1 undervoltage attachment and 1 underload attachment.

On the double-coil automatic standard double-handle (D. T.) coverplate of the series-trip breakers:

1 overload coil, 1 shunt coil, and 1 undervoltage attachment.
1 overload coil, 1 shunt coil, and 1 underload attachment.
1 overload coil, 1 overvoltage coil, and 1 undervoltage attachment.
1 overload coil, 1 overvoltage coil, and 1 underload attachment.

On the triple-coil automatic special double-handle (D. T.) coverplate of the transformer-trip breakers (prices for this coverplate on request):

3 overload coils and 2 undervoltage attachments.
3 overload coils and 2 underload attachments.
3 overload coils, 1 undervoltage attachment, and 1 underload attachment.
2 overload coils, 1 shunt coil, 1 undervoltage attachment, and 1 underload attachment.
2 overload coils, 1 overvoltage coil, 1 undervoltage attachment, and 1 underload attachment.
1 overload coil, 1 overvoltage coil, 1 shunt coil, 1 undervoltage attachment, and 1 underload attachment.
2 overvoltage coils, 1 shunt coil, 1 undervoltage attachment and 1 underload attachment.
3 overvoltage coils, 1 undervoltage attachment and 1 underload attachment.

CONSTRUCTION

The construction of all breakers is such that the entire breaker may be assembled, lined up, and the contacts adjusted before the tanks are placed in position. This feature of accessibility is a decided advantage in securing quick and accurate repair and adjustment. In breakers having separate pole units, a pole unit can be quickly removed and another substituted, thus reestablishing service in a minimum of time.

Instruction cards for installing and operating are supplied with all breaker shipments. These cards should be carefully read and the instructions followed to obtain the best operating results.

TYPE OF MOUNTING

To a large extent, the available space and the required degree of isolation of live parts determine the mounting construction of a circuit-breaker. Generally speaking, for simple plants of not over 3000-kilovoltampere capacity requiring panels up to 800-ampere capacity, and where the voltage is not higher than 2500, single-frame circuit-breakers can be mounted directly on a switchboard panel, on the panel frame, or on a separate pipe-mounting bracket. Where the requirements exceed these, remote control with the circuit-breaker mounted away from the board and controlled from the panel either by direct mechanical connection or by an auxiliary electrical circuit becomes advisable. Where a high degree of isolation is not necessary, open mounting of breakers on wall or pipe frames is permissible. For large power houses and high-capacity substations of moderate voltages, where it is necessary to isolate the units as much as possible, the cell-mounting circuit-breaker is desirable. See Figs. 163 to 174 for suggested arrangements.

Summary of Types of Mounting Available

Manually Operated

Type of Breaker	Mounting					
	Panel	Panel Frame	Wall	Pipe Frame	Pole	Subway
I	Yes	No	Yes	No	No	No
D	Yes	No	Yes	No	Yes	Yes
H	Yes	No	Yes	No	Yes	No
QF	Yes	Yes	Yes	Yes	No	No
F	Yes	Yes	Yes	Yes	Yes	Yes
Electrically Operated						
F	No	No	Yes	Yes	No	No

HANDLE AND COVERPLATE

The coverplate with handle for the manually-operated indoor breakers is mounted on the front of the panel or pipe-frame brackets. The same type of coverplate arrangement is used on the **types D H, QF and F (except type F-3 multiple multipole) manually-operated breakers.** A coverplate equipped with a socket and removable operating handle is used on the type F-3 multiple multipole manually-operated breakers. A switchboard or other switching scheme carrying a system of manually-operated Westinghouse breakers, either panel mounting, panel-frame mounting, or remote-control pipe-frame, or wall mounting, presents a neat and uniform appearance on its front due to the use of the same style and type of coverplates and operating handles.

The full-automatic manually-operated **types QF and F** oil circuit-breakers have the overload trip mechanism (coils, releasing triggers, etc.) mounted in the coverplate, whereas the type H breakers have the overload coils in the breaker tanks.

One or more operating handles may extend through the coverplate depending upon the breaker-construction.

TERMINAL INSULATION

In order to preclude the possibility of dust and dirt collecting on exposed insulating surfaces, reducing the insulating value of such surface so that flashover between terminals or between terminals and ground may occur on the outside of the breaker, it is recommended that on service voltages of 2200 and over, all exposed terminals be insulated after installation. This also prevents the possibility of short-circuiting terminal leads by conducting gases expelled from the tanks and vents when the circuit-breaker ruptures heavy short-circuits.

For many Westinghouse oil circuit-breakers special micarta insulating tubes are made for this purpose; these are listed under "Oil Circuit-Breaker Accessories." These tubes, when provided with caps at the top, provide an easily removable and an effective form of terminal insulation. However, for ordinary service, taping of exposed leads is all that is required.

OIL

(*For more complete information on insulating oils, see Section 5-A on "Westinghouse Insulating Materials and Supplies"*).

(*For oil drying and purifying outfits, for cleaning and dehydrating insulating oils, see Section 4-B on "Westinghouse Feeder-Voltage Regulators and Transformer Apparatus"*).

For ordinary use, the standard HF (high-flash) oil is used with oil circuit-breakers, and a quantity sufficient for the circuit-breaker is regularly furnished as standard (and is included in the list price). This oil begins to thicken at a temperature of 15 degrees Fahrenheit. When oil circuit-breakers are installed in locations where they will be subjected to lower temperature than this, 15-F oil should be used (and ordered as an additional item on the order). 15-F oil does not begin to thicken until the temperature of minus 50 degrees Fahrenheit is reached. It is a rather light oil and volatilizes readily, so that care must be taken when it is used in the summer time, to see that the level of the oil is not so lowered by evaporation as to appreciably decrease the head of oil over the contacts.

As the oil in oil circuit-breakers should preferably be changed and contacts cleaned twice a year, it is recommended that where such apparatus is subject to low temperatures, 15-F oil be substituted for HF in the fall, and this replaced again by HF in the spring.

Satisfactory operation of oil circuit-breakers depends upon the use of suitable oil; hence, use only oil furnished with the breaker or recommended therefor by the breaker manufacturer.

OIL CIRCUIT-BREAKERS, GENERAL—Continued

DIAGRAMS OF TYPICAL CIRCUIT-BREAKER CONNECTIONS

Index

Hand-Operated Breakers

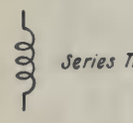
	Figs.
OVERLOAD TRIP	
Single-Throw	
Series-Trip	1 to 11
Current-Transformer-Trip	
Without Relays	12 to 25
With Contact-Opening Relay	26 to 37
Double-Throw	
Series-Trip	
Both Throws Automatic	41 to 48
One Throw Automatic	49 to 59
Current-Transformer-Trip	
Without Relays	
Both Throws Automatic	60 to 73
One Throw Automatic	74 to 87
OVERLOAD AND SHUNT OR UNDERVOLTAGE TRIP	
Single-Throw	
With Contact-Closing Relays	122 to 133
Double-Throw	
With Contact-Closing Relays	
Both Throws Automatic	134 to 145
One Throw Automatic	146 to 157
UNDERVOLTAGE TRIP	158 to 162

Electrically-Operated Breakers

Sigle-Throw	112 to 118

For other diagrams of typical connections refer to section -B— "Westinghouse Instruments and Relays" and to Westinghouse Switchboard Data Book.

Key to Symbols Used

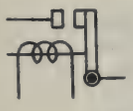


Series Trip Coil

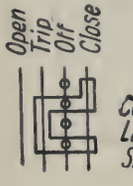
Trip Coil used with Current Transformers and Shunt Trip.

Closing Coil

*Current Transformers.**



Control Relay



Control Switch with Lamp Cutout for Single-Bus System.

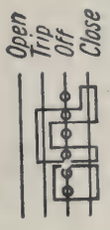
(R) *Red Indicating Lamp*
Lights when Circuit-breaker Closes.
Dark when Circuit-breaker Opens.

(G) *Green Indicating Lamp*
Lights when Circuit-breaker Opens
Dark when Circuit-breaker Closes

(W) *White Indicating Lamp*
Lights when Breaker is Tripped by Relay.

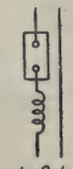
8 Pt. Pallet Switch.
Contacts shown for Open Position of Circuit-breaker.

8 Pt. Pallet Switch.
Contacts shown for Closed Position of Circuit-breaker.



Control Switch with Lamp Cutout and Relay Cutout for Double-Bus System.

*Like-polarity primary and secondary terminals of current transformers are marked with white or black tape. All current transformers must be connected with the same polarity (color) of primary terminal nearest the breaker. For diagram purposes as outlined, current-transformer secondary terminals have the same polarity (color) as the primary terminal shown adjacent there

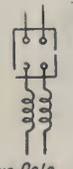


Single-Pole Single-Phase One Trip Coil

Fig. 1

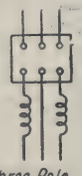
Two-Pole Single-Phase Two-Wire One Trip Coil

Fig. 2



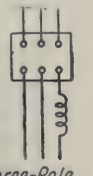
Two-Pole Single-Phase Two Trip Coils

Fig. 3



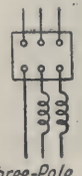
Three-Pole Single-Phase Three-Wire Two Trip Coils

Fig. 4



Three-Pole Three-Phase Balanced Load One Trip Coil

Fig. 5

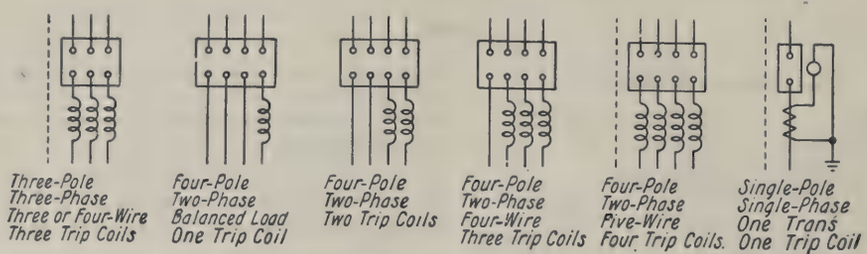


Three-Pole Three-Phase Two Trip Coils

Fig. 6

OIL CIRCUIT-BREAKERS, GENERAL—Continued

Figures 7 to 32



Three-Pole Three-Phase Three or Four-Wire Three Trip Coils — Fig. 7

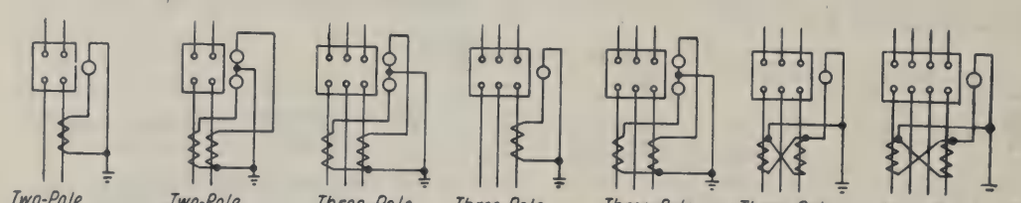
Four-Pole Two-Phase Balanced Load One Trip Coil — Fig. 8

Four-Pole Two-Phase Two Trip Coils — Fig. 9

Four-Pole Two-Phase Four-Wire Three Trip Coils — Fig. 10

Four-Pole Two-Phase Five-Wire Four Trip Coils. — Fig. 11

Single-Pole Single-Phase One Trans One Trip Coil — Fig. 12



Two-Pole Single-Phase One Trans. One Trip Coil — Fig. 13

Two-Pole Single-Phase Grounded Neutral Two Trans. Two Trip Coils — Fig. 14

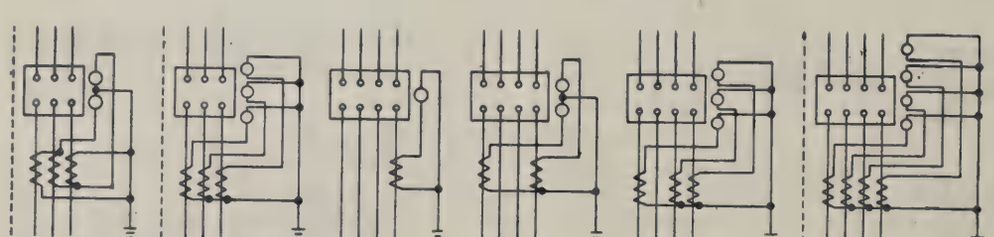
Three-Pole Single-Phase Three-Wire Two Trans. Two Trip Coils — Fig. 15

Three-Pole Three-Phase Balanced Load One Trans. One Trip Coil — Fig. 16

Three-Pole Three-Phase Two Trans. Two Trip Coils — Fig. 17

Three-Pole Three-Phase Two Trans. One Trip Coil. — Fig. 18

Four-Pole Two-Phase Balanced Load Two Trans. One Trip Coil — Fig. 18-A



Three-Pole Three-Phase Three Trans. Z-Connected Two Trip Coils — Fig. 19

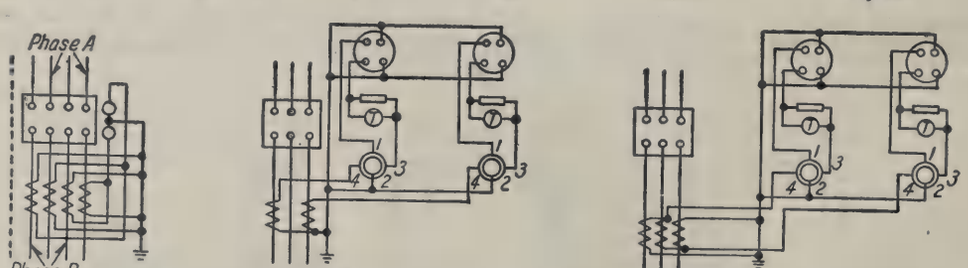
Three-Pole Three-Phase Three Trans. Y-Connected Three Trip Coils — Fig. 20

Four-Pole Two-Phase Balanced Load One Trans. One Trip Coil — Fig. 21

Four-Pole Two-Phase Two Trans. Two Trip Coils — Fig. 22

Four-Pole Two-Phase Inter-connected Three Trans. Three Trip Coils — Fig. 23

Four-Pole Two-Phase Four or Five-Wire Four Trans. Four Trip Coils — Fig. 24



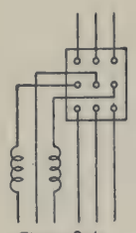
Four-Pole Two-Phase Four or Five-Wire Four Trans. Two Trip Coils — Fig. 25

Three-Pole Three-Phase Two Trans. Two Relays Two Trip Coil Two Direct Trip Attachments. — Fig 31

Three-Pole Three-Phase Z-Connected Three Trans. Two Relays Two Trip Coil Two Direct Trip Attachments — Fig 32

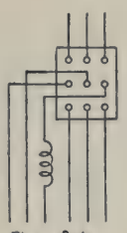
OIL CIRCUIT-BREAKERS, GENERAL—Continued

Figures 41 to 63



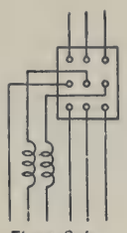
Three-Pole Single-Phase Three-Wire Two Trip Coils

Fig. 41



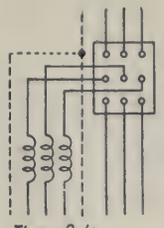
Three-Pole Three-Phase Balanced Load One Trip Coil

Fig. 42



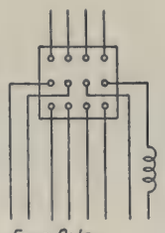
Three-Pole Three-Phase Two Trip Coils

Fig. 43



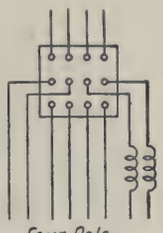
Three-Pole Three-Phase Three or Four-Wire Three Trip Coils

Fig. 44



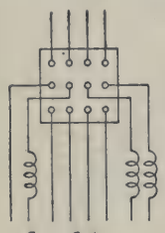
Four-Pole Two-Phase Balanced Load One Trip Coil

Fig. 45



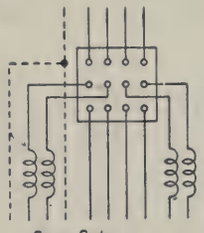
Four-Pole Two-Phase Two Trip Coil

Fig. 46



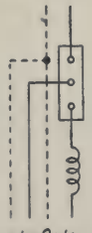
Four-Pole Two-Phase Four-Wire Three Trip Coils

Fig. 47



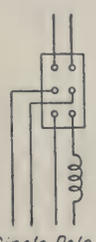
Four-Pole Two-Pole Four or Five-Wire Four Trip Coils

Fig. 48



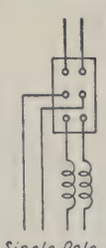
Single-Pole Single-Phase One Trip Coil

Fig. 49



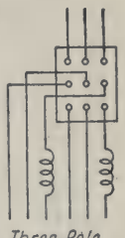
Single-Pole Single-Phase One Trip Coil

Fig. 50



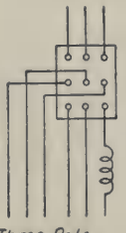
Single-Pole Single-Phase Two Trip Coils

Fig. 51



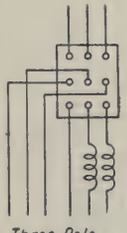
Three-Pole Single-Phase Three-Wire Two Trip Coils

Fig. 52



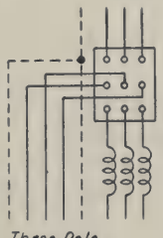
Three-Pole Three-Phase Balanced Load One Trip Coil

Fig. 53



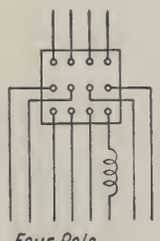
Three-Pole Three-Phase Two Trip Coils

Fig. 54



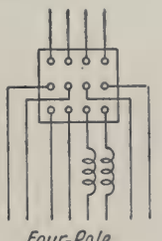
Three-Pole Three-Phase Three or Four-Wire Three Trip Coils

Fig. 55



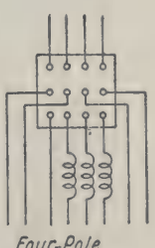
Four-Pole Two-Phase Balanced Load One Trip Coil

Fig. 56



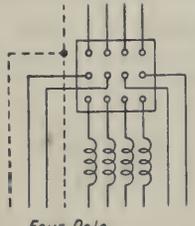
Four-Pole Two-Phase Two Trip Coils

Fig. 57



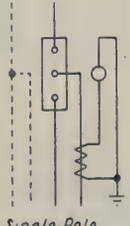
Four-Pole Two-Phase Four-Wire Three Trip Coils

Fig. 58



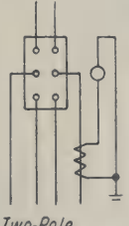
Four-Pole Two-Phase Four or Five-Wire Four Trip Coils

Fig 59



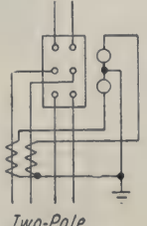
Single-Pole Single-Phase One Trans One Trip Coil

Fig. 60



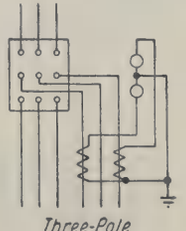
Two-Pole Single-Phase One Trans One Trip Coil

Fig. 61



Two-Pole Single-Phase Grounded Neutral Two Trans Two Trip Coils

Fig. 62

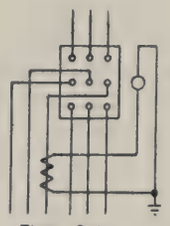


Three-Pole Single-Phase Three Wire Two Trans Two Trip Coils

Fig. 63

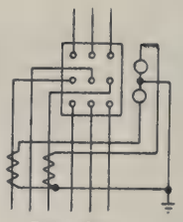
OIL CIRCUIT-BREAKERS, GENERAL—Continued

Figures 64 to 80



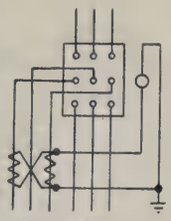
Three-Pole
Three-Phase
Balanced Load
One Transformer
One Trip Coil

Fig. 64



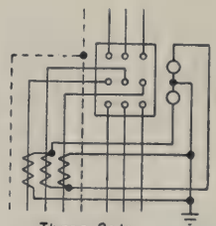
Three-Pole
Three-Phase
Two Transformers
Two Trip Coils

Fig. 65



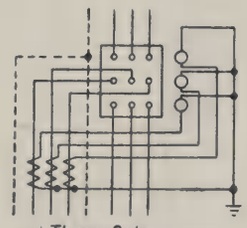
Three-Pole
Three-Phase
Two Transformers
One Trip Coils

Fig. 66



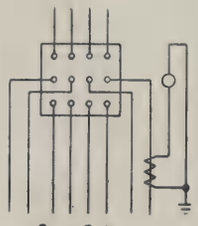
Three-Pole
Three-Phase
Three or Four-Wire
Z-Connected
Three Transformers
Two Trip Coils

Fig. 67



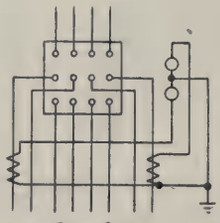
Three-Pole
Three-Phase
Three or Four-Wire
Y-Y Connected
Three Transformers
Three Trip Coils

Fig. 68



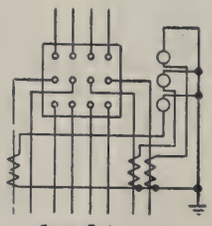
Four-Pole
Two-Phase
Balanced Load
One Transformer
One Trip Coil

Fig. 69



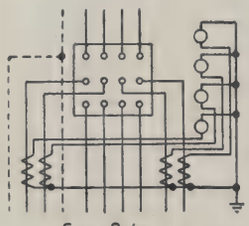
Four-Pole
Two-Phase
Two Transformers
Two Trip Coils

Fig. 70



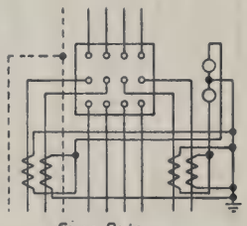
Four-Pole
Two-Phase
Inter-connected
Three Transformers
Three Trip Coils

Fig. 71



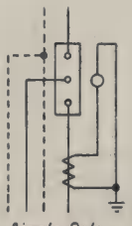
Four-Pole
Two-Phase
Four or Five-Wire
Four Trans
Four Trip Coils

Fig. 72



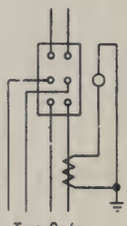
Four-Pole
Two-Phase
Four or Five-Wire
Four Trans
Two Trip Coils

Fig. 73



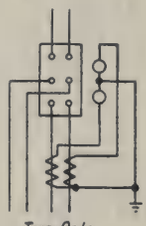
Single-Pole
Single-Phase
Two-Wire
One Trans
One Trip Coil

Fig. 74



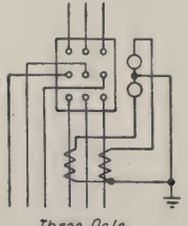
Two-Pole
Single-Phase
One Trans
One Trip Coil

Fig. 75



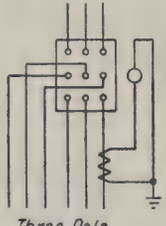
Two-Pole
Single-Phase
Two Trans
Two Trip Coils

Fig. 76



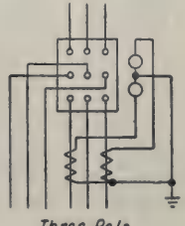
Three-Pole
Single-Phase
Three-Wire
Two Trans
Two Trip Coils

Fig. 77



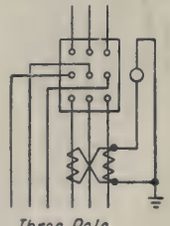
Three-Pole
Three-Phase
Balanced Load
One Trans
One Trip Coil

Fig 78



Three-Pole
Three-Phase
Two Trans
Two Trip Coils

Fig. 79

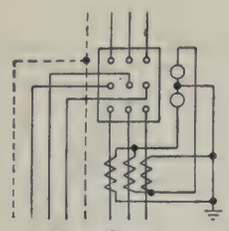


Three-Pole
Three-Phase
Two Trans
One Trip Coil
Vector Parallel

Fig. 80

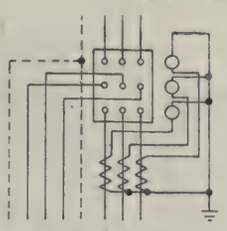
OIL CIRCUIT-BREAKERS, GENERAL—Continued

Figures 81 to 115



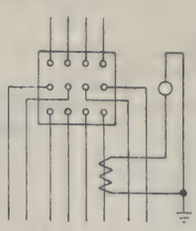
Three-Pole
Three-Phase
Three or Four-Wire
Z-Connected
Three Trans
Two Trip Coils

Fig. 81



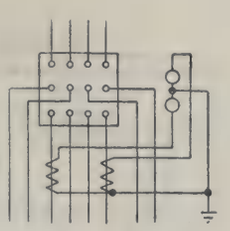
Three-Pole
Three-Phase
Three or Four-Wire
Three Trans
Three Trip Coils
Y-Y Connected

Fig. 82



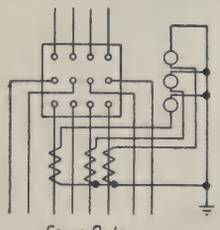
Four-Pole
Two-Phase
Balanced Load
One Trans
One Trip Coil

Fig. 83



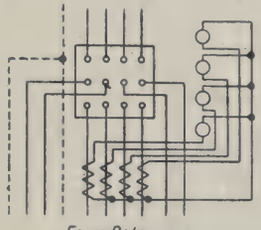
Four-Pole
Two-Phase
Two Trans
Two Trip Coils

Fig. 84



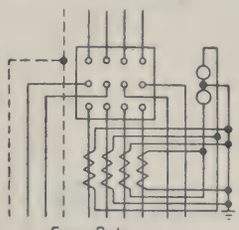
Four-Pole
Two-Phase
Inter-connected
Three Transformers
Three Trip Coils

Fig. 85



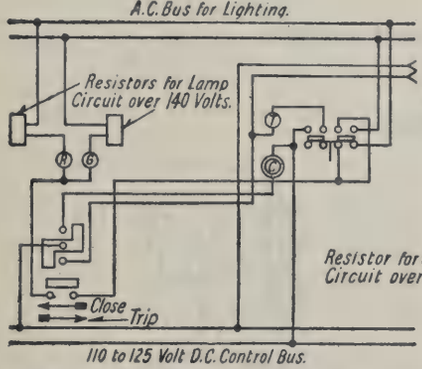
Four-Pole
Two-Phase
Four or Five-Wire
Inter-connected
Four Transformers
Four Trip Coils

Fig. 86



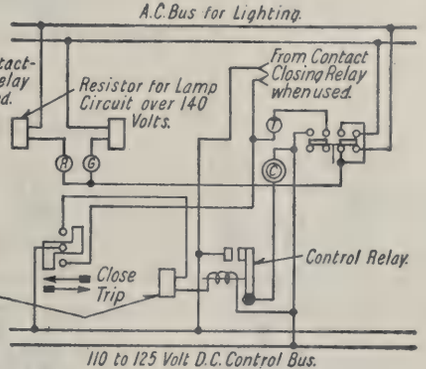
Four-Pole
Two-Phase
Four or Five-Wire
Inter-connected
Four Transformers
Vector Parrallel
Two Trip Coils

Fig. 87


A.C. Bus for Lighting.
Resistors for Lamp Circuit over 140 Volts.
From Contact-Closing Relay when used.
Resistor for Control Circuit over 125 Volts.
Close
Trip
110 to 125 Volt D.C. Control Bus.

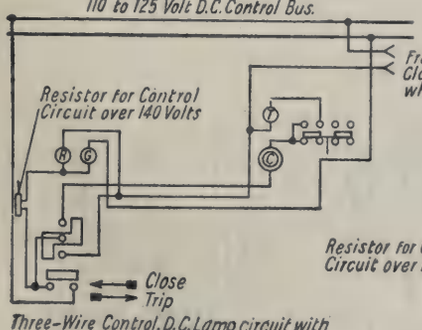
Three-Wire Control, Lamp Cutout Contacts, Separate Lighting Circuit.

Fig. 112


A.C. Bus for Lighting.
From Contact Closing Relay when used.
Resistor for Lamp Circuit over 140 Volts.
Control Relay.
Close
Trip
110 to 125 Volt D.C. Control Bus.

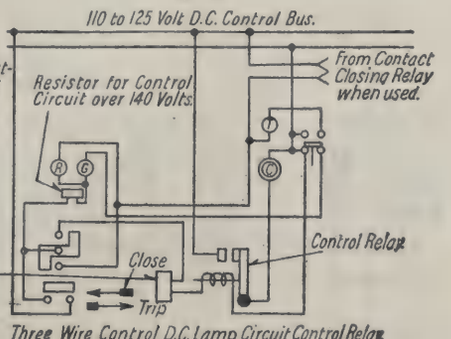
Three-Wire Control, Control Relay Separate Lighting Circuit.

Fig. 113


110 to 125 Volt D.C. Control Bus.
From Contact-Closing Relay when used.
Resistor for Control Circuit over 140 Volts
Resistor for Control Circuit over 125 Volts
Close
Trip

Three-Wire Control, D.C. Lamp circuit with Lamp Cutout Contacts.

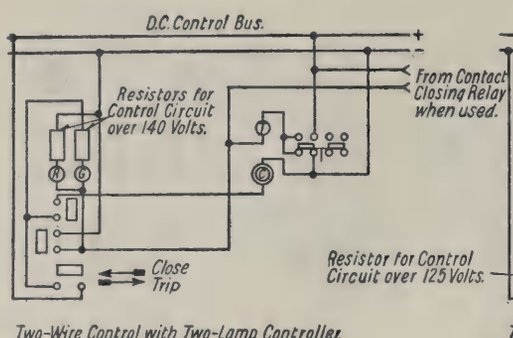
Fig. 114


110 to 125 Volt D.C. Control Bus.
From Contact Closing Relay when used.
Resistor for Control Circuit over 140 Volts.
Control Relay
Close
Trip

Three Wire Control, D.C. Lamp Circuit Control Relay.

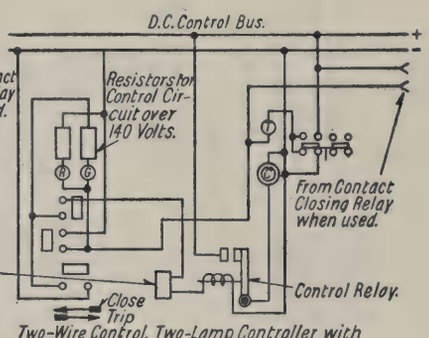
Fig. 115

Figures 116 to 129



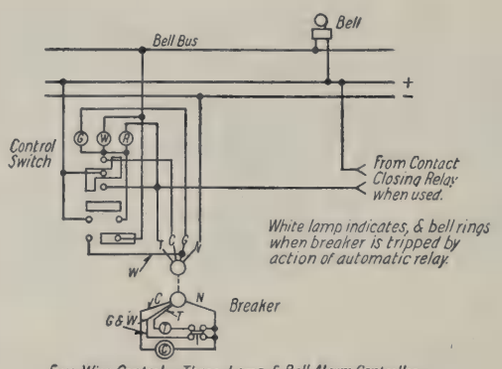
Two-Wire Control with Two-Lamp Controller.

Fig. 116



Two-Wire Control, Two-Lamp Controller with Control Relay.

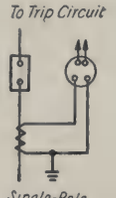
Fig. 117



Four-Wire Control —Three-Lamp & Bell Alarm Controller.

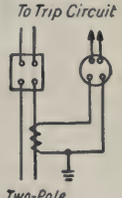
Fig. 118

Single-Phase Circuits



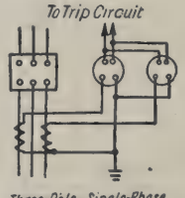
Single-Pole Single-Phase One Trans. One Relay.

Fig. 122



Two-Pole. Single-Phase One Trans. One Relay.

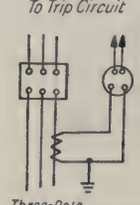
Fig. 123



Three-Pole. Single-Phase Three-Wire. Two Trans. Two Relays

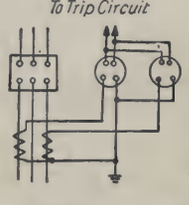
Fig. 125

Three-Phase Circuits



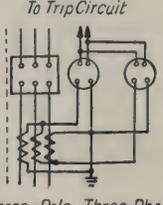
Three-Pole Three-Phase Balanced Load One Trans. One Relay

Fig. 126



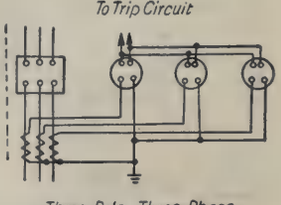
Three-Pole Three-Phase Two Trans. Two Relays

Fig. 127



Three-Pole Three-Phase Three-Wire or Four-Wire Δ Connected Ground System Three Trans. Two Relays

Fig. 128



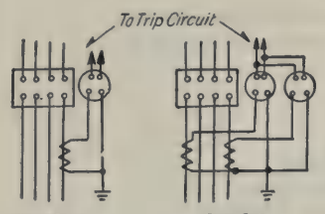
Three-Pole Three-Phase Three-Wire or four-Wire Y-Connected Three Trans. Three Relays

Fig. 129

OIL CIRCUIT-BREAKERS, GENERAL—Continued

Figures 130 to 145

Two-Phase Circuits

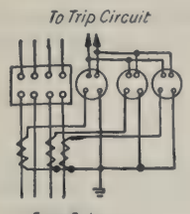


Four-Pole
Two-Phase
Balanced Load
One Transformer
One Relay

Fig. 130

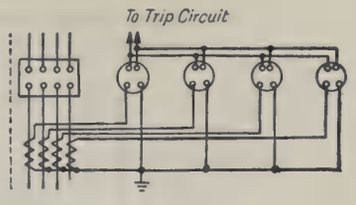
Four-Pole
Two-Phase
Two Transformers
Two Relays

Fig. 131



Four-Pole.
Two-Phase.
Inter-connected
Three Transformers.
Three Relays

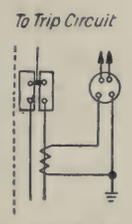
Fig. 132



Four-Pole Two-Phase
Four or Five-Wire
Four Trans. Four Relays

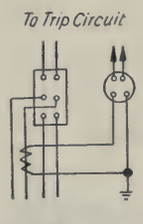
Fig. 133

Single-Phase Circuits



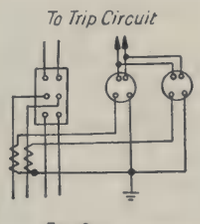
Single-Pole
Single-Phase
One Transformer
One Relay

Fig. 134



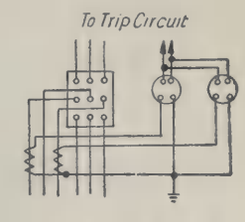
Two-Pole
Single-Phase
One Transformer
One Relay

Fig. 135



Two-Pole.
Single-Phase.
Two Transformers
Two Relays

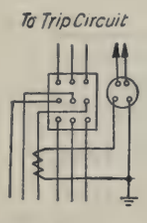
Fig. 136



Three-Pole Single-Phase
Three-Wire
Two Transformers
Two Relays

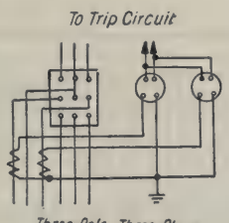
Fig. 137

Three-Phase Circuits



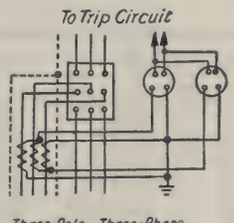
Three-Pole Three-Phase
Balanced Load
One Transformer
One Relay

Fig. 138



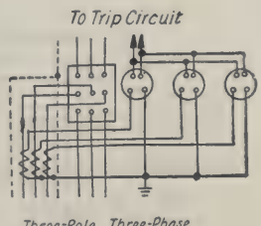
Three-Pole Three-Phase
Two Transformers
Two Relays

Fig. 139



Three-Pole Three-Phase
Three or Four-Wire
Grounded Systems
Z-Connected
Three Transformers Two Relays

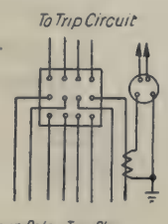
Fig. 140



Three-Pole Three-Phase
Three or Four-Wire
Y-Connected
Three Transformers Three Relays

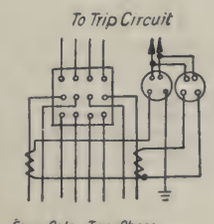
Fig. 141

Two-Phase Circuits



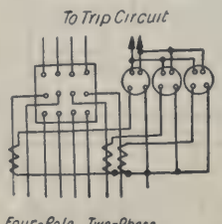
Four-Pole Two-Phase
Balanced Load.
One Transformer One Relay

Fig. 142



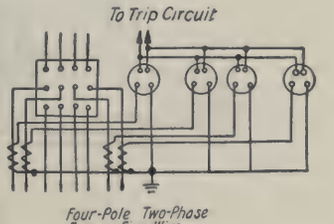
Four-Pole. Two-Phase
Two Transformers. Two Relays.

Fig. 143



Four-Pole Two-Phase
Three Transformers Three Relays

Fig. 144



Four-Pole Two-Phase
Four or Five-Wire
Four Transformers
Four Relays

Fig. 145

255-56A

Figures 156-A and 156-B

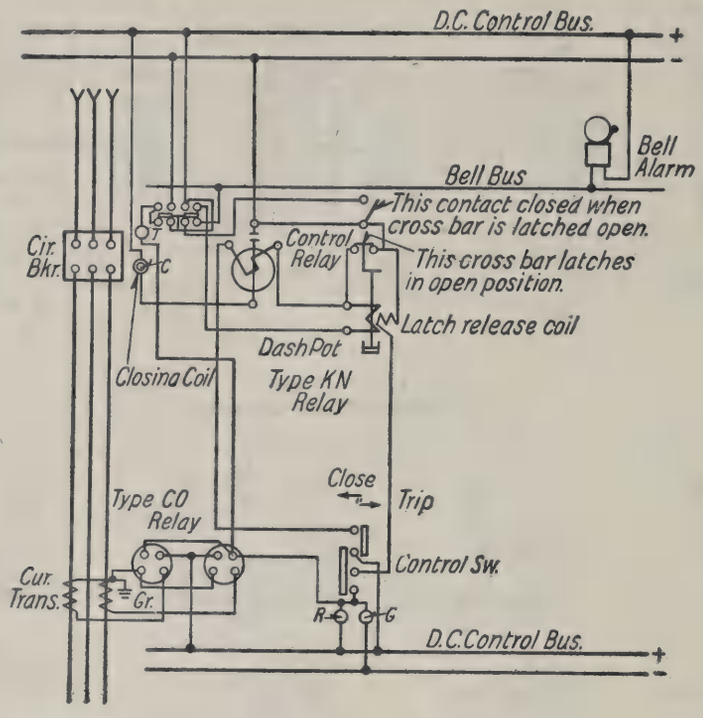


FIG. 156-A—TRIP-FREE RELAY, ONE PER STATION

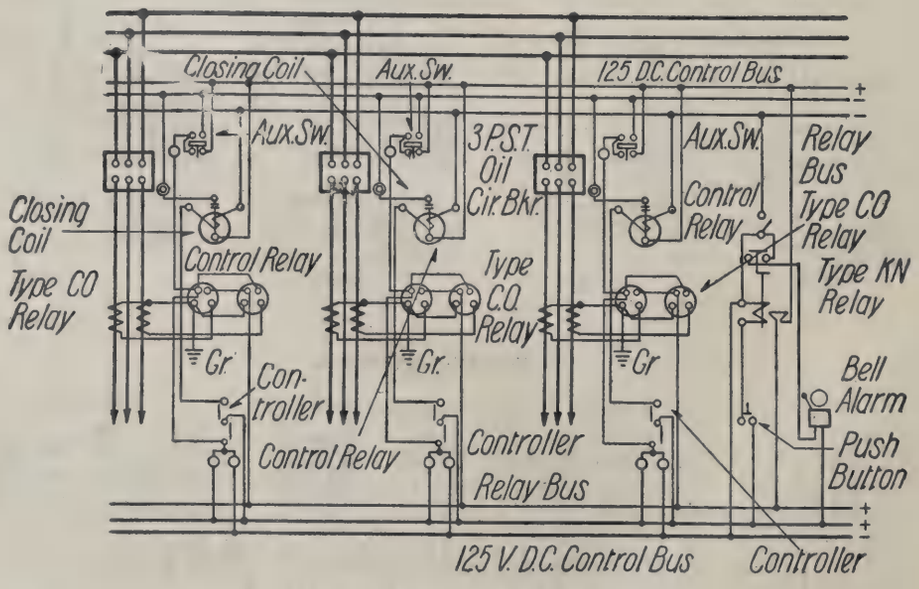
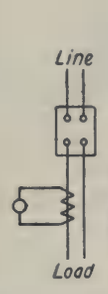


FIG. 156-B—TRIP-FREE RELAY, ONE PER STATION

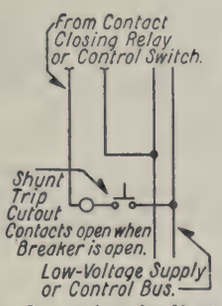
OIL CIRCUIT-BREAKERS, GENERAL—Continued

Figures 158 to 165



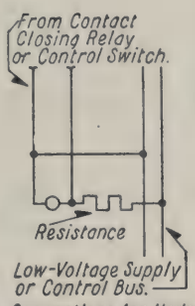
Connections for Underload Trip Coil with Hand Resetting Mechanism.

Fig. 158


From Contact Closing Relay or Control Switch.
Shunt Trip Cutout Contacts open when Breaker is open.
Low-Voltage Supply or Control Bus.

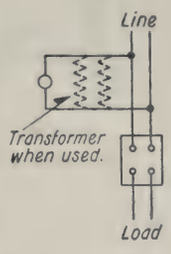
Connections for Shunt Trip Coil to Shunt Trip Cutout Contacts.

Fig. 159



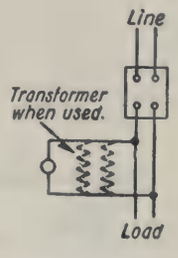
Connections for Undervoltage Trip Coil used with Resistance as a Shunt Trip.

Fig. 160



Connections for Self-resetting Type of Undervoltage Trip Device.

Fig. 161



Connections for Hand-resetting Undervoltage Trip Device. Connection also applies for Overvoltage Trip.

Fig. 162

METHODS OF MOUNTING MANUALLY-OPERATED CIRCUIT-BREAKERS

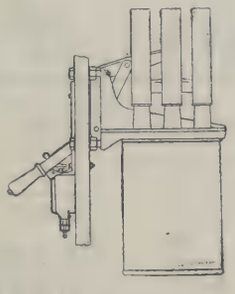


FIG. 163—MANUALLY-OPERATED DIRECT-CONTROL CIRCUIT-BREAKER, PANEL-MOUNTING (AUTOMATIC)

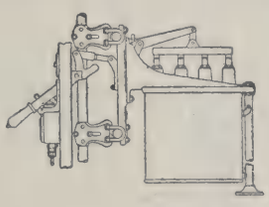


FIG. 164—MANUALLY-OPERATED DIRECT-CONTROL CIRCUIT-BREAKER, PANEL-FRAME-MOUNTING (AUTOMATIC)

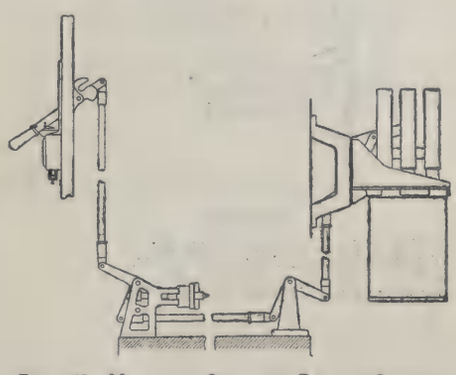


FIG. 165—MANUALLY-OPERATED REMOTE-CONTROL CIRCUIT-BREAKER, WALL-MOUNTING, BELL CRANKS ABOVE FLOOR (AUTOMATIC)

OIL CIRCUIT-BREAKERS, GENERAL—Continued

Figures 166 to 170

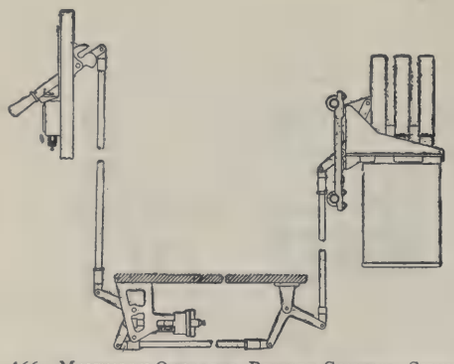


FIG. 166—MANUALLY-OPERATED REMOTE-CONTROL CIRCUIT-BREAKER, PIPE-MOUNTING, BELL CRANKS BELOW FLOOR (AUTOMATIC)

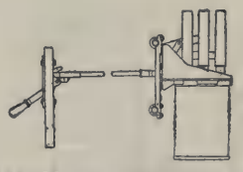


FIG. 167—MANUALLY-OPERATED REMOTE-CONTROL CIRCUIT-BREAKER, PIPE-MOUNTING, HORIZONTAL PULL, WITHOUT BELL CRANKS, (NON-AUTOMATIC)

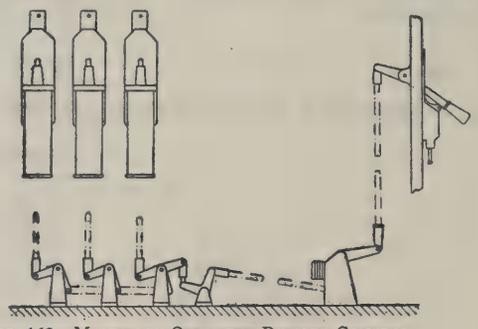


FIG. 169—MANUALLY-OPERATED REMOTE-CONTROL MULTIPLE SINGLE-POLE CIRCUIT-BREAKER, WALL-MOUNTING, BELL CRANKS ABOVE FLOOR, (AUTOMATIC)

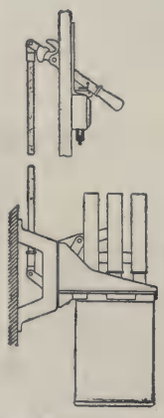
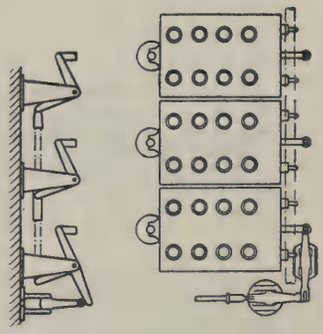


FIG. 168—MANUALLY-OPERATED REMOTE-CONTROL CIRCUIT-BREAKER, WALL MOUNTING, UPWARD PULL, WITHOUT BELL CRANKS, (AUTOMATIC)



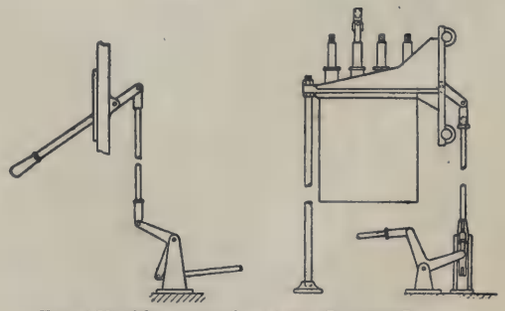


FIG. 170—MANUALLY-OPERATED REMOTE-CONTROL MULTIPLE-MULTIPOLE CIRCUIT-BREAKER PIPE-MOUNTING, BELL CRANKS ABOVE FLOOR, (NON-AUTOMATIC)

METHODS OF MOUNTING OF ELECTRICALLY-OPERATED CIRCUIT-BREAKERS

Figures 171 to 175

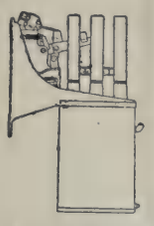


FIG. 171—ELECTRICALLY-OPERATED CIRCUIT-BREAKER

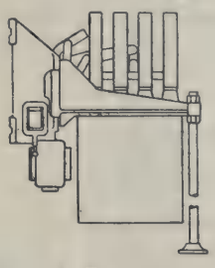


FIG. 172—ELECTRICALLY-OPERATED CIRCUIT-BREAKER, WALL OR PIPE-MOUNTING (AUTOMATIC)

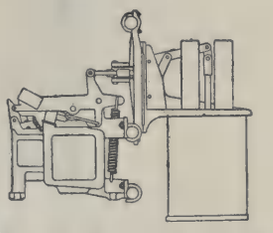


FIG. 173—ELECTRICALLY-OPERATED CIRCUIT-BREAKER, PIPE-MOUNTING

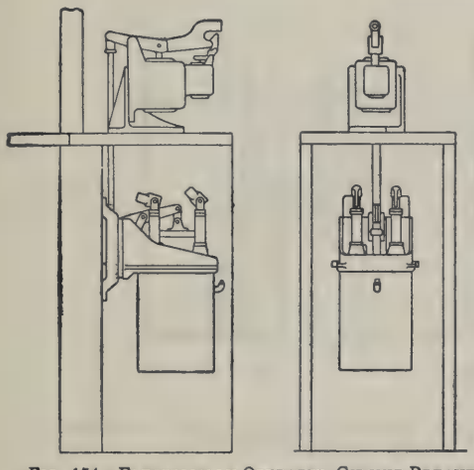


FIG. 174—ELECTRICALLY-OPERATED CIRCUIT-BREAKER CELL-MOUNTING MECHANISM ABOVE BREAKER

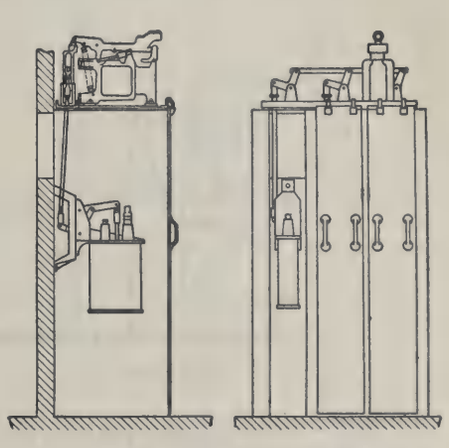


FIG. 175—TYPE F-2 MULTIPLE SINGLE-POLE BREAKER ARRANGED FOR REPLACEMENT BY TYPE E-8 BREAKER

TYPICAL CIRCUIT-BREAKER AND BUS STRUCTURES

For description of item numbers see Fig. 184.
For table of dimensions see Fig. 185.

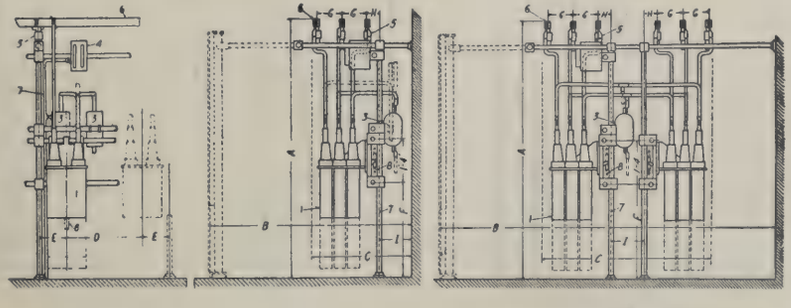


FIG. 176-177 FIG. 176 FIG. 177

FIGS. 176 AND 177—OIL CIRCUIT-BREAKER AND BUS STRUCTURE WITHOUT DISCONNECTING SWITCHES. TYPICAL OF STRUCTURES WITH TYPE D, F-1, F-2, OR F-3 BREAKER

Fig. 176 shows a one-breaker single-bus structure.
Fig. 177 shows a two-breaker double-bus structure.

OIL CIRCUIT-BREAKERS, GENERAL—Continued

For description of item numbers see Fig. 184.
For table of dimensions see Fig. 185.

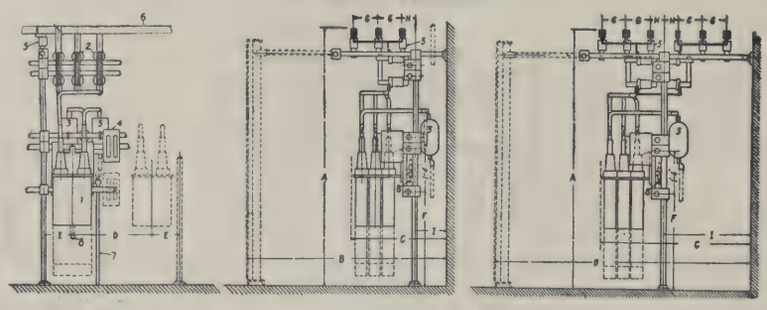


FIG. 178–179 FIG. 178 FIG. 179

FIGS. 178 AND 179—OIL CIRCUIT-BREAKER AND BUS STRUCTURE WITH DISCONNECTING SWITCHES. TYPICAL OF STRUCTURES WITH TYPE D, F-1, F-2 OR F-3 BREAKER
Fig. 178 shows a one-breaker single-bus structure.
Fig. 179 shows a one-breaker double-bus structure.

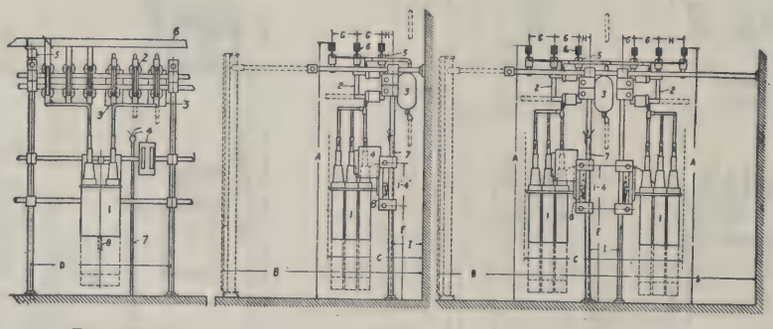


FIG. 180–181 FIG. 180 FIG. 181

FIGS. 180 AND 181—OIL CIRCUIT-BREAKER AND BUS STRUCTURE WITH DISCONNECTING SWITCHES ON EACH SIDE OF THE BREAKER. TYPICAL OF STRUCTURE WITH TYPE D, F-1, F-2 OR F-3 BREAKER
Fig. 180 shows a one-breaker single-bus structure.
Fig. 181 shows a two-breaker double-bus structure.
NOTE—Dimension D may be decreased by raising the bus-bars, increasing dimension A, and thus allowing room for the disconnecting switches to be arranged in two horizontal rows of three each instead of as shown.

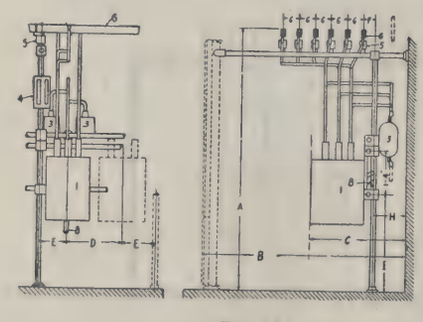


FIG. 182

FIG. 182—OIL CIRCUIT-BREAKER AND BUS-BAR STRUCTURE WITHOUT DISCONNECTING SWITCHES. ONE-BREAKER DOUBLE-BUS SYSTEM. TYPICAL STRUCTURE WITH 300-AMPERE DOUBLE-THROW TYPE D OR F-2 OIL CIRCUIT-BREAKERS.

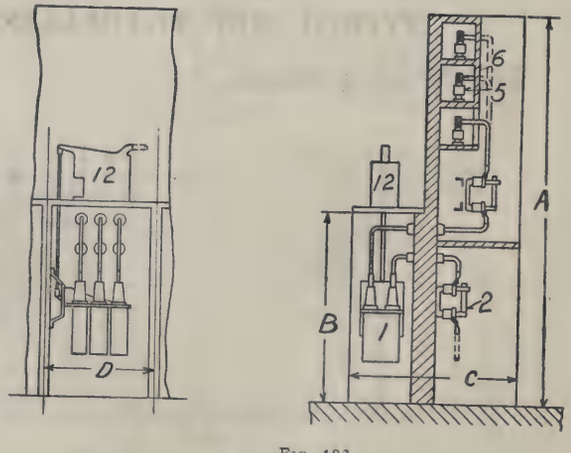


FIG. 183

FIG. 183—OIL CIRCUIT-BREAKER AND BUS-BAR STRUCTURE, ENCLOSED CONSTRUCTION, WALL MOUNTING.
Showing typical structure for type F breakers to match structure for type E, C and O breakers.

Fig. 184—Description of Item Numbers for Figures 176 to 183, Inclusive

Item No.	Description
1	Remote-control manually or electrically operated oil circuit-breaker.
2	Disconnecting switch.
3	Current transformer.
4	Voltage transformer with primary fuse block and fuses for 2400 volts and under.
5	Bus-bar support.
6	Bus-bars.
7	Conduit for secondary leads of instrument transformers (supplied by purchaser).
8	Operating rods of circuit-breaker (supplied by purchaser).
9	Voltage transformer, 6600 volts and over.
10	Voltage transformer primary fuse blocks and fuses for 6600 volts and over.
11	Countershaft with operating levers for manually-operated or solenoid-operated breakers.
12	Solenoid for electrically-operated breakers.

Fig. 185—Circuit-Breaker and Bus Structure

Table of Dimensions

All dimensions are approximate and are for reference only in determining the space required for the switchboard equipment. Approved outlines should be obtained from the Company for construction purposes.

Fig.	Breaker Type	Bus System	Dimensions in Inches A	B *Minimum	B Standard	C	D
176	D, F-1, F-2	Single	96	80	84	32	20
176	F-3,	Single	96	84	84	36	24
177	D, F-1, F-2	Double	96	136	144	52	20
177	F-3,	Double	96	144	144	60	24
178	D, F-1, F-2, F-3	Single	96	84	84	36	26
179	D, F-1, F-2, F-3	Double	96	132	132	84	26
180	D, F-1, F-2, F-3	Single	96	84	84	36	52
181	D, F-1, F-2, F-3	Double	96	144	144	60	52
182	D	Double	96	80	84	32	20
182	F-2	Double	96	84	84	36	28
183	D, F-1, F-2, F-3	Single	138	...	...	54	36

*Figured on the basis of the switchboard proper occupying a space of one foot and of having three-foot aisles. Use standard distance if possible as this dimension must be the same for all breakers in one structure.

INSTRUCTIONS FOR ORDERING OIL CIRCUIT-BREAKERS

LIST PRICE INCLUDES

For Manually-Operated Non-Automatic Breakers—

Breaker with oil.

Standard tube terminals up to 800-ampere 60-cycle capacities, inclusive.

Bell cranks, with remote-control breakers, and panel-mounting face plate.

Doors for cell structures as described (on special type F-2 breaker only).

For Manually-Operated Automatic Breakers—

In addition to apparatus included with non-automatic breakers, as above, the following—

Transformer-trip or series-trip coils as ordered.

For Electrically-Operated Non-Automatic Breakers—

Breaker with oil.

Standard tube terminals up to 800-ampere 60-cycle capacities, inclusive.

Doors for cell structures as described (on special type F-2 breakers only).

Electro-magnet mechanism with shunt closing and tripping coils; with accelerating spring device where necessary; and with the necessary connecting details, except rods, where outline dimension information states that rods are not supplied.

For Electrically-Operated Automatic Breakers—

In addition to aparatus included with electrically-operated non-automatic breakers, the following—

Transformer-trip coils.

For Pipe-Frame Mounting Breakers—

A complete set of frame parts as described.

LIST PRICES DO NOT INCLUDE

Control switches. Signal lamps.

Relays. Control relays.

Current transformers.

Pipe control rods, when required for remote-control breakers.

Terminals for capacities above 800-ampere 60-cycle capacities.

Hand-closing levers on electrically-operated breakers (usually one per station for each kind of breaker is sufficient.)

Control Switches and Control Relays—

The standard drum-type control switches as used with the electrically-operated breakers may or may not handle the full closing current of the breaker closing-magnet coils. There may be required in addition to the drum control switch a control relay as referred to on pages of this section on oil circuit-breaker accessories. For application of drum control switches and control relays, see data under "General Information" and "Operation" of the various types of breakers.

Control relays are not required in the tripping circuit of the breaker when standard Westinghouse relays are used.

SPECIFY ON ORDER FOR BREAKER

For apparatus included under a style number refer to breaker tables.

Style number. Type. Single or double throw. Maximum current (amperes) which the breaker will be required to interrupt. Amperes. Service voltage. Breaker rated voltage. Cycles (frequency). Number of poles. Method of trip (For manually-operated non-automatic or automatic, and for electrically-operated non-automatic or automatic, and for double-throw, *characteristics each side*). *Number of transformer trip coils.* If electrically-operated, *method of operation* (direct current, or frequency alternating current) *and range of operating voltage. Mounting* (indoor or outdoor). *Pull. Accessories as designated. Terminals or contact nuts* (above 800 amperes when ordered), *give size and number of cables per stud, or number of nuts. Oil.*

Also specify on order in breaker item *frequency of the current-transformer trip coils*, when ordered for operation on alternating current.

Also specify on order in breaker item *voltage of the control circuit* at the breaker for electrically-operated breakers. The control voltages are to be specified by the range in voltage. For example, give the normal voltage as "..... (100) volts, voltage range ..... to ..... (70 to 140) volts." Operating coils for a control voltage of 70 to 140 volts direct current are included in the list price of the breaker. Operating coils having a voltage range other than that specified will be considered special; prices on request. Standard operating coils for a range of 140 to 280 volts, will be furnished at the same price as the coils now included in the list price of the breaker but on special order.

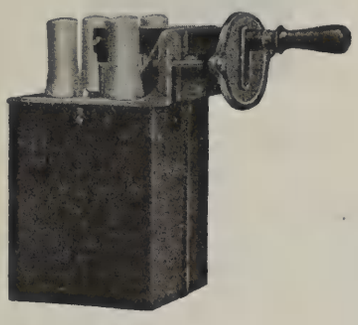
In addition to specfying the voltage of the direct-current closing and shunt tripping coils, specify *frequency of the alternating-current shunt-trip coils* (only), when ordered to operate on alternating current.

Items not included in the style number or the list price should be specified as *separate items* on the order.

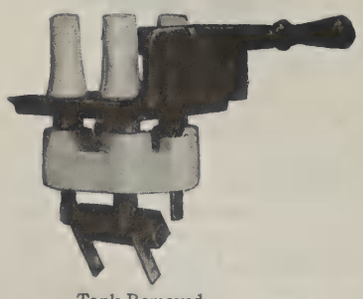
TYPE I OIL CIRCUIT-BREAKERS

MANUALLY-OPERATED—NON-AUTOMATIC FOR INDOOR SERVICE—SINGLE AND DOUBLE THROW

For Capacities up to 60 Amperes 4500 Volts, A.C. Interrupting Capacity at Rated Voltage, 300 Amperes



Complete



Tank Removed

Fig. 1—Two-Pole Dust-Proof Panel-Mounting Breaker

Application

The type I oil circuit-breakers are two, three or four-pole breakers for controlling inductive loads of small capacity on alternating-current circuits. They are made for either panel or wall mounting and are either dust-proof or dust and damp-proof as listed. The dust and damp-proof wall-mounting forms are particularly adapted as service switches mounted in cellars, kiosks, and outdoor switch-houses, where the breaker is subjected to moisture but not exposed to the weather. The double-throw breakers of this form are often used as service change-over switches on block signal and other systems.

Distinctive Features

The characteristic features of the type I oil circuit-breakers are: knife blade contacts submerged in oil; live parts carried on porcelain base affording high quality of permanent insulation between adjacent poles, and between frame and live parts; small space required for mounting; light weight; tanks removable without disturbing contacts, making easy accessibility of parts for purpose of inspection and repairs, enclosure of all live parts; and low first cost.

Operation

The type I oil circuit-breakers are non-automatic manually-operated only. In general, they are opened and closed by one lever-type handle, but the dust and damp-proof switches, Style Nos. 226540 and 226541 have crank-type handles as shown in the illustrations.

Style No. 226540 is a single-throw three-pole breaker having two positions, "on" and "off", as in the regular form.

Style No. 226541 is a double-throw two-pole transfer breaker having three positions, (1) both throws "on", (2) one throw "on" with the other throw "off", and (3) first throw "off" with the second throw "on".

The double-two-pole selector breaker, Style No. 226542 has two lever-type handles, either of which can be in the "on" or "off" position at the same time, making four combinations; in this breaker both sets of blades are mounted on the same hinge jaws.

The constant-current lighting form of breaker Style No. 119372, has two handles as shown in Fig. 2. One handle operates a single pole used for short circuiting the constant-current regulating device, the other operates two poles for controlling both sides of the line. This form of breaker is available only for panel-mounting.

Construction

The panel-mounting form of breaker is designed for mounting on the rear of the switchboard panel

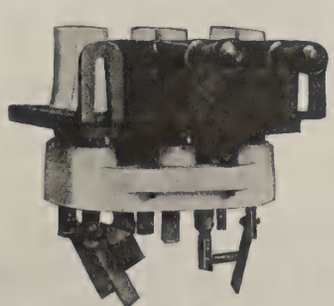


Fig. 2—Three-Pole Dust-Proof Panel-Mounting Constant-Current Lighting Breaker—Tank Removed

TYPE I OIL CIRCUIT-BREAKERS—Continued

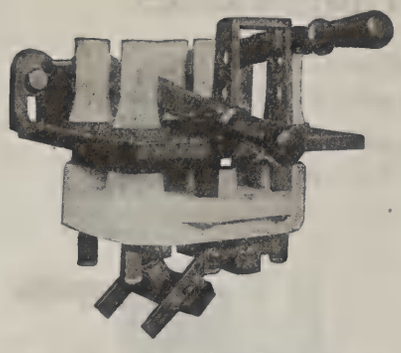


FIG. 3—DOUBLE-TWO-POLE DUST-PROOF AND DAMP-PROOF WALL-MOUNTING SELECTOR BREAKER—TANK REMOVED

FIG. 5—THREE-POLE DUST-PROOF AND DAMP-PROOF WALL-MOUNTING BREAKER

or iron frame bracket. The coverplate through which the handle projects is supplied for mounting on the front of the panel or bracket.

The wall-mounting form of breaker is so constructed that the handle projects over the back of the case, thereby permitting the breaker to be mounted directly on a wall, post, or any convenient vertical support. This feature renders the breaker particularly adaptable for installation in places where no switchboard is available for mounting apparatus.

Tanks—The oil tanks are rectangular in shape and are made of heavy sheet iron . An insulating lining is used as an additional protection against arcing from current carrying parts to the tank metal. The method of fastening the tank to the breaker frame, while secure, permits of easy removal for the purpose of inspection and repair.

Mechanism—The knife-blade contacts are actuated by specially treated wooden rods connected to a lever which is operated by a handle outside of the breaker. This design gives a simple but rugged construction.

Terminal Bushings and Studs — The leads are brought out directly at the top. Connections to the outside circuit are made inside the breaker by a socket terminal and a porcelain insulator is slipped over the joint, thus providing a straight continous connection from the line with maximum insulation.

Contacts—Knife-blade contacts are used as they insure the best contact in this class of breaker for low-temperature rise. The breaker is essentially a knife switch submerged in oil and arranged for external operation.

Style number includes the breaker complete as listed but without oil which should be specified as an extra item on the order.

Poles	Gallons Oil	Approx. Wt., Lb. Without Oil* Net	Shipping	Style No.	List Price
Dust-Proof Panel-Mounting†					
Single-Throw					
2	1	10	25	119371	$25 50
3	1½	15	35	123242	35 75
3‡	2	17	40	119372‡	40 00
4	2½	20	45	123243	45 00
Dust-Proof Wall-Mounting					
Single-Throw					
2	1	10	25	108099	25 50
3	1½	15	35	108100	35 75
4	2½	20	45	108101	41 00
Dust-Proof and Damp-Proof Wall-Mounting					
Single-Throw					
3 Selector-Double-Two	1½	17	40	226540	62 00
	2	20	45	226542	57 00
Double-Throw					
2	2	20	45	226541	57 00

The interrupting capacity at rated voltage of all breakers listed above is 300 amperes. For interrupting capacities at lower than rated voltage refer to pages on "Application of Oil Circuit-Breakers."

*Approximate weight of oil is 7½ pounds per gallon, net; 9 pounds, shipping.

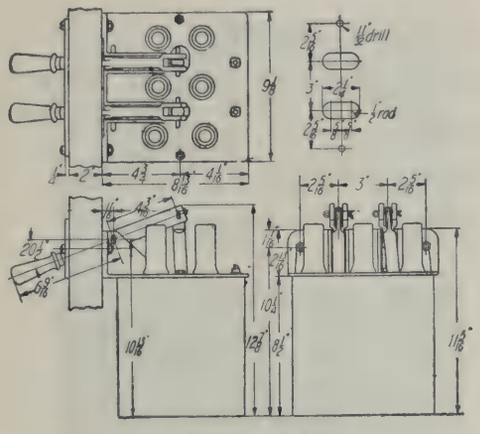
†Although the type I oil circuit-breakers are insulated for 4500-volt service, engineering practice indicates that panel-mounting breakers should not be used on service voltages higher than 2500-volts. These breakers are made for mounting on panels 2 inches thick. When they are to be mounted on thinner panels, spacers must be used on the mounting bolts.

‡Special switch for use on constant-current lighting panels. For description refer to previous page.

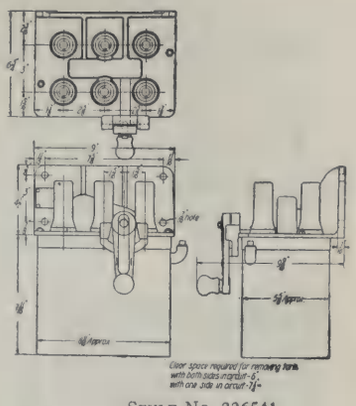
For information as to what material is furnished with these breakers, see "Instructions for Ordering."

TYPE I OIL CIRCUIT-BREAKERS—Continued

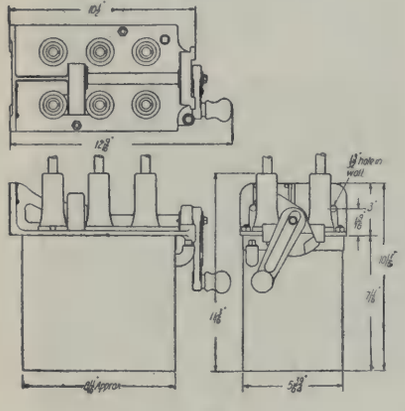
OUTLINE DIMENSIONS



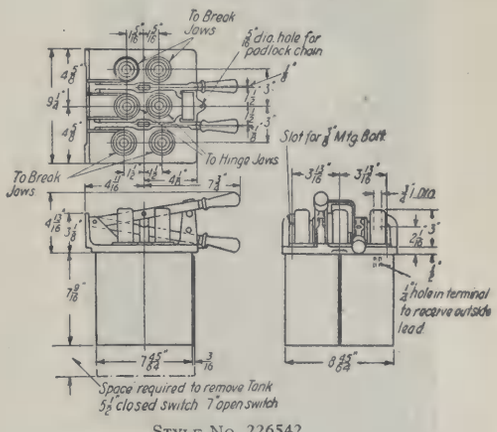
STYLE No. 119372



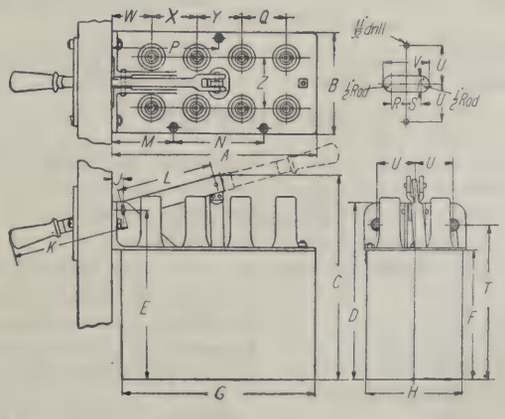
STYLE No. 226541



STYLE No. 226540


To Break Jaws
⅝ dia. hole for padlock chain
Slot for ⅝ Mtg. Bolt
To Hinge Jaws
To Break Jaws
¼ hole in terminal to receive outside lead
Space required to remove Tank 5 closed switch 7 open switch

STYLE No. 226542



Style No.	DIMENSIONS IN INCHES																						
	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R	S	T	U	V	W	X	Y	Z
119371	6¾	6	12	10 1/16	10	7⅝	6 1/32	5 21/32	11/16	6⅞	3⅛	3⅝	—	3⅝	—	⅞	¼	9	2¼	2¾	2 1/16	2⅝	—	3½
108099	6¾	6	12	10 1/16	10	7⅝	6 1/32	5 21/32	11/16	6⅞	3⅛	3⅝	—	3⅝	—	⅞	⅛	9	2¼	2¾	2 1/16	2⅝	—	3½
123242	9⅝	6	12⅛	10½	10	7¾	8 3/16	5⅝	11/16	6⅞	3½	3⅝	—	6¼	—	1	⅛	9½	2¼	2⅞	2⅝	2⅝	2⅝	3
108100	9⅝	6	12⅛	10½	10	7¾	8 3/16	5⅝	11/16	6⅞	3½	3⅝	—	6¼	—	1	⅛	9½	2¼	2⅞	2⅝	2⅝	2⅝	3
123243	12	6	12¼	10½	10	7¾	11⅜	5⅝	11/16	6⅞	5 11/16	3⅝	5¼	6¼	2⅝	1	⅛	9⅛	2¼	2⅞	2⅜	2⅝	2⅝	3
108101	12	6	12¼	10½	10	7¾	11⅜	5⅝	11/16	6⅞	5 11/16	3⅝	5¼	6¼	2⅝	1	⅛	9⅛	2¼	2⅞	2⅜	2⅝	2⅝	3

These dimensions are for reference only. For official dimensions apply to the nearest district office.

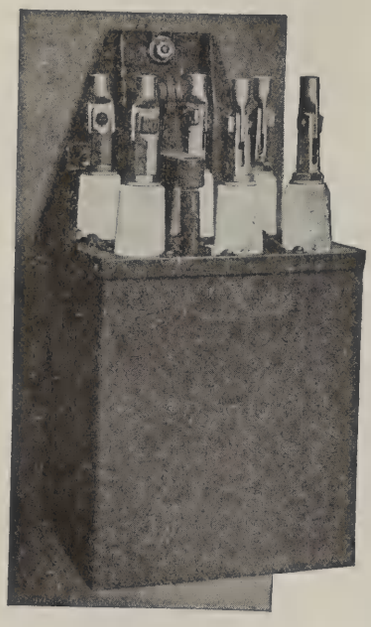
TYPE D OIL CIRCUIT-BREAKERS

MANUALLY-OPERATED NON-AUTOMATIC

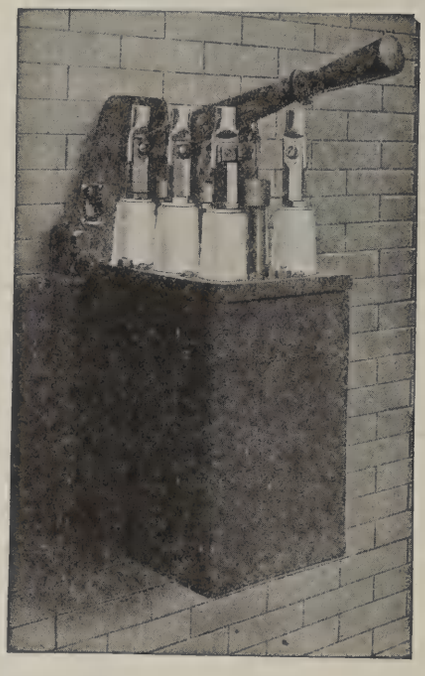
FOR INDOOR, OUTDOOR, AND SUBWAY SERVICE—SINGLE AND DOUBLE-THROW

For Capacities up to 300 Amperes, 1500 Volts Alternating Current

Interrupting Capacities at Rated Voltage 700 to 800 Amperes



INDOOR FOR PANEL MOUNTING
300-AMPERE 7500-VOLT TWO-POLE
DOUBLE-THROW



INDOOR FOR WALL-MOUNTING
300-AMPERE 7500-VOLT THREE-POLE
SINGLE-THROW

APPLICATION

These non-automatic oil circuit-breakers have a wide range of application, being made for indoor service in panel-mounting, direct wall-mounting, and remote-control wall- or pipe-mounting forms; for outdoor service in pole or wall-mounting; and for subway-mounting.

Indoor Mounting—The panel-mounting form, as its name indicates, is designed for mounting on the rear of the switchboard panel or frame bracket.

The direct wall-mounting form is particularly adaptable to motor installations, because of the ease with which it may be mounted on any vertical support convenient to the motor operator.

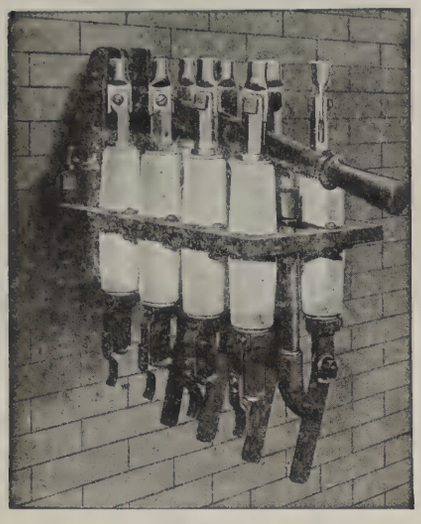
The remote-control wall- or pipe-mounting form allows the breaker to be mounted at any suitable place, and operated from a switchboard or other position as desired.

Outdoor Mounting—The outdoor form of wall- or pole-mounting breaker is primarily intended for service in exposed places. It is particularly adapted for controlling lines where they enter buildings, for controlling branch feeders from the main lines, for sectionalizing feeders, and cutting out transformers, or for any of the other numerous purposes for which an outdoor form of breaker may be utilized on distribution systems.

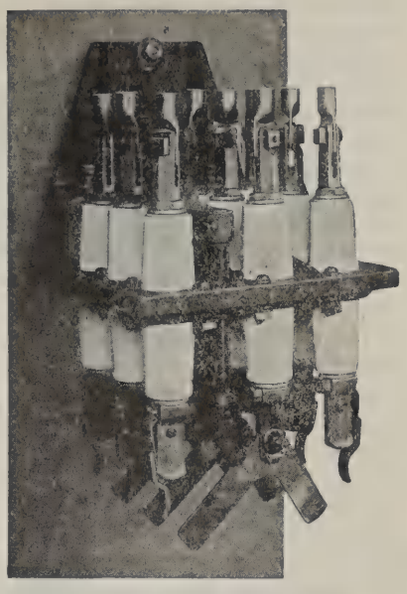
Subway Mounting—The subway form of breaker is intended for mounting in subways, manholes, or other places where a breaker may be required to operate submerged. The subway form of breaker is made in two-, three- or four-pole; single- and double-throw, for capacities up to 200 amperes, 4500 volts.

Interrupting Capacity—The interrupting capacity at rated voltage of the type D 200-ampere break-

TYPE D OIL CIRCUIT-BREAKERS—Continued



INDOOR FOR WALL MOUNTING, 300-AMPERE 7500 VOLT FOUR-POLE SINGLE-THROW (Tank Removed)



INDOOR FOR PANEL-MOUNTING, 300-AMPERE 7500-VOLT THREE-POLE DOUBLE-THROW (Tank Removed)

ers is 800 amperes; of the 300-ampere breakers, 700 amperes.

For interrupting capacities of the type D oil circuit-breakers at other than rated voltages, see Tables C and D on pages on "Application of Oil Circuit-Breakers."

DISTINCTIVE FEATURES

The characteristic features of the type D oil circuit-breakers are:—knife-blade contacts submerged in oil and protected by auxiliary arcing contacts; live parts carried on insulating supports affording a high quality of permanent insulation between adjacent poles, and between the frame and live parts; all parts supported by a single frame easily mounted on panel, wall, pipe-frame, post, bracket, or other vertical support; small space required for mounting; accessibility of parts for the purpose of inspection and repair; enclosure of all live metal parts; simple but rugged construction.

OPERATION

See also pages of this section on "Oil Circuit-Breakers—General Information".

The type D oil circuit-breakers are non-automatic direct or remote-control, manually operated only. In general, they are opened and closed by one lever-type or crank-type handle, except in the case of a double two-pole breaker. In the double two-pole breaker there is a separate handle for each part of the breaker.

CONSTRUCTION

Indoor-Form

Mounting—The panel-mounting form of breaker is designed for mounting on the rear of the switchboard panel, or iron frame bracket; the coverplate through which the handle projects, is supplied for mounting on the front of the panel, or bracket.

The wall-mounting form of breaker is so constructed that the handle projects outward over the tank, thereby permitting the breaker to be mounted directly on a wall, post, or any convenient vertical support. This feature renders the breaker particularly adaptable for installation in places where no switchboard is available for mounting apparatus, and for motor installations where it is desirable to mount the breaker convenient to the motor operator.

The remote-control wall- or pipe-mounting form of breaker is so constructed that the breaker proper is mounted directly on a wall, or other vertical support, or upon pipe framework. The breaker mechanism is operated through bell cranks, from a coverplate and handle, mounted on the front of a switchboard panel, iron frame bracket, or other support.

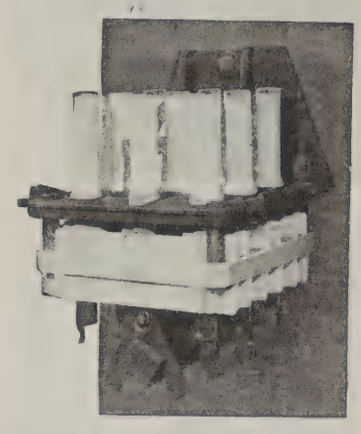
Tanks—The oil tanks are rectangular in shape and are made of heavy sheet iron. Individual insulating cells on single-throw breakers, and an insulating lining on double-throw breakers, are used as an additional protection against arcing from current-carrying parts to the metal of the tank.

TYPE D OIL CIRCUIT-BREAKERS—Continued

Where the individual insulating cells are used on the single-throw breakers, they form a separate compartment for each pole. While the tank is securely fastened to the breaker frame, the construction permits of easy removal for the purpose of inspection and repair.

The tanks are deep to allow ample space above the oil level to act as an expansion chamber for the arc gases, and to reduce slopping of the oil from internal disturbances. The gases are vented through the clearance between the wooden operating rod and the frame.

The multi-pole single tank construction is used throughout in the type D line of breakers.

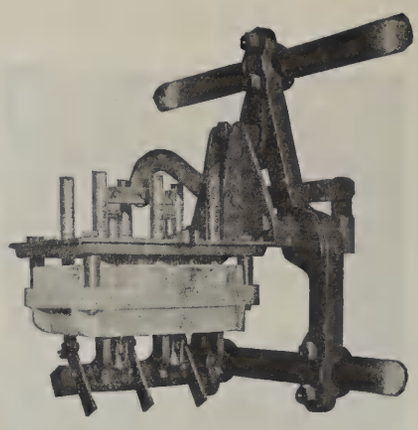


INDOOR FOR PANEL-MOUNTING, 200-AMPERE 4500-VOLT THREE-POLE DOUBLE-THROW
(Tank Removed, Porcelain Insulating Tubes Shown on Terminals)

Mechanism—The hinged knife-blade contacts are actuated by specially treated wooden rods connected to a lever, which is operated by a handle outside of the breakers. This design gives a simple but rugged construction.

Terminal Bushings and Studs—The leads in the 200 ampere, 4500 volt breaker are brought out directly at the top. Connections to the outside circuit are made inside the breaker by a socket terminal, and a porcelain insulator is slipped over the joint, thus providing a straight continuous connection from the line with maximum insulation.

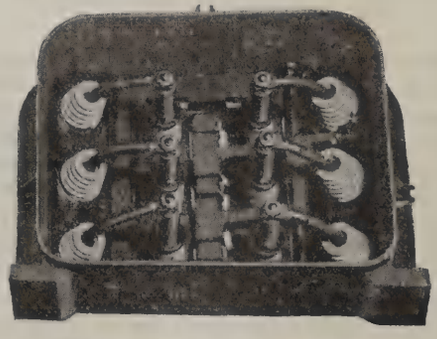
In the 300 ampere, 7500 volt breaker, the terminal bushing or stud with stationary contact clips on the lower extremity, is supported by a one piece vertical pillar-type porcelain bushing clamped to the frame work. The studs and micarta tube details are clamped to these insulators. This construction avoids the use of babbit and cement, reducing the cost and the time and labor required for maintenance. Lock washers are used on the clamped bolts and current carrying parts, to prevent loosening from vibration or hammer blows that might occur in the operation of the breaker or from other apparatus located nearby.



INDOOR FOR PIPE MOUNTING, REMOTE CONTROL 200-AMPERE 4500-VOLT THREE-POLE SINGLE-THROW
(Porcelain Insulating Tubes Removed from Terminals)

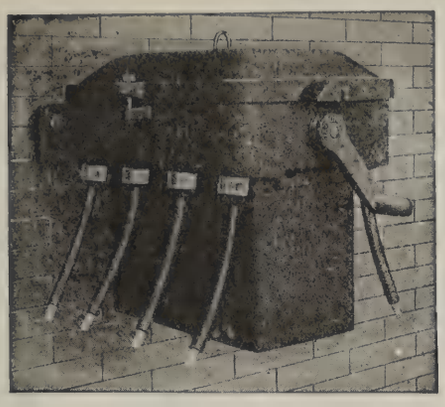
Terminals and Terminal Lugs—On the 300-ampere, 7500-volt breaker, copper tube terminals are supplied. For connecting this form of terminal to the terminal stud, a brass or copper sleeve is supplied, threaded at one end to screw to the stud, and split at the other end to receive the flat end of the tube terminal. The copper tube terminal is held in the slot of the sleeve by a bolt, supplied with a lock washer. On special order, terminals may be omitted, or contact nuts with or without special terminals supplied.

Main and Auxiliary Contacts—Hinged knife-blade contacts are used, as they insure the best contact in this class of breaker for low-temperature rise. The main contact jaws are flared so that the knife-blade readily engages upon closing. The breaker is essentially a knife switch submerged in oil and arranged for external operation. The main moving contacts are extended so as to engage an auxiliary arcing piece, mounted on or attached to the stationary main contact jaw. This auxiliary contact



OUTDOOR-FORM WALL OR POLE MOUNTING 300-AMPERES—7500 VOLTS WITH COVER REMOVED TO SHOW TERMINAL AND LEAD ARRANGEMENT

TYPE D OIL CIRCUIT-BREAKERS—Continued



OUTDOOR FOR WALL OR POLE MOUNTING
4500-VOLT 200-AMPERE FOUR-POLE
SINGLE-THROW

OUTDOOR FOR WALL OR POLE MOUNTING -
200-AMPERE 4500-VOLT THREE-POLE
DOUBLE-THROW

takes the final break, thus preventing any burning of the main contacts. The arcing pieces are inexpensive and readily replaced when worn or burned away.

Special Breakers

The double two-pole breakers are in reality two, two-pole breakers mounted one behind the other in the same case, and each controlled by its own handle. This arrangement gives a very compact breaker for controlling two circuits, when there is not room on the switchboard panel for two separate breakers. These breakers are two-pole, single- and double-throw.

Outdoor Form

The wall- or pole-mounting breaker is enclosed in a weather-proof case having lugs cast thereon for mounting the breaker on a wall or pole. On breaker, style number 257694, stirrups are also provided for mounting the breakers beneath the cross arm.

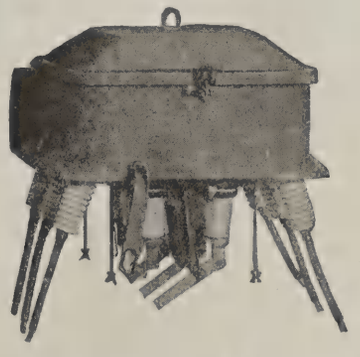
In these breakers, the contact and insulation construction is exactly the same as described for the indoor forms, the only difference being in the construction of the handle and the method of bringing out the leads. On these outdoor breakers a crank handle is used for operation. The leads are brought out underneath the top part of the case, through sealed bushings at the side and underneath the main casting. The sealing-in of the bushings prevents the entrance of rain or moisture to the interior of the breaker.

Subway-Form

The housing for the subway breaker complete, including the oil tank, is of cast iron. All housing joints are made water-proof by the use of gaskets. The housing has lugs cast thereon for mounting the breaker on the wall of the subway, manhole or other place of mounting.

In the subway form of breaker, the contact and insulation construction is the same as that described on a previous page for the indoor form of breaker the only difference being in the method of bringing out the leads. The leads enter the breaker housing through individual water-proof bushings in the top of the case. The operating handle is provided with a water-proof stuffing box and is latched in either the *on* or *off* positions.

SUBWAY 200-AMPERE 4500-VOLT THREE
POLE DOUBLE-THROW



OUTDOOR-FORM WALL OR POLE MOUNTING,
300-AMPERES—7500 VOLTS WITH TANK
REMOVED TO SHOW CONTACTS

TYPE D OIL CIRCUIT-BREAKERS—Continued

PRICES

Except where noted, style number includes the breaker complete as listed, but without oil, which should be specified as a separate item on the order.

INDOOR-FORM DIRECT-CONTROL

Maximum Continuous Amperes	Maximum Volts	Poles	Dimension Reference Fig.	Gallons Oil	Approximate Wt. Lbs. Without Oil* Net	Shipping	Style No.	List Price
				Panel-Mounting‡				
				Single-Throw				
200	4500	2	1	1½	30	50	27736	$ 65 00
300	7500	2	3	3	70	100	203428	98 00
200	4500	3	1	2	40	65	27741	80 00
300	7500	3	3	3	80	115	203429	118 00
200	4500	4	1	2½	50	78	27746	105 00
300	7500	4	3	4	95	135	203430	157 00
				Double-Throw				
200	4500	2	2	2	45	68	27751	86 00
300	7500	2	4	5	90	125	203431	116 00
200	4500	3	2	3	60	88	27756	104 00
300	7500	3	4	5	110	150	203432	140 00
200	4500	4	2	3½	75	108	27761	138 00
300	7500	4	4	6	125	175	203433	185 00
				Double Two-Pole				
200	4500	Single-Throw	1†	2½	50	78	58650	148 00
200	4500	Double-Throw	2†	3½	75	108	58651	202 50
				Wall-Mounting				
				Single-Throw				
200	4500	2	1	1½	30	50	27766	$ 64 00
300	7500	2	3	3	70	100	203434	95 00
200	4500	3	1	2	40	60	27771	77 00
300	7500	3	3	3	80	115	203435	115 00
200	4500	4	1	2½	50	78	27776	103 00
300	7500	4	3	4	95	135	203436	153 00
				Double-Throw				
200	4500	2	2	2	45	68	27781	86 00
300	7500	2	4	5	90	125	203437	116 00
200	4500	3	2	3	60	88	27786	104 00
300	7500	3	4	5	110	150	203438	140 00
200	4500	4	2	3½	75	108	27791	138 00
300	7500	4	4	6	125	175	203439	185 00

*Approximate weight of oil equals 7½ pounds per gallon, net; and 9 pounds, shipping.

†Same dimensions as the four-pole 200-amphere breaker shown under this reference.

‡Although the type D oil circuit-breakers are insulated for 4500 or 7500 volt service, engineering practice indicates that panel-mounting breakers should not be used on service voltages higher than 2500 volts. These breakers are made for mounting on material 2 inches thick. When they are to be mounted on thiner panels, spacers must be used on the mounting bolts. Spacers will be furnished free of charge when ordered with the breaker.

For information as to material furnished with these breakers, (nuts, cable terminals, etc.), see "Instructions for Ordering."

Order by Style Number

TYPE D OIL CIRCUIT-BREAKERS—Continued

INDOOR-FORM REMOTE-CONTROL—Continued

Maximum Continuous Amperes	Maximum Volts	Poles	Dimensions Reference Fig.	Gallons Oil	Approximate Wt. Lbs. Without Oil* Net	Shipping	Style No.	List Price
Wall-Mounting—Bell Cranks Above or Below Floor								
Single-Throw								
200	4500	2	1, 5	1½	70	110	206000	$ 90 00
300	7500	2	3, 5	3	110	150	206012	123 00
200	4500	3	1, 5	2	80	115	206001	105 00
300	7500	3	3, 5	3	120	170	206013	143 00
200	4500	4	1, 5	2½	90	125	206002	130 00
300	7500	4	3, 5	4	135	180	206014	182 00
Double-Throw								
200	4500	2	2, 6	4	90	125	206003	111 00
300	7500	2	4, 6	5	135	180	206015	141 00
200	4500	3	2, 6	3	105	145	206004	129 00
300	7500	3	4, 6	5	155	210	206016	165 00
200	4500	4	2, 6	3½	120	170	206005	163 00
300	7500	4	4, 6	6	170	235	206017	210 00
Pipe-Mounting—Bell Cranks Above or Below Floor								
Single-Throw								
200	4500	2	1, 5	1½	70	110	206036	$ 90 00
300	7500	2	3, 5	3	110	150	206048	123 00
200	4500	3	1, 5	2	80	115	206037	105 00
300	7500	3	3, 5	3	120	170	206049	143 00
200	4500	4	1, 5	2½	90	125	206038	130 00
300	7500	4	3, 5	4	135	180	206050	152 00
Double-Throw								
200	4500	2	2, 6	2	90	125	206039	111 00
300	7500	2	4, 6	5	135	180	206051	141 00
200	4500	3	2, 6	3	105	145	206040	129 00
300	7500	3	4, 6	5	155	210	206052	165 00
200	4500	4	2, 6	3½	120	170	206041	163 00
300	7500	4	4, 6	6	170	235	206053	210 00

*Approximate weight of oil equals 7½ pounds per gallon, net; and 9 pounds, shipping.

The cover plates controling remote-control manually-operated breakers are designed for mounting on 2-inch material. When these cover plates are to be mounted on material less than 2 inches thick, spacers must be used on the mounting bolts; when they are to be mounted on material between 2 and 4 inches thick, longer mounting bolts than standard are required. Spacers or longer mounting bolts will be furnished free of charge when ordered with the breaker.

For information as to material furnished with these breakers, (nuts, cable terminals, etc.), see "Instructions for Ordering."

Panel-Mounting

Single-Throw Remote Control

Double-Throw Remote Control

SWITCHBOARD HANDLES AND COVER PLATES

Order by Style Number

TYPE D OIL CIRCUIT-BREAKERS—Continued

OUTDOOR-FORM

Wall or Pole-Mounting

Maximum Continuous Amperes	Maximum Volts	Poles	Dimensions Reference Fig.	Gallons Oil	Approximate Wt. Lbs. Without Oil* Net	Shipping	Style No.	List Price
				Single-Throw				
200	4500	2	7	1½	50	78	257694	$ 80 00
200	4500	1	8	1	35	55	57930	60 00
200	4500	2	8	1½	50	78	221943	80 00
200	4500	3	8	2½	66	96	221944	97 00
200	4500	4	[illegible]	3	85	125	221945	128 00
300	7500	2	10	4¾	130	175	221949	144 00
300	7500	3	10	4¾	130	175	221950	173 00
200	15000	2	11	6¼	150	200	221953	174 00
200	15000	3	11	6¼	150	200	221954	210 00
				Double-Throw				
200	4500	2	9	2½	75	108	221946	104 00
200	4500	3	9	3½	100	138	221947	146 00
200	4500	4	9	4½	130	175	221948	194 00
300	4500	3	12	6½	175	220	257742	325 00

For single-pole switches other than listed, double-pole switches can be used with contacts in series (giving double-break) or in parallel (giving double-capacity; i.e., 400 amperes).

SUBWAY-FORM

Maximum Continuous Amperes	Maximum Volts	Poles	Dimensions Reference Fig.	Gallons Oil	Approximate Wt. Lbs. Without Oil* Net	Shipping	Style No.	List Price
				Single-Throw				
200	4500	2	13	2	80	115	194389	$112 00
200	4500	3	13	2½	95	130	194391	135 00
200	4500	4	13	3½	110	150	194393	179 00
				Double-Throw				
200	4500	2	14	3	95	130	194390	141 00
200	4500	3	14	3½	110	150	194392	175 00
200	4500	4	14	5	125	170	194394	215 00

For single-pole switches other than listed, double-pole switches can be used with contacts in series (giving double-break) or in parallel (giving double capacity; i.e., 400 amperes).

NOTE—With each subway-type of breaker should be ordered the necessary cable bushings from the following table. These [illegible] not included in style number but are included in the list price of the breaker.

CABLE BUSHINGS

For Use on Subway-Mounting Switches.

Diameter Hole Inches	Style No.	List Price	Diameter Hole Inches	Style No.	List Price
⅝	219970	‡	1¼	47969	‡
¾	47608	‡	1½	59932	‡
1	60010	‡			

*Approximate weight of oil equals 7½ pounds per gallon, net, and 9 pounds, shipping.
‡Included in price of subway breakers listed above.

Order by Style Number

For information as to material furnished with these breakers, (nuts, cable terminals, etc.), see "Instructions for Ordering."

SUBWAY 200-AMPERE 4500-VOLT THREE-POLE SINGLE-THROW

OUTDOOR-FORM WALL OR POLE MOUNTING 200-AMPERE 4500-VOLT WITH STIRRUP FOR CROSS-ARM MOUNTING (STYLE NO. 257694 ONLY)

TYPE D OIL CIRCUIT-BREAKERS—Continued

OUTLINE DIMENSIONS

Indoor-Form—Panel- and Wall-Mounting

200 Amperes 4500 Volts

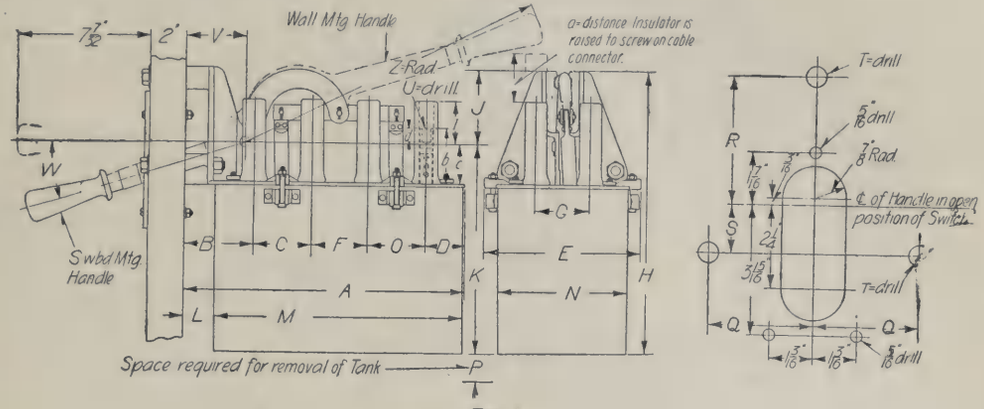


FIG. 1

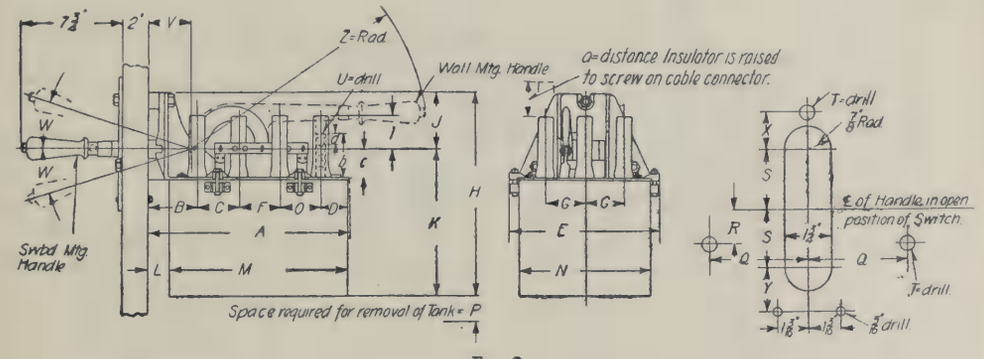


FIG. 2

Poles	DIMENSIONS IN INCHES																								
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P†	Q	R	S	T	U	V	W	X	Y	Z
Single-Throw—Fig. 1																										
2	8 13/16	3 11/16	3 1/8	2 1/8	8 1/2	...	3	15 7/16	2 3/8	4 1/8	11 5/16	1 43/64	7 5/32	7 1/8	...	8 3/4	2 7/8	3 1/2	1 5/16	9/16	1/2	13/16	21	...	...	13 5/16
3	12 1/16	3 11/16	3 1/8	2 1/8	8 1/2	3 1/8	3	15 7/16	2 3/8	4 1/8	11 5/16	1 9/16	10 1/2	7 1/8	...	8 3/4	2 7/8	3 1/2	1 5/16	9/16	1/2	2	19	...	...	15
4	15 5/16	3 11/16	3 1/8	2 1/8	8 1/2	3 1/8	3	15 7/16	2 3/8	4 1/8	11 5/16	1 5/8	13 1/2	7 1/8	3 1/8	8 3/4	2 7/8	3 1/2	1 5/16	9/16	1/2	3 7/32	18	...	...	17 1/8
Double-Throw—Fig. 2																										
2	8 13/16	3 11/16	3 1/8	2 1/8	11 1/2	...	3	15 5/8	2 3/8	4 5/16	11 5/16	1 5/8	7 1/4	10	...	8 3/4	3 3/4	1 5/16	2 1/4	9/16	1/2	13/16	21	1 7/16	1 11/16	14
3	12 1/16	3 11/16	3 1/8	2 1/8	11 1/2	3 1/8	3	15 5/8	2 3/8	4 5/16	11 5/16	1 5/8	10 3/8	10	...	8 3/4	3 3/4	1 5/16	2 1/4	9/16	1/2	2	19 1/4	1 7/16	1 11/16	15 1/8
4	15 5/16	3 11/16	3 1/8	2 1/8	11 1/2	3 1/8	3	15 5/8	2 3/8	4 5/16	11 5/16	1 5/8	13 1/2	10	3 1/8	8 3/4	3 3/4	1 5/16	2 1/4	9/16	1/2	3 7/32	17 1/2	1 7/16	1 11/16	18

†Space to remove tank.

These dimensions are for reference only. For official dimensions apply to the nearest district office.

TYPE D OIL CIRCUIT-BREAKERS—Continued

Indoor-Form—Panel- and Wall-Mounting

300 Amperes 7500 Volts

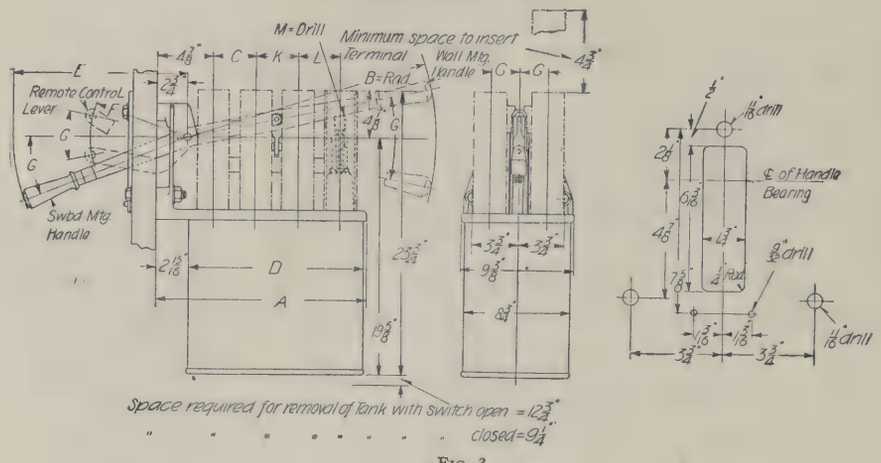


FIG. 3

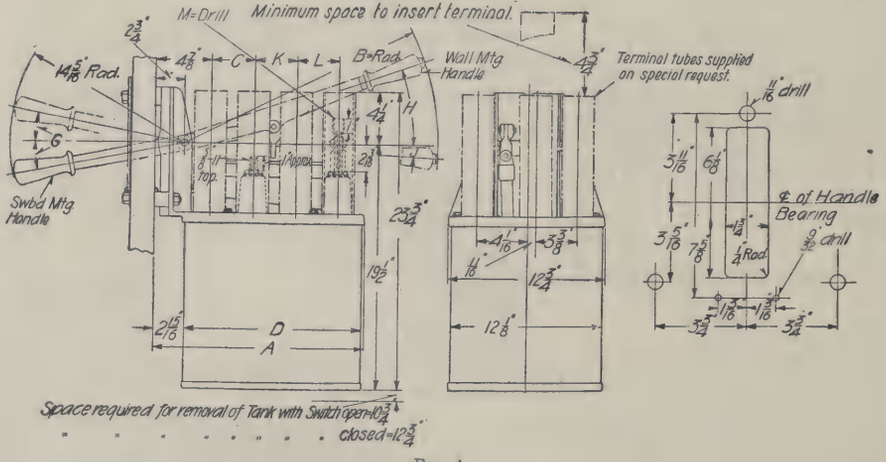


FIG. 4

Single-Throw—Fig. 3

Poles	DIMENSIONS IN INCHES									
	A	B	C	D	E	F	G Degrees	K	L	M
2	14 1/8	17 1/8	7	10 7/8	13 1/4	6	28	....	....	.747
3	14 1/8	17 1/8	3 1/2	10 7/8	13 1/4	6	28	3 1/2	....	.747
4	17 5/8	20 3/8	3 1/2	14 3/8	14	8	22	3 1/2	3 1/2	.747

Double-Throw—Fig. 4

Poles	DIMENSIONS IN INCHES									
	A	B	C	D	G Degrees	H Degrees	J Degrees	K	L	M
2	14 1/8	17 7/16	7	10 7/8	14	25	3	....	....	.747
3	14 1/8	17 7/16	3 1/2	10 7/8	14	25	3	3 1/2	....	.747
4	17 5/8	20 3/4	3 1/2	14 3/8	11	19	3	3 1/2	3 1/2	.747

These dimensions are for reference only. For official dimensions apply to the nearest district office.

TYPE D OIL CIRCUIT-BREAKERS—Continued

Indoor-Form—Remote-Control For All Indoor Breakers

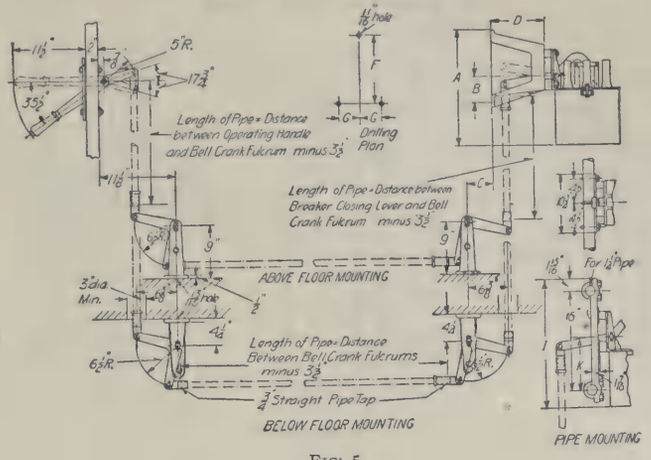

Length of Pipe = Distance between Operating Handle and Bell Crank Fulcrum minus 3½"
Drilling Plan
Length of Pipe = Distance between Breaker Closing Lever and Bell Crank Fulcrum minus 3½"
ABOVE FLOOR MOUNTING
Length of Pipe = Distance Between Bell Crank Fulcrums minus 3½"
¾" Straight Pipe Tap
BELOW FLOOR MOUNTING
For ½" Pipe
PIPE MOUNTING

FIG. 5

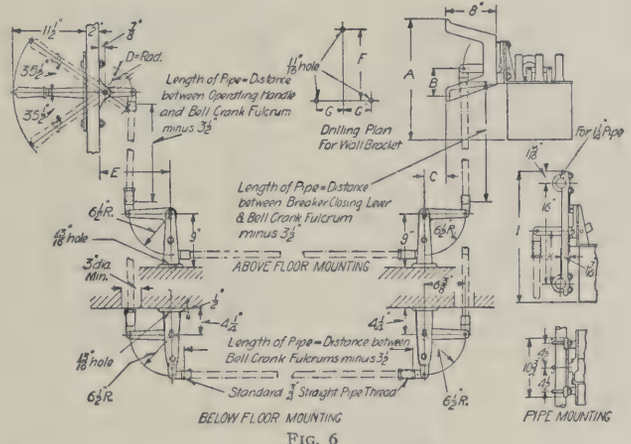

D-Rod.
Length of Pipe = Distance between Operating Handle and Bell Crank Fulcrum minus 3½"
Drilling Plan For Wall Bracket
Length of Pipe = Distance between Breaker Closing Lever & Bell Crank Fulcrum minus 3½"
ABOVE FLOOR MOUNTING
Length of Pipe = Distance between Bell Crank Fulcrums minus 3½"
Standard ¾" Straight Pipe Thread
BELOW FLOOR MOUNTING
For ½" Pipe
PIPE MOUNTING

FIG. 6

Amp.	Volts	Poles	Dimensions in Inches								
			A	B	C	D	E	F	G	I	K
Single-Throw—Fig. 5											
200	4500	2	18 3/16	4 1/4	4 1/2	8 1/2	...	11	3 1/4	20 3/4	8 1/2
		3	18 3/16	4 1/4	4 1/8	8 1/2	...	11	3 1/4	20 3/4	8 1/2
		4	18 3/16	4 1/4	3 1/8	8 1/2	...	11	3 1/4	20 3/4	8 1/2
300	7500	2	26 3/16	8 3/8	1 7/16	8	...	14	3 15/16	26 3/8	11 3/16
		3	26 3/16	8 3/8	1 7/16	8	...	14	3 15/16	26 3/8	11 3/16
		4	26 3/16	8 3/8	3 1/2	8	...	14	3 15/16	26 3/8	11 3/16
Double-Throw—Fig. 6											
200	4500	2	19 5/16	4 1/4	3 3/4	4 1/16	10 31/32	11 1/2	4 1/4	20 15/16	8 1/16
		3	19 5/16	4 1/4	3 1/16	4 1/16	10 31/32	11 1/2	4 1/4	20 15/16	8 1/16
		4	19 5/16	4 1/4	2 1/2	4 1/16	10 31/32	11 1/2	4 1/4	20 15/16	8 1/16
300	7500	2	27 5/8	6 13/16	4 1/2	4 1/16	10 7/8	14	3 15/16	27 13/16	9 5/8
		3	27 5/8	6 13/16	4 1/2	4 1/16	10 7/8	14	3 15/16	27 13/16	9 5/8
		4	27 5/8	6 13/16	4 1/2	3 1/4	10 3/16	14	3 15/16	27 13/16	9 5/8

These dimensions are for reference only. For official dimensions apply to the nearest district office.

TYPE D OIL CIRCUIT-BREAKERS—Continued

Outdoor-Form—Wall- or Pole-Mounting—Continued

200 Amperes. 4500 Volts

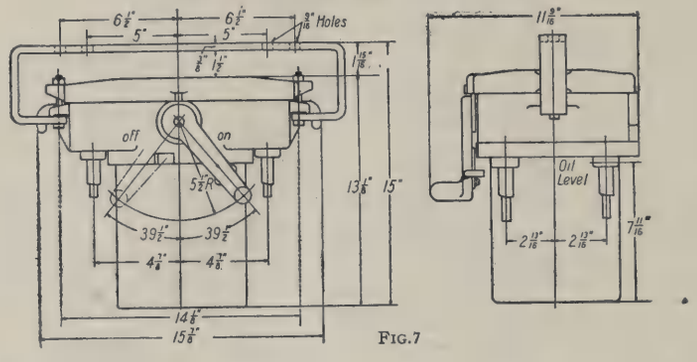


FIG. 7

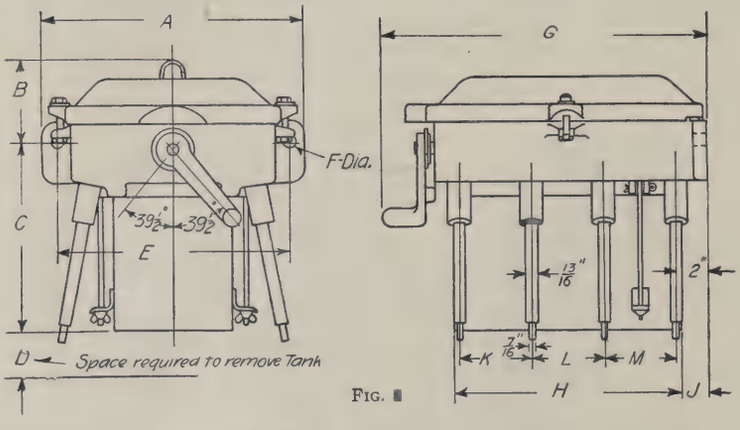


FIG. 8

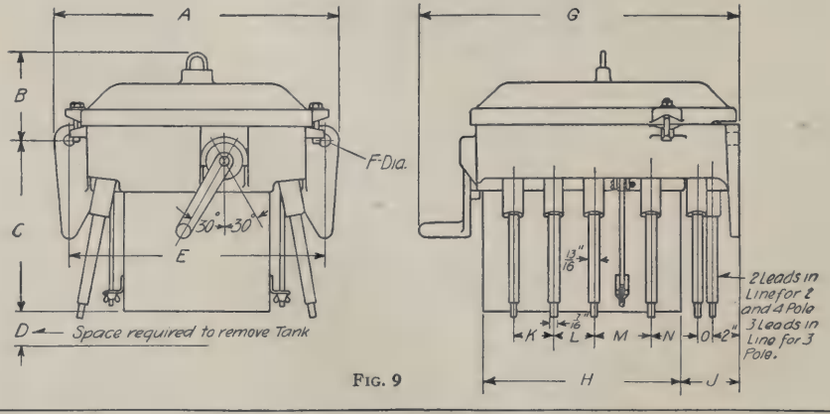


FIG. 9

Poles	Dimensions in Inches													
	A	B	C	D	E	F	G	H	J	K	L	M	N	O
Single-Throw—Fig. 8														
1	16 1/2	3 11/16	11 7/8	...	14 3/4	3/4	9	...	...	...	...	...	...	...
2	15 7/8	5	11 1/16	8	14	13/16	12 1/8	7 3/8	1 1/16	5 1/2	...	...	...	...
3	15 7/8	5	11 1/16	8	14	13/16	15 1/16	10 1/2	1 1/16	4 5/16	4 5/16	...	...	...
4	15 7/8	5	11 1/16	8	14	13/16	19 1/16	13 3/8	1 3/4	4 5/8	4 5/8	4 3/8	...	...
Double-Throw—Fig. 9														
2	19 1/2	5 11/16	11 3/4	9	17 1/2	13/16	15 5/16	7 1/4	3 11/16	5 1/4	...	...	2 5/8	...
3	19 1/2	5 11/16	11 3/4	9	17 1/2	13/16	18 7/16	10 3/8	3 11/16	3 3/4	4 1/2	...	2 3/4	...
4	19 1/2	5 11/16	11 3/4	9	17 1/2	13/16	21 13/16	13 1/2	4 1/16	2 3/4	2 3/4	3 1/8	3 1/8	1

These dimensions are for reference only. For official dimensioms apply to the nearest district office. 258—11

TYPE D OIL CIRCUIT-BREAKERS—Continued

Outdoor-Form—Wall- or Pole-Mounting—Continued

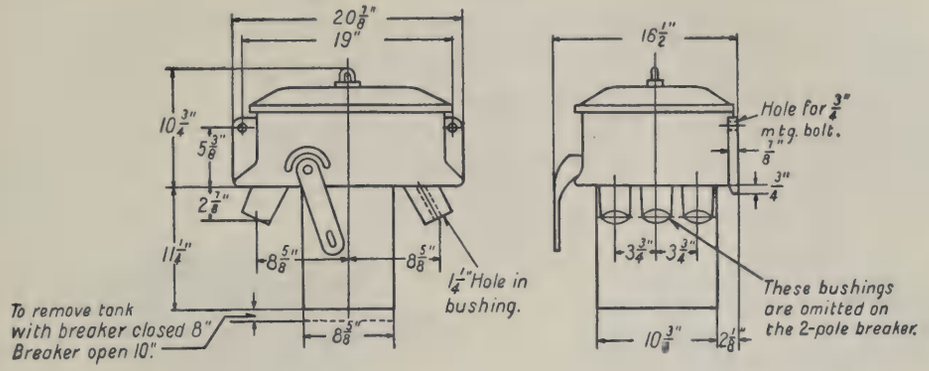


FIG. 10

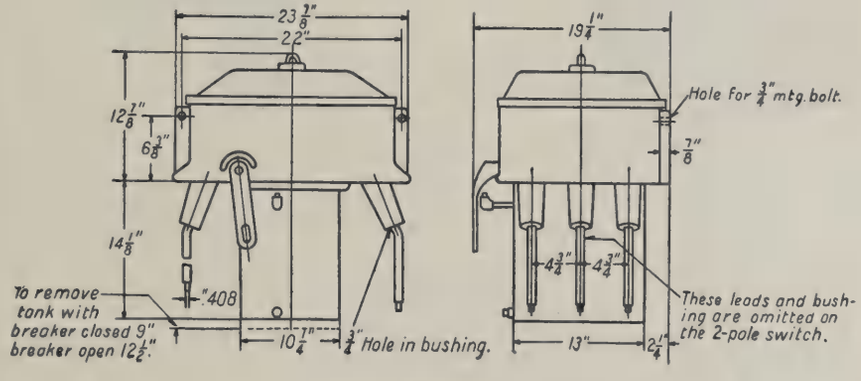


FIG. 11

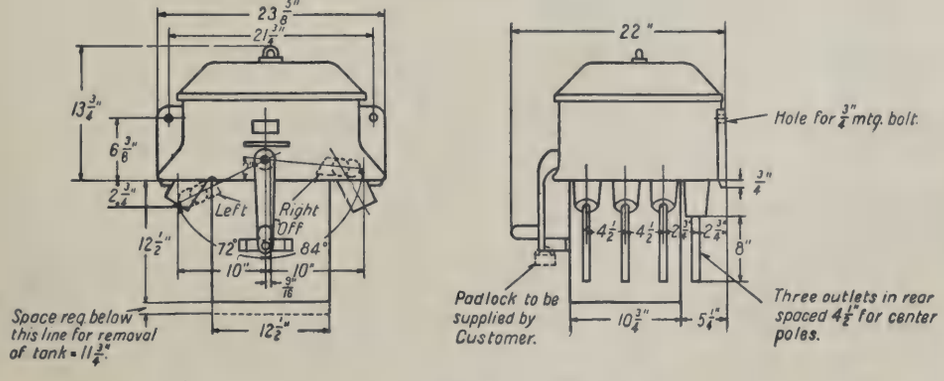
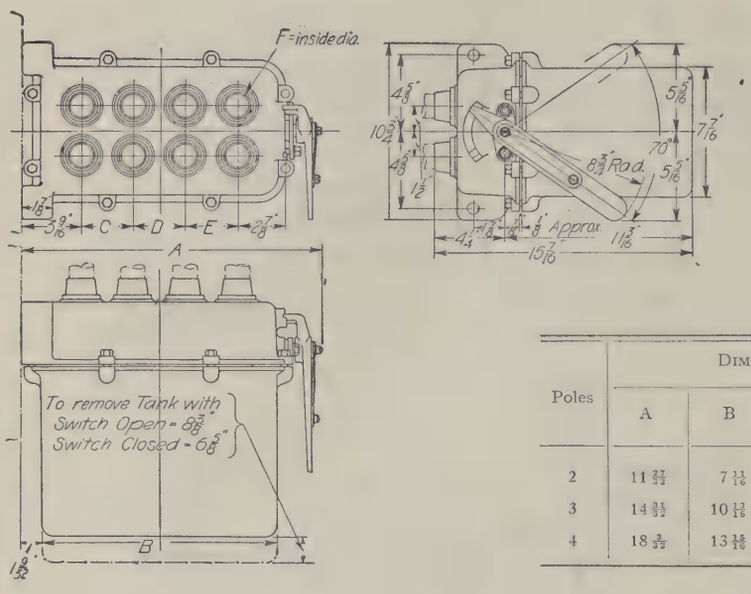


FIG. 12

These dimensions are for reference only. For official dimensions apply to the nearest district office.

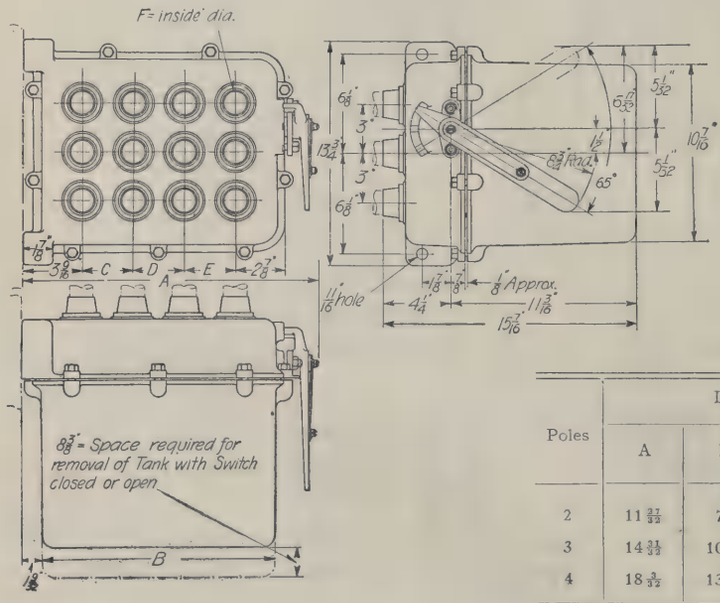
TYPE D OIL CIRCUIT-BREAKERS—Continued

Subway Form



Poles	Dimensions in Inches					
	A	B	C	D	E	F
2	11 27/32	7 11/16	3⅛	...	...	1½
3	14 31/32	10 13/16	3⅛	3⅛	...	1½
4	18 3/32	13 15/16	3⅛	3⅛	3⅛	1½

Fig. 13—Single-Throw



Poles	Dimensions in Inches					
	A	B	C	D	E	F
2	11 27/32	7 11/16	3⅛	...	...	1½
3	14 31/32	10 13/16	3⅛	3⅛	...	1½
4	18 3/32	13 15/16	3⅛	3⅛	3⅛	1½

Fig. 14—Double-Throw

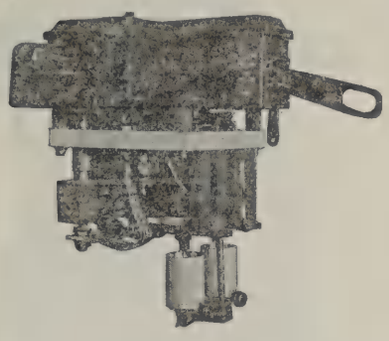
These dimensions are for reference only. For official dimensions apply to the nearest district office.

TYPE H OIL CIRCUIT-BREAKERS

MANUALLY-OPERATED AUTOMATIC AND NON-AUTOMATIC FOR INDOOR AND OUTDOOR SERVICE—SINGLE-THROW

For Capacities up to 100 Amperes, 2500 Volts Alternating Current, and 250 Volts Direct Current

Interrupting Capacity at Rated Voltage, 2900 and 4500 Amperes



Closed with Tank Off
Three-Pole Indoor Wall-Mounting Type H Oil Circuit-Breaker. Full-Automatic Overload Trip with Adjustable Inverse-Time Element.
50 to 100 Amperes, 750 Volts

Three-Pole Indoor Wall-Mounting Type H Oil Circuit-Breaker. Plain-Automatic Overload or Plain Undervoltage Trip

APPLICATION

The type H oil circuit-breakers are small-capacity manually-operated single-throw breakers for indoor use (dustproof wall-mounting) and outdoor use (weatherproof, wall- or pole-mounting).

These breakers supply the need for a simple, reliable, and, at the same time, inexpensive oil circuit-breaker for use in general industrial applications. They are particularly useful for controlling motor circuits, or other loads of low power factor, where excessive arcing would occur when using an air-break switch at low power factor, thus making the use of an oil circuit-breaker advisable. (*See also pages on type QF motor-starting oil circuit-breakers.*)

Slip-Ring Motors—The starting currents on slip-ring motors usually range from one and a half to twice full-load current, depending upon the characteristic of the motor load, and the number of steps in the starting device. Under these conditions the motor has a power factor nearly as high as when the motors are running. The breaker selected should, therefore, have a full-load rating equivalent to one and a half times the full-load motor current, and the calibration of the breaker should provide a maximum setting equal to twice the full-load motor current. With breakers used in starting slip-ring motors, inverse-time-limit attachments should be used to prevent the breaker from opening when the motor is started, or on momentary overloads. It is also recommended that an undervoltage release attachment should be used in this application.

Squirrel-Cage Motors—The starting current of squirrel-cage motors usually ranges from 5 to 10 times full-load current at a very low power factor. It is to be noted that the higher starting currents are usually taken by high-speed motors. The breaker selected should have a full-load rating equivalent to one and one half times full-load motor current and the calibration of the breaker should provide a range of at least two times full-load current. Due to the high starting currents, the breaker should *always* be equipped with inverse-time-limit attachments.

When starting heavy-inertia loads in order that the breaker does not trip on the starting current, it may be necessary to set the tripping point of the breaker too high to properly protect the motor except for short-circuit conditions. If this condition exists, it may be desirable to by-pass the circuit breaker during starting.

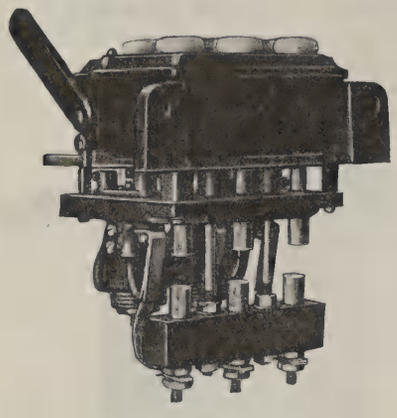
Before selecting the breaker for squirrel-cage motors, the application, and the time required to accelerate the motor should be carefully investigated. Except for smaller motors, it is desirable to furnish

TYPE H OIL CIRCUIT-BREAKERS—Continued

an auto-starter in addition to the breaker. It is recommended that an undervoltage release attachment should be used with breakers for this application, if the auto-starter is not so equipped.

Because of the excessive moisture and drippings inherent in mines, the weatherproof breakers are being used extensively as low-capacity and low-voltage breakers in such service.

The type H oil circuit-breakers can be used on direct-current circuits of voltages up to 250, where the maximum short-circuit current that the breaker may be called upon to trip will not exceed 500 amperes.



Open Closed

THREE-POLE INDOOR WALL-MOUNTING TYPE H OIL CIRCUIT-BREAKER. PLAIN-OVERLOAD TRIP TANK REMOVED

DISTINCTIVE FEATURES

Interrupting Capacity—The interrupting capacity at rated voltage of the type H 2500-volt breakers is 2900 amperes; of the 750-volt breakers, 4500 amperes.

For interrupting capacities of the type H oil circuit-breakers at other than rated voltages, see Tables C and D on pages on "Application of Oil Circuit-Breakers."

The advantageous features of the type H oil circuit-breakers are: compactness of form; ample contacts of the "butt" type; submersion and opening of all contacts under oil; quick opening of contacts; open position maintained by gravity; tanks removable without disturbing the operating mechanism or contacts, making inspection easy; self-contained multipole operating mechanism.

OPERATION

(See also pages on "Oil Circuit-Breakers—General Information.")

The type H manually-operated oil circuit-breakers are direct-control plain-automatic and full-automatic. The electrically-operated breakers are non-automatic (except through current transformers and relays).

Manually-Operated—Manually-operated breakers for direct-control indoor or outdoor service are listed in various capacities from 3 to 100 amperes. The operating handles are slotted to permit of machine tool skipper rod operation, or remote-control rope operation where desired.

Electrically Operated—Electrically-operated indoor wall-mounting breakers can be supplied on special order for direct-current control; prices on request. These are plain non-automatic shunt-trip breakers, which can be made automatic through current transformers and relays controlling the direct-current circuits.

General Operation—An adjusting mechanism is provided whereby the current at which the overload device will operate may be regulated. This mechanism consists of a graduated scale on the outside of the case and an adjusting lever which is used to lower or raise the position of the plungers in the overload coils, thus increasing or decreasing the amount of current required to raise the plungers and trip the breaker. The calibration as given in the tables is on 60-cycle alternating current; but the same calibration is entirely satisfactory on 25-cycle alternating current (as the error on 25-cycle is practically negligible).

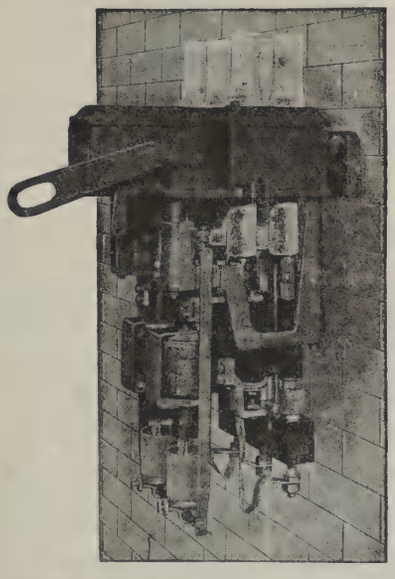
Plain-Automatic Overload Trip—A breaker with plain-automatic overload trip, when closed with an excessive overload or a short circuit on the line, will remain closed as long as the closing handle is held in the closed position, but as the trip mechanism will be released by the overload, the breaker will not remain closed after releasing the closing handle. This feature precludes the use of this form of breaker in motor-starting service (such

TYPE H OIL CIRCUIT-BREAKERS—Continued

as squirrel-cage motors), which requires, in starting, a current of sufficient magnitude to trip the breaker at its overload setting, but it does not interfere with the use of the breaker on lighting and similar service. The breaker is furnished in dustproof, but not weatherproof cases.

Full-Automatic Overload Trip—Breakers equipped with full-automatic overload-trip mechanism, trip free and open the circuit when closed on a line having an excessive overload or short circuit; thus making it impossible to hold the breaker in a closed position.

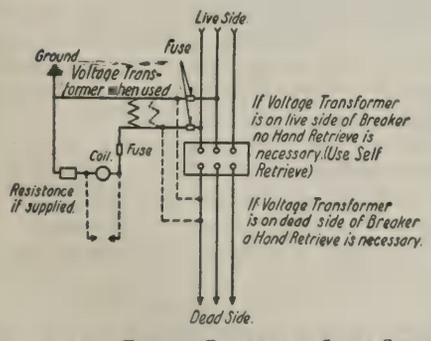
Inverse-Time-Element Dash Pot—The standard full-automatic breakers are regularly supplied with inverse-time-element oil-filled dashpots mounted inside the case. These dashpots are adjustable for time elements from practically instantaneous operation to at least a one-half minute operation at loads of 200 per cent of the breaker calibration settings. Breakers as shipped have the dashpot set for operation in the maximum time and to meet the local characteristics under which the breaker will be used, require adjustment by the purchaser before use, to meet the line. Breakers with dashpots can be used for motor-starting purposes when auto-starters are not used, as the dashpots will take care of the high-starting currents by holding the breaker closed during the starting operation.



Tank Removed. Breaker Closed. 5 to 25 Amperes

Complete. 5 to 100 Amperes

THREE-POLE INDOOR WALL-MOUNTING TYPE H OIL CIRCUIT-BREAKER
FULL-AUTOMATIC OVERLOAD TRIP AND ADJUSTABLE INVERSE-TIME ELEMENT. 2500 VOLTS


Live Side
Fuse
Ground
Voltage Transformer when used
If Voltage Transformer is on live side of Breaker no Hand Retrieve is necessary. (Use Self Retrieve)
Coil
Fuse
Resistance if supplied
If Voltage Transformer is on dead side of Breaker a Hand Retrieve is necessary.
Dead Side

CONNECTIONS FOR TRIPPING BREAKER BY SHORT-CIRCUITING UNDERVOLTAGE COIL IN CONNECTION WITH A RESISTOR (AND RELAY WHEN USED).

The inverse-time-element dashpot attachment is furnished in the dustproof and weatherproof breakers.

Undervoltage Trip—The undervoltage trip mechanism is entirely enclosed in a dustproof or weatherproof housing. The mechanism is positive in operation under all conditions, resetting automatically the mechanism in the weatherproof breakers—resets as the breaker opens; and in the conduit breakers, as the breaker closes. The rating of coil as shown in the tables is the normal operating voltage of the coil. The mechanism will operate and trip the breaker with a voltage drop to approximately fifty per cent of normal rating.

TYPE H OIL CIRCUIT-BREAKERS—Continued

CONSTRUCTION

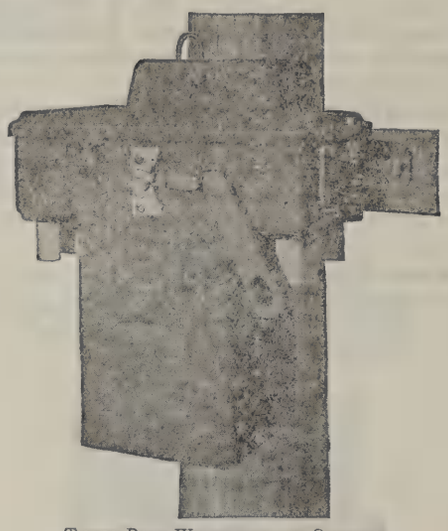
(See also Pages on "Oil Circuit-Breakers—General Information".)

The type H oil circuit-breaker is a single frame, self-contained breaker, the tripping coils, operating mechanism, and contacts being enclosed in one case and immersed under oil. This construction gives a compact, complete breaker, easily mounted on a wall, or any vertical support, and readily connected into the circuit without unnecessary dismantling.

Dustproof indoor wall-mounting breakers are listed two, three or four-pole for maximum capacities up to 100 amperes, automatic-overload series trip, or plain-automatic undervoltage trip. Overload breakers for voltages up to 750 are listed plain-automatic, also full-automatic with adjustable inverse-time-limit dashpot mechanism; and for voltages up to 2500, full-automatic with and without inverse-time-limit dashpot mechanism.

Dustproof and weatherproof wall-mounting breakers, including undervoltage trip are listed two, three or four-pole for voltages up to 750 and for maximum capacities up to 100 amperes. These are the standard weatherproof breakers having full automatic-overload trip with inverse-time-limit dashpot mechansim combined with undervoltage trip mounted inside the weatherproof housing. These breakers are designed especially for motor service, but automatic undervoltage protection is required in addition to automatic overload protection, and should be used for dustproof indoor mounting, as well as weatherproof outdoor mounting.

Conduit Breakers—Indoor dustproof breakers are listed for conduit wiring. These breakers, either with or without provision for mounting ammeters on the top castings, are full-automatic-overload trip, and are equipped with inverse-time-limit and undervoltage release attachments. Holes are provided in the sides of the breaker case for the conduit connection. In ordering these breakers, state the size, number, and location of outlets desired. For permissible sizes and locations of conduit holes, see outline dimensions.



THREE-POLE WEATHERPROOF OUTDOOR MOUNTING TYPE H OIL CIRCUIT-BREAKER UNDERVOLTAGE AND FULL-AUTOMATIC OVERLOAD TRIP WITH ADJUSTABLE INVERSE-TIME ELEMENT, 5 TO 100 AMPERES, 750 VOLTS

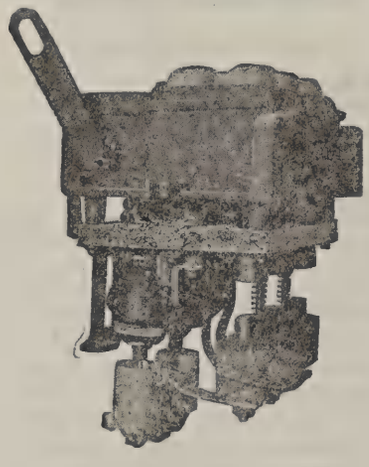
The "conduit breakers with ammeter mounting cover" are arranged to take the type SR ammeter. The type SR ammeter is similar in construction to the type SM ammeter listed in section 3-B, "Westinghouse Instruments and Relays," and will be furnished at the price of the corresponding type SM self-contained ammeter. The ammeter selected should be such that it will not be injured by the largest current that may pass through the breaker.

Mounting—All the type H oil circuit-breakers are arranged for wall mounting.

Tanks and Cases—The oil tank is made of heavy sheet iron with all seams welded, thus making a non-leaking oil vessel. The tank is securely fastened to the frame but the construction permits of easy removal for inspection and repair. The supporting frame of the breaker has a flange which encloses the upper end of the tank when in place, thus preventing any tank distortion under heavy internal pressure.

The tanks are rectangular, and are deep enough to allow ample space above the oil to act as an expulsion chamber for the arc gases and to reduce slopping of oil from internal disturbances.

The breakers in dustproof cases are constructed with all operating parts inside the case and tanks—except those parts that it is necessary to have outside in order to facilitate adjustment and control; such as the slotted operating handle, and the overload adjusting levers.



OPEN WITH TANK OFF.
THREE-POLE INDOOR WALL-MOUNTING TYPE H OIL CIRCUIT-BREAKER. FULL AUTOMATIC OVERLOAD TRIP WITH ADJUSTABLE INVERSE-TIME-ELEMENT.
50 TO 100 AMPERES, 750 VOLTS

TYPE H OIL CIRCUIT-BREAKERS—Continued

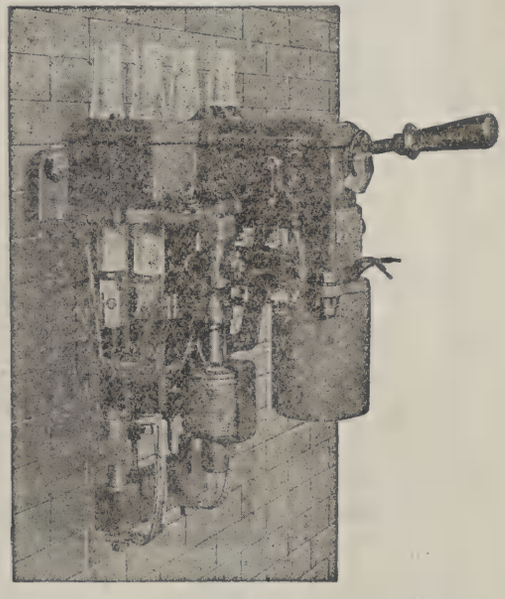
The breakers in weatherproof cases are arranged for indoor or outdoor service. All the operating mechanism, including the inverse-time-limit attachments and undervoltage release mechanism, are supplied inside the case, the slotted operating handle and adjusting levers only being outside the case.

Mechanism—The handle or lever used to close the breaker is connected through a toggle mechanism, to rods carrying the moving contacts. The arrangement of levers is such that a heavy pressure is produced between the contact surfaces with but slight pressure on the operating handle by the operator. The breakers are tripped manually by the same lever as is used for closing in the full-automatic type of breaker and by a small tripping lever in the plain-automatic type of breaker.

Terminal Bushings, Studs and Lugs—In the 750-volt breakers, the line leads are secured by two set screws. In the 2500-volt breakers, bolted-on copper tube terminals are supplied. The line leads in the breakers with dustproof cases are brought out through porcelain bushings in the top of the case. The line leads for the weatherproof breakers are brought out through porcelain bushings on the underside of the case and are so arranged that the leads can be made to droop from the bushing. The drooping leads prevent moisture from running down along the leads between them and the bushings, and into the case. The line leads for conduit breakers are brought into the breaker case through the conduit, and spread out for connection to the breaker terminals.

Contacts—The cylindrical-rod butt-type contact is used. The contacts consist of cylindrical rods, the lower one backed by spiral springs to insure contact. This type of contact is used on the multiple unit control system of heavy street-railway equipment and has been adapted with great success in oil circuit-breaker practice. It insures good contact at all times, and prevents any possible failure due to the eating away of the contacts by continued arcing. The compression springs take up any wear that may occur. The contacts have long life, and are readily removed and replaced when necessary

Closed



Open

TWO-POLE ELECTRICALLY OPERATED INDOOR WALL-MOUNTING TYPE H OIL CIRCUIT-BREAKER
NON-AUTOMATIC. 100 AMPERES, 2500 VOLTS

TYPE H OIL CIRCUIT-BREAKERS—Continued

TABLE I—DUSTPROOF INDOOR WALL-MOUNTING

For Voltages up to 750—For Cable Connection

Maximum Continuous Amperes	Poles	Range Of Adjustment Amperes	Dimension Reference Fig.	Gallons Oil	Approximate Wt. Lb. Without Oil* Shipping	Style No.	List Price
With Plain-Automatic Overload Trip							
5	2	5— 10	1	1.5	59	199416	47 00
10	2	10— 20	1	1.5	59	65747	47 00
15	2	15— 30	1	1.5	59	199417	47 00
25	2	25— 50	1	1.5	59	65748	47 00
50	2	50—100	1	1.5	59	65749	47 00
75	2	75—150	1	1.5	59	65750	60 00
100	2	100—200	1	1.5	59	65751	60 00
5	3	5— 10	1	1.5	64	199418	57 50
10	3	10— 20	1	1.5	64	65752	57 50
15	3	15— 30	1	1.5	64	199419	57 50
25	3	25— 50	1	1.5	64	65753	57 50
50	3	50—100	1	1.5	64	65754	57 50
75	3	75—150	1	1.5	64	65755	70 00
100	3	100—200	1	1.5	64	65756	70 00
5	4	5— 10	1	2.0	69	199420	85 00
10	4	10— 20	1	2.0	69	65757	85 00
15	4	15— 30	1	2.0	69	199421	85 00
25	4	25— 50	1	2.0	69	65758	85 00
50	4	50—100	1	2.0	69	65759	85 00
75	4	75—150	1	2.0	69	65760	100 00
100	4	100—200	1	2.0	69	65761	100 00

Non-Automatic

Omission from Above List Prices for Non-Automatic Breakers

2 Pole	$6 00
3 Pole	8 50
4 Pole	9 00

With Full-Automatic Overload Trip And Inverse-Time-Limit							
5	2	5— 10	1	2.0	71	199422	57 00
10	2	10— 20	1	2.0	71	199423	57 00
15	2	15— 30	1	2.0	71	199424	57 00
25	2	25— 50	1	2.0	71	199425	57 00
50	2	50—100	1	2.0	71	199426	57 00
75	2	75—150	1	2.0	71	199427	70 00
100	2	100—200	1	2.0	71	199428	70 00
5	3	5— 10	1	2.0	76	199429	70 50
10	3	10— 20	1	2.0	76	199430	70 50
15	3	15— 30	1	2.0	76	199431	70 50
25	3	25— 50	1	2.0	76	199432	70 50
50	3	50—100	1	2.0	76	199433	70 50
75	3	75—150	1	2.0	76	199434	85 00
100	3	100—200	1	2.0	76	199435	85 00
5	4	5— 10	1	2.5	81	199436	97 00
10	4	10— 20	1	2.5	81	199437	97 00
15	4	15— 30	1	2.5	81	199438	97 00
25	4	25— 50	1	2.5	81	199439	97 00
50	4	50—100	1	2.5	81	199440	97 00
75	4	75—150	1	2.5	81	199441	117 00
100	4	100—200	1	2.5	81	199442	117 00

TABLE II—DUSTPROOF-AND-WEATHERPROOF INDOOR-AND-OUTDOOR WALL MOUNTING

For Voltages Up To 750—For Cable Connection

Maximum Continuous Amperes	Poles	Range of Adjustment Amperes	Dimension Reference Fig.	Gallons Oil	Approximate Wt. Lb. Without Oil* Shipping	Style No.	List Price
Full-Automatic Overload Trip With Inverse-Time-Limit Attachment							
5	2	5– 10	3	2½	98	211917	70 00
10	2	10– 20	3	2½	98	211918	70 00
15	2	15– 30	3	2½	98	211919	70 00
25	2	25– 50	3	2½	98	211920	70 00
50	2	50–100	3	2½	98	211921	70 00
75	2	75–150	3	2½	98	211922	85 00
100	2	100–200	3	2½	98	211923	85 00
5	3	5– 10	3	2½	101	211924	83 50
10	3	10– 20	3	2½	101	211925	83 50
15	3	15– 30	3	2½	101	211926	83 50
25	3	25– 50	3	2½	101	211927	83 50
50	3	50–100	3	2½	101	211928	83 50
75	3	75–150	3	2½	101	211929	100 00
100	3	100–200	3	2½	101	211930	100 00
5	4	5– 10	3	3	110	211931	110 00
10	4	10– 20	3	3	110	211932	110 00
15	4	15– 30	3	3	110	211933	110 00
25	4	25– 50	3	3	110	211934	110 00
50	4	50–100	3	3	110	211935	110 00
75	4	75–150	3	3	110	211936	132 00
100	4	100–200	3	3	110	211937	132 00

Conduit Connection—The breakers listed above can be supplied for conduit connection on special order; prices on request

*Shipping weight of oil is approximately 9 pounds per gallon.

For information as to material furnished with these breakers, (nuts, cable terminals, etc.), see "Instructions for Ordering.

Order by Style Number

TYPE H OIL CIRCUIT-BREAKERS—Continued

TABLE III—DUSTPROOF AND WEATHERPROOF INDOOR AND OUTDOOR WALL-MOUNTING*

Full-Automatic With Inverse Time Attachment and Undervoltage Trip

For Cable Connection

Amperes	Poles	Gallons Oil Required	Approx. Shipping Wt. Lbs. Without Oil‡	110 Volts† Style No.	110 Volts† List Price	220 Volts† Style No.	220 Volts† List Price	440 Volts† Style No.	440 Volts† List Price	550 Volts† Style No.	550 Volts† List Price
25 Cycle											
5	2	2½	102	226859	$ 90 00	226880	$ 90 00	226901	90 00	226922	$ 90 00
10	2	2½	102	226860	90 00	226881	90 00	226902	90 00	226923	90 00
15	2	2½	102	226861	90 00	226882	90 00	226903	90 00	226924	90 00
25	2	2½	102	226862	90 00	226883	90 00	226904	90 00	226925	90 00
50	2	2½	102	226863	90 00	226884	90 00	226905	90 00	226926	90 00
75	2	2½	102	226864	105 00	226885	105 00	226906	105 00	226927	105 00
100	2	2½	102	226865	105 00	226886	105 00	226907	105 00	226928	105 00
5	3	2½	106	226866	101 00	226887	101 00	226908	101 00	226929	101 00
10	3	2½	106	226867	101 00	226888	101 00	226909	101 00	226930	101 00
15	3	2½	106	226868	101 00	226889	101 00	226910	101 00	226931	101 00
25	3	2½	106	226869	101 00	226890	101 00	226911	101 00	226932	101 00
50	3	2½	106	226870	101 00	226891	101 00	226912	101 00	226933	101 00
75	3	2½	106	226871	118 00	226892	118 00	226913	118 00	226934	118 00
100	3	2½	106	226872	118 00	226893	118 00	226914	118 00	226935	118 00
5	4	3	116	226873	129 00	226894	129 00	226915	129 00	226936	129 00
10	4	3	116	226874	129 00	226895	129 00	226916	129 00	226937	129 00
15	4	3	116	226875	129 00	226896	129 00	226917	129 00	226938	129 00
25	4	3	116	226876	129 00	226897	129 00	226918	129 00	226939	129 00
50	4	3	116	226877	129 00	226898	129 00	226919	129 00	226940	129 00
75	4	3	116	226878	150 00	226899	150 00	226920	150 00	226941	150 00
100	4	3	116	226879	150 00	226900	150 00	226921	150 00	226942	150 00
60 Cycle											
5	2	2½	102	226943	81 00	226964	90 00	226985	90 00	227006	90 00
10	2	2½	102	226944	81 00	226965	90 00	226986	90 00	227007	90 00
15	2	2½	102	226945	81 00	226966	90 00	226987	90 00	227008	90 00
25	2	2½	102	226946	81 00	226967	90 00	226988	90 00	227009	90 00
50	2	2½	102	226947	81 00	226968	90 00	226989	90 00	227010	105 00
75	2	2½	102	226948	95 00	226969	105 00	226990	105 00	227011	105 00
100	2	2½	102	226949	95 00	226970	105 00	226991	105 00	227012	105 00
5	3	2½	106	226950	95 00	226971	101 00	226992	101 00	227013	101 00
10	3	2½	106	226951	95 00	226972	101 00	226993	101 00	227014	101 00
15	3	2½	160	226952	95 00	226973	101 00	226994	101 00	227015	101 00
25	3	2½	106	226953	95 00	226974	101 00	226995	101 00	227016	101 00
50	3	2½	106	226954	95 00	226975	101 00	226996	101 00	227017	101 00
75	3	2½	106	226955	111 00	226976	118 00	226997	118 00	227018	118 00
100	3	2½	106	226956	111 00	226977	118 00	226998	118 00	227019	118 00
5	4	3	116	226957	122 00	226978	129 00	226999	129 00	227020	129 00
10	4	3	116	226958	122 00	226979	129 00	227000	129 00	227021	129 00
15	4	3	116	226959	122 00	226980	129 00	227001	129 00	227022	129 00
25	4	3	116	226960	122 00	226981	129 00	227002	129 00	227023	129 00
50	4	3	116	226961	122 00	226982	129 00	227003	129 00	227024	129 00
75	4	3	116	226962	144 00	226983	150 00	227004	150 00	227025	150 00
100	4	3	116	226963	144 00	226984	150 00	227005	150 00	227026	150 00

***Dimension Reference**—See Fig. 2

Range of adjustment—All type H breakers listed above have a calibration range of 100 to 200 per cent of normal ampere rating.

‡Shipping weight of oil is approximately 9 pounds per gallon.

†Voltage listed is normal rating of undervoltage trip coil.

For information as to material furnished with these breakers (nuts, cable terminals, etc.), see "Instructions for Ordering."

Order by Style Number

TYPE H OIL CIRCUIT-BREAKERS—Continued

TABLE IV—INDOOR WALL-MOUNTING

For Voltages up to 750—For Conduit Connection

Poles	Normal Rating of Undervoltage Trip Coil Volts		Gal. Oil	Approx. Wt. Lb. Without Oil* Ship.	Style No.										List Price	
	25-Cycle	60-Cycle			2-amp.	3-amp.	5-amp.	8-amp.	12-amp.	20-amp.	30-amp.	50-amp.	70-amp.	100-amp.	2 to 50-amp.	70 & 100-amp.
Full-Automatic Overload Trip—With Inverse-Time-Limit and Undervoltage-Release Attachment and Ammeter-Mounting Cover																
2	...	110	2.5	70	265347	265348	265349	265350	265351	265352	265353	265354	265355	265356	$ 96 00	$110 00
2	110	220	2.5	70	265227	265228	265229	265230	265231	265232	265233	265234	265235	265236	105 00	120 00
2	220	440–550	2.5	70	265257	265258	265259	265260	265261	265262	265263	265264	265265	265266	105 00	120 00
2	440	...	2.5	70	265287	265288	265289	265290	265291	265292	265293	265294	265295	265296	105 00	120 00
2	550	...	2.5	70	265317	265318	265319	265320	265321	265322	265323	265324	265325	265326	105 00	120 00
3	...	110	2.5	76	265357	265358	265359	265360	265361	265362	265363	265364	265365	265366	110 00	126 00
3	110	220	2.5	76	265237	265238	265239	265240	265241	265242	265243	265244	265245	265246	116 00	133 00
3	220	440–550	2.5	76	265267	265268	265269	265270	265271	265272	265273	265274	265275	265276	116 00	133 00
3	440	...	2.5	76	265297	265298	265299	265300	265301	265302	265303	265304	265305	265306	116 00	133 00
3	550	...	2.5	76	265327	265328	265329	265330	265331	265332	265333	265334	265335	265336	116 00	133 00
4	...	110	3.0	80	265367	265368	265369	265370	265371	265372	265373	265374	265375	265376	137 00	159 00
4	110	220	3.0	80	265247	265248	265249	265250	265251	265252	265253	265254	265255	265256	144 00	165 00
4	220	440–550	3.0	80	265277	265278	265279	265280	265281	265282	265283	265284	265285	265286	144 00	165 00
4	440	...	3.0	80	265307	265308	265309	265310	265311	265312	265313	265314	265315	265316	144 00	165 00
4	550	...	3.0	80	265337	265338	265339	265340	265341	265342	265343	265344	265345	265346	144 00	165 00

Dimension Reference—See Fig. 4.

TABLE V—DUSTPROOF INDOOR WALL-MOUNTING—Continued

For Voltages Up To 2500—For Cable Connection

Amperes	Range of Adjustments Amperes	Poles	Dimension Reference Fig.	Gallons Oil Required	Shipping Wt. Lbs. Without Oil*	Full-Automatic Overload Trip and Inverse Time Element Style No.	Full-Automatic Overload Trip and Inverse Time Element List Price	Full-Automatic Overload Trip Style No.	Full-Automatic Overload Trip List Price
5	5– 10	2	2	2¾	71	217480	$ 70 00	217501	$ 60 00
10	10– 20	2	2	2¾	71	217481	70 00	217502	60 00
15	15– 30	2	2	2¾	71	217482	70 00	217503	60 00
25	25– 50	2	2	2¾	71	217483	70 00	217504	60 00
50	50–100	2	2	2¾	71	217484	70 00	217505	60 00
75	75–150	2	2	2¾	71	217485	85 00	217506	75 00
100	100–200	2	2	2¾	71	217486	85 00	217507	75 00
5	5– 10	3	2	2½	76	217487	83 50	217508	70 00
10	10– 20	3	2	2½	76	217488	83 50	217509	70 00
15	15– 30	3	2	2½	76	217489	83 50	217510	70 00
25	25– 50	3	2	2½	76	217490	83 50	217511	70 00
50	50–100	3	2	2½	76	217491	83 50	217512	70 00
75	75–100	3	2	2½	76	217492	100 00	217513	85 00
100	100–200	3	2	2½	76	217493	100 00	217514	85 00
5	5– 10	4	2	3¼	81	217494	110 00	217515	95 50
10	10– 20	4	2	3¼	81	217495	110 00	217516	95 50
15	15– 30	4	2	3¼	81	217496	110 00	217517	95 50
25	25– 50	4	2	3¼	81	217497	110 00	217518	95 50
50	50–100	4	2	3¼	81	217498	110 00	217519	95 50
75	75–150	4	2	3¼	81	217499	132 00	217520	117 00
100	100–200	4	2	3¼	81	217500	132 00	217521	117 00

TABLE VI—INDOOR WALL-MOUNTING—Continued

For Voltages Up To 2500—For Cable Connection

Poles	Rating of Undervoltage Trip Coil Volts		Gal. Oil	Approx. Wt. Lb. Without Oil* Ship.	Style No.										List Price	
	25-Cycle	60-Cycle			2-amp.	3-amp.	5-amp.	8-amp.	12-amp.	20-amp.	30-amp.	50-amp.	70-amp.	100-amp.	2 to 50-amp.	70 & 100-amp.
Full-Automatic Overload Trip With Inverse-Time-Limit and Undervoltage-Release Attachment																
2	110	...	2.5	70	265047	265048	265049	265050	265051	265052	265053	265054	265055	265056	$ 81 00	$ 95 00
2	...	110	2.5	70	265077	265078	265079	265080	265081	265082	265083	265084	265085	265086	81 00	95 00
3	110	...	2.5	76	265057	265058	265059	265060	265061	265062	265063	265064	265065	265066	95 00	111 00
3	...	110	2.5	76	265087	265088	265089	265090	265091	265092	265093	265094	265095	265096	95 00	111 00
4	110	...	3.0	80	265067	265068	265069	265070	265071	265072	265073	265074	265075	265076	122 00	144 00
4	...	110	3.0	80	265097	265098	265099	265100	265101	265102	265103	265104	265105	265106	122 00	144 00

Range of Adjustment—All type H breakers listed above have a calibration range of 60 to 150 per cent of normal ampere rating.
Outline Dimensions—See Fig. 5.
*Shipping weight of oil is approximately 9 pounds per gallon.
For information as to material furnished with these breakers, (nuts, cable terminals, etc.), see "Instructions for Ordering."

Order by Style Number

TYPE H OIL CIRCUIT-BREAKERS—Continued

TABLE VII—AUXILIARY PARTS

The following special feature can be supplied only when ordered complete with breakers listed in Table I. The list price is to be added to the list price of the standard breaker to make total price of complete special breaker.

SHUNT TRIP

	Additional List Price
Fitted to 2-Pole Breakers	$ 8 50
Fitted to 3 and 4-pole Breakers	10 00

OUTLINE DIMENSIONS

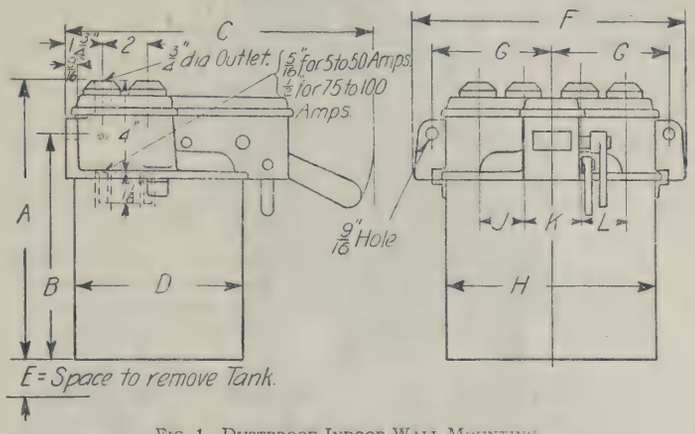


FIG. 1—DUSTPROOF INDOOR WALL MOUNTING

POLES	A	B	C	D	E	F	G	H	J	K	L
	DIMENSIONS IN INCHES										
With Plain-Automatic Overload Trip											
2	12 5/16	10 1/16	13 11/16	7 5/16	7½	10½	4½	8 1/8	...	5	...
3	12 5/16	10 1/16	13 11/16	7 5/16	7½	10½	4½	8 1/8	2½	...	2½
4	12 5/16	10 1/16	13 11/16	7 5/16	7½	12	5¼	9 5/8	2	2½	2
With Full-Automatic Overload Trip and Inverse Time Element											
2	14 9/16	12 5/16	13 11/16	7 5/16	9¼	10½	4½	8 1/8	...	5	...
3	14 9/16	12 5/16	13 11/16	7 5/16	9¼	10½	4½	8 1/8	2½	...	2½
4	14 9/16	12 5/16	13 11/16	7 5/16	9¼	12	5¼	9 5/8	2	2½	2
With Undervoltage Trip Only											
2	12 5/16	10 1/16	13 11/16	7 5/16	8	10½	4½	8 1/8	...	5	...
3	12 5/16	10 1/16	13 11/16	7 5/16	8	10½	4½	8 1/8	2½	...	2½
4	12 5/16	10 1/16	13 11/16	7 5/16	8	12	5¼	9 5/8	2	2½	2

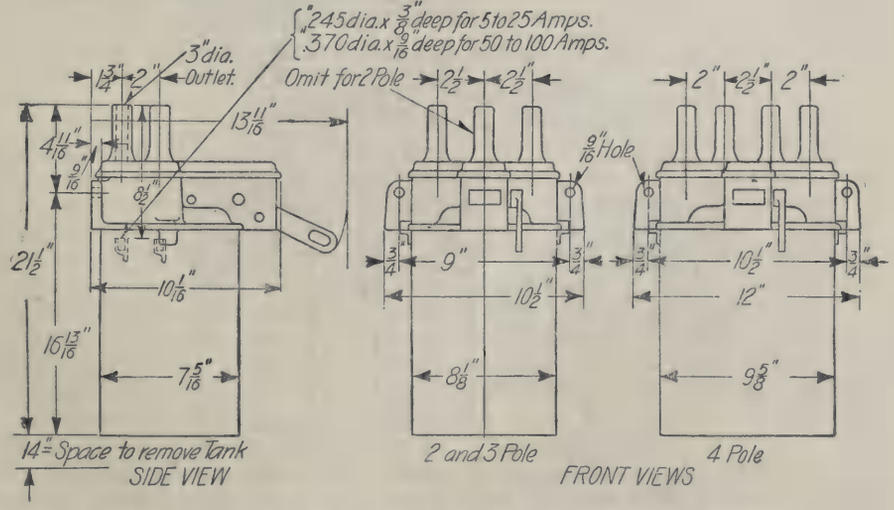


FIG. 2—DUSTPROOF AND WEATHERPROOF INDOOR AND OUTDOOR WALL MOUNTING

These dimensions are for reference only. For official dimensions apply to the nearest district office.

TYPE H OIL CIRCUIT-BREAKERS—Continued

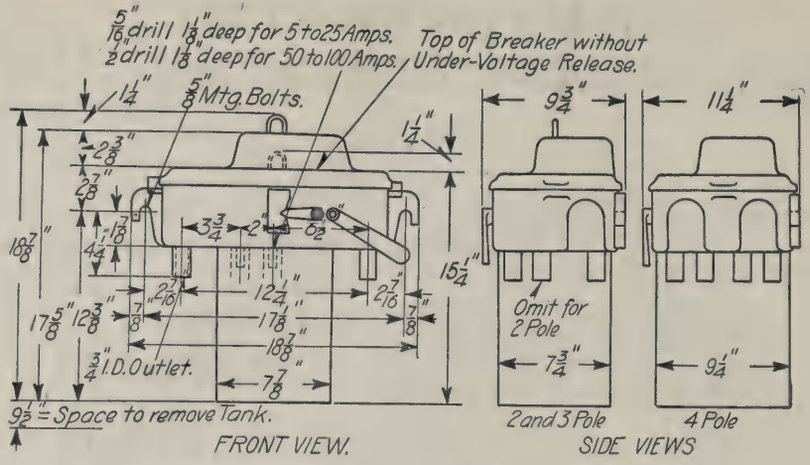


FIG. 3—DUSTPROOF AND WEATHERPROOF INDOOR-AND-OUTDOOR WALL MOUNTING

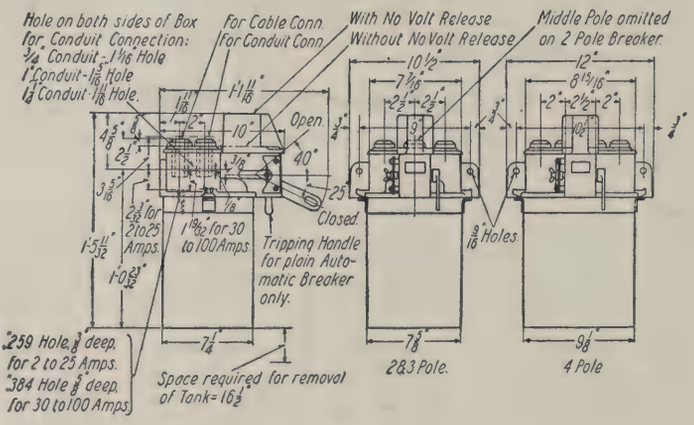

Hole on both sides of Box for Conduit Connection:
3/4" Conduit - 1 1/16" Hole
1" Conduit - 1 3/8" Hole
1 1/2" Conduit - 1 7/8" Hole.
For Cable Conn.
For Conduit Conn.
With No Volt Release
Without No Volt Release
Middle Pole omitted on 2 Pole Breaker
Open
40°
25°
Closed
Tripping Handle for plain Automatic Breaker only.
3/16" Holes
2 3/8" for 2 to 25 Amps.
1 9/32" for 30 to 100 Amps.
.259 Hole 3/8" deep. for 2 to 25 Amps.
.384 Hole 5/8" deep. for 30 to 100 Amps.
Space required for removal of Tank = 16 1/2"
2 & 3 Pole.
4 Pole

FIG. 4—INDOOR WALL MOUNTING—FOR VOLTAGES UP TO 750
(For Top View, See Fig. 5)

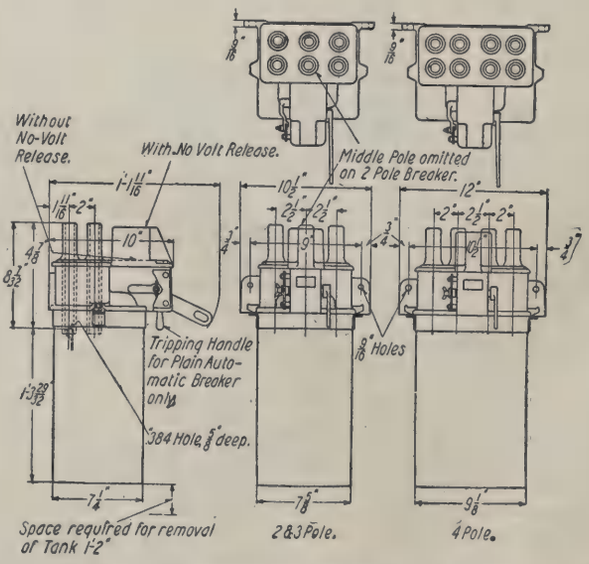

Without No-Volt Release.
With No Volt Release.
Middle Pole omitted on 2 Pole Breaker.
Tripping Handle for Plain Automatic Breaker only.
3/8" Holes
.384 Hole 5/8" deep.
Space required for removal of Tank 1'-2"
2 & 3 Pole.
4 Pole.

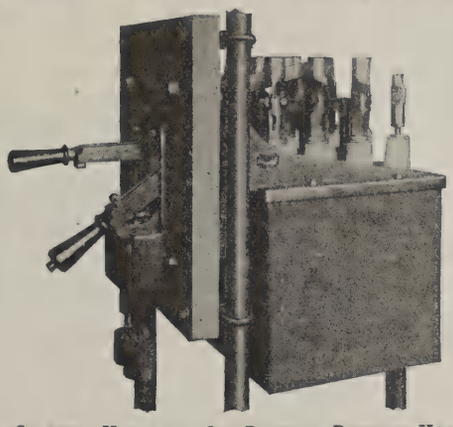
FIG. 5—INDOOR WALL MOUNTING—FOR VOLTAGES UP TO 2500

These dimensions are for reference only. For official dimensions apply to the nearest district office.

TYPE QF OIL CIRCUIT-BREAKERS FOR MOTOR STARTING

MANUALLY-OPERATED—FOR INDOOR SERVICE NON-AUTOMATIC STARTING POSITION AUTOMATIC RUNNING POSITION

For Capacities up to 600 Amperes 7500 Volts A. C. Interrupting Capacities of 1000 to 3000 Amperes at Service Voltage



TYPE QF AUTO-STARTER, STARTING HANDLE IN OFF POSITION, RUNNING HANDLE IN CLOSED POSITION

APPLICATION

The type QF motor-starting oil circuit-breakers are especially designed for starting, in connection with auto-transformers, three-phase squirrel-cage induction and self-starting synchronous motors up to 720 horsepower. When properly applied they protect the motor in the running position from heavy overloads and short circuits, and guard it against the sudden application of full voltage to the motor after it has slowed down or come to rest following an interruption of power supply.

For proper application to motors see Table I on following pages.

The breakers listed herein are suitable for motors having the same starting characteristics as standard Westinghouse motors. When starting equipments for motors of other than Westinghouse manufacture are desired, full motor data as indicated under "instructions for ordering" should be referred to the nearest district office of the company.

When the system capacity is higher than the interrupting capacity of the type QF breakers but the maximum possible short circuit current is within the limits given in tables C and D on pages on "Application of Oil Circuit-Breakers," a non-automatic starter may be used in series with a breaker having the automatic features of the starter, and of interrupting capacity high enough to suit the circuit conditions. Positive and speedy closing of the starter is particularly necessary in this case, and electrical operation should be used if such closing cannot otherwise be assured. Manual operation might prove unsatisfactory on large systems unless the attendants are fully aware of the necessity for positive operation.

DISTINCTIVE FEATURES

The following features embodied in the construction of the type QF breaker make it especially suitable for the service intended: Highly efficient form of wedge and finger-type contacts of ample proportions. Heavy auxiliary arcing tips for protecting main contacts. (These arcing tips have long life under frequent starting operations, which burn them away at a very slow rate.) Easy means of renewing the arcing tips (only a pair of pliers required.) Submersion and opening of all contacts under a good head of oil. Positive and direct gravity break, assisted by spring tension. Strong sheet iron tanks (with all seams lap-welded and bottom flanged and welded) readily removable without disturbing the mechanism or contacts, thus making inspection and renewal of arcing tips easy. Contacts arranged so that auto-transformers are only energized during starting position. Double-handle with mechanical interlock for motors that do not require preventive resistance during the starting period, thus obviating the possibility of short-circuiting the auto-transformer windings. Double-handle without interlock for motors requiring preventive resistance, thus permitting continuous application of graduated voltages on the motor during the starting application. Safety to operator insured by ample insulation in the breaker. Safety to apparatus insured by inverse-time-limit, automatic over-load current-transformer trip coils, and by undervoltage release mechanism which opens the breaker when the voltage fails. Large short-circuit current interrupting ability.

TYPE QF MOTOR-STARTING OIL CIRCUIT-BREAKERS—Continued

OPERATION

(See also pages on "Oil Circuit-Breakers—General Information.")

These breakers are manually operated. To start a motor with a circuit-breaker that has no preventive resistance the starting handle is moved down as far as it will go and held there until the motor has come up to speed. In this position the auto-transformers are magnetized and the motor is connected to the starting voltage. Then the starting handle is released, and the running handle is immediately moved down as far as it will go, where it remains latched. In passing to the running position, the auto-transformers are de-energized and full-line voltage is applied to the motor.

Where a preventive resistance is used, the handle interlock is omitted and the starting handle is held down as before until the motor no longer gains speed, then the running handle is moved down before the starting handle is released, thus applying continuous voltage to the motor through the preventive resistance and preventing the shock resulting from full voltage being applied suddenly to the motor windings.

Overload and Undervoltage Protection—The inverse-time-limit feature is provided in connection with the automatic overload current-transformer trip coils on the breaker so that the motor circuit will not be opened on momentary overloads, such as occur when changing from the starting to the running position. The time in which the automatic overload trip will operate is inversely proportional to the amount of the overload, tripping being instantaneous in case of a short circuit. The overload tripping range is from 80 per cent to 160 per cent of the current rating of the current transformers for the trip coil circuit.

The breaker trips independently of the running handle so that the operator cannot hold it closed against an injurious overload.

The undervoltage release opens the contacts when the voltage has decreased to approximately one-half its normal value. This feature is provided to guard against an excessive current, due to the return of power to a motor which may be out of phase or at rest. The undervoltage coils operate directly from the motor circuit when the voltage does not exceed 550 volts; for voltages higher than 550 volts voltage transformers having a 100 or 110-volt secondary, and primary fuse blocks and fuses are required.

Preventive Resistance—Experience has shown that when the circuit of certain motors in general service is opened during the starting period, disturbances are produced which may be injurious to the motor winding when line voltage is applied to the motor. To prevent these disturbances a preventive resistance is used for two-pole and four-pole motors above 200 horse-power, motors above 200 horse-power that require full-load starting torque or greater, and for all motors of 500 horse-power and larger. With this preventive resistance the starting circuit is not opened till the running contacts are closed, this prevents the large rush of current that would otherwise occur where full voltage is applied. These cases should be referred to the company for proper application. It should be noted that the preventive resistance is in circuit during the starting period only.

CONSTRUCTION

The type QF motor-starting oil circuit-breaker is a double-throw breaker with special moving and stationary contact arrangement. In effect, it is a three-pole, double-throw breaker with three additional terminals used to complete the auto-transformer circuits when the breaker is in a starting position.

Mounting—These breakers are furnished for panel-mounting, panel-frame mounting, and remote-control wall and pipe-mounting, direct or reverse connected. These mountings are practically the same as those used on the type F line of oil circuit-breakers.

Tanks—The tanks used are constructed in the same way as those used on the type F line of oil circuit-breakers.

Mechanism—The mechanism used is similar to that for the type F double-throw oil circuit-breakers, except interlocks may or may not be used. Two handles, one for starting and one for running, are provided on this breaker. These handles may or may not be mechanically interlocked, depending upon whether or not preventive resistance is used, so that one or both sides can be closed at a time. The starting side is non-automatic; the running side is full-automatic (trip-free on overload) with undervoltage release and inverse-time-limit attachments.

It should be particularly noted that the remote-control breaker **with reverse connection** is different from the remote-control breaker with **direct connection,** due to the position of the breaker being reversed with respect to the operating handle on the front of the panel.

Auto-Transformers—The auto-transformers are mounted separately from the breakers. The tap leads of the transformers are permanently connected to the motor leads.

The type QF breaker is suitable for use with either two single-phase auto-transformers, or one three-phase auto-transformer. The three-phase auto-transformer for use with this breaker must have all nine leads brought out because the star connection must be made by the special contacts of

TYPE QF MOTOR-STARTING OIL CIRCUIT-BREAKERS—Continued

the switch when it is in the starting position.

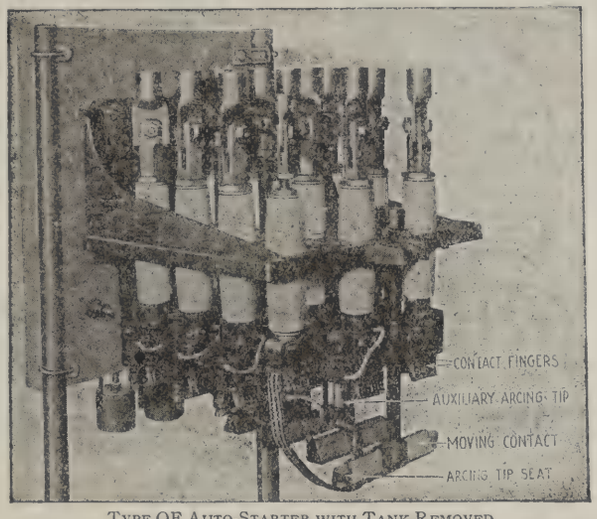
When a single set of auto-transformers *specially* designed for such service is to be used for starting two or more motors, complete data should be given to the company, as the connections require modification when group-starting is used.

Auto-transformers are not included with the circuit-breakers listed.

Terminals—The terminal bushings, terminal studs, terminals, and terminal lugs are the same as those used in the type F oil circuit-breakers of similar capacity.

Main and Auxiliary Contacts—The Main contacts are of the regular well known type F oil circuit-breaker wedge type.

The auxiliary or arcing contacts are of the regular type F construction on the 300-ampere capacity, but on the 600-ampere capacity they are of double the area of the regular type F auxiliary contact, thus giving a heavier auxiliary arcing tip.



TYPE QF AUTO-STARTER WITH TANK REMOVED

INSTRUCTIONS FOR ORDERING

(*See also pages on "Oil Circuit-Breakers—General Information."*)

In choosing a motor-starting breaker there are several considerations to be observed, the mere fact that the continuous-ampere rating of the breaker is equal to the maximum continuous overload current of the motor is *not* necessarily sufficient.

The following data must be carefully considered in determining the proper starting equipment for a motor:

A—Full-load motor rating, including the amount and duration of overload guarantees.

B—Nature of the load which the motor drives and the average number of starts that will be made per day.

C—Current obtainable from the supply system in case of the dead short circuit between the switch and motor. If not known, give data so that this can be calculated. Such data will be:

(1)—Kilovolt-ampere capacity, and per cent reactance of synchronous machinery that can feed the power through the breaker.

(2)—Kilovolt-ampere capacity and per cent reactance of all step-up and step-down transformers between the synchronous machinery and the motor-starting breaker.

(3)—Size of wire or cable and length and spacing of conductors of all circuits between the synchronous machinery and the motor-starting breaker.

D—Method of obtaining starting voltage, namely:

(a)—From two single-phase auto-transformers.

(b)—From one three-phase auto-transformer *with neutral connection arranged to be made external from case.*

(c)—Reduced voltage taps on secondary of step-down transformer. In this case a standard three-pole, double-throw type F-2 breaker sometimes may be used, depending on the size of the motor.

E—(a)—Amperes in motor winding required to start the motor.

(b)—Amperes required to start the motor when connected to the reduced voltage starting-tap with tap voltage percentages.

(c)—Per cent of normal voltage required to start the motor.

F—Motor amperes at full-voltage with motor locked.

G—Will each motor have its own set of starting auto-transformers or will group-starting be employed?

TYPE QF MOTOR-STARTING OIL CIRCUIT-BREAKERS—Continued

Table I following indicates which size of breaker may be used for a given size of motor on certain common commercial voltage systems and for different classes of service that the motor may drive. Motor service is divided respecting the effect of starting currents on the conducting parts of the breaker into two general classes (a) motor-generator set service, and (b) general service. Class (a) service will be less severe with regard to the burning of arcing tips than motors applied to industrial machinery. The sizes of the motors of the motor-generator sets are for standard Westinghouse sets, which require approximately 30 per cent of full-load torque to start the set at 50 to 35 per cent full-line voltage. Similar size motors of motor-generator sets built by other manufacturers may be started by the type QF breakers according to Table I, *provided the starting torque and voltage are the same as for the corresponding standard Westinghouse motors.*

TABLE I—APPLICATION OF TYPE QF BREAKERS TO MOTOR SIZES

	Maximum Short Circuit Amperes that Starter can withstand for 5 Seconds without injury		Interrupting Capacity Amperes Panel-Mounting		Interrupting Capacity Amperes Remote-Control		Maximum H. P. General Service*		Maximum H. P. Motor-Generator Sets	
Volts	300-Amp.	600-Amp.	300-Amp.	600-Amp.	300-Amp.	600-Amp.	300-Amp.	600-Amp.	300-Amp.	600-Amp.
220	15000	30000	15000	30000	15000	30000	100	200	125	225
440	15000	30000	15000	30000	15000	30000	200	300	225	290
550	15000	30000	15000	30000	15000	30000	225	400	290	§
2200	15000	30000	7700	7700	9800	9800	500	†	720	
4000	15000	30000	3950	3950	5000	5000	500	†	‡	
6600	15000		2150		2700		500		†	

*For information as to when preventive resistance should be used, see paragraph "Preventive Resistance" on previous page.

†Although the type QF breaker will start and carry the current of a 2160-horsepower motor, it is likely that the system supplying such a motor will be too large to allow of applying a starter with all the automatic features on it. In most cases of this kind the starter will have to be non-automatic and the motor protected by an automatic breaker having suitable rupturing capacity.

‡There are no standard 4000-volt motor-generator sets of capacities higher than 290 horsepower

§Limited to 290 horsepower as the next size of standard set requires a starter of over 600-ampere capacity.

†Although the type QF breaker will start and carry the current of a 1420-horsepower motor, it is likely that the system supplying such a motor will be too large to allow of applying a starter with all the automatic features on it. In most cases of this kind the starter will have to be non-automatic and the motor protected by an automatic breaker having suitable rupturing capacity.

TABLE II—PRICES

Style number includes the type QF motor-starting circuit-breaker complete as described, without oil or auto-transformer, which must be ordered separately. (See the general ordering instructions on the first pages on oil circuit-breakers.)

Direct-Control

Maximum Continuous Amperes	Maximum Volts	Interrupting Capacity at Rated Voltage, Amp.	Gallons Oil	Approximate Shipping Weight Lb.	Style No.	List Price
Panel-Mounting†						
300	7500	1900	15½	337	246401	$427 50
600	4500	4000	15½	400	246402	580 00
Panel-Frame-Mounting						
300	7500	1900	15½	360	246403	457 50
600	4500	4000	15½	430	246404	610 00

Remote-Control With Bell Cranks†

Maximum Continuous Amperes	Maximum Volts	Interrupting Capacity at Rated Volts Amperes	Gallons Oil	Approximate Shipping Weight Lb.	Style No. Wall Mounting	Style No. Pipe Mounting	List Price
Direct-Connected							
300	7500	2400	15½	490	246405	246409	$475 00
600	4500	5000	15½	552	246406	246410	630 00
Reverse-Connected							
300	7500	2400	15½	490	246413	246417	475 00
600	4500	5000	15½	552	246414	246418	630 00

*Although the type QF motor-starting oil circuit-breakers are insulated for 4500- and 7500-volt service, engineering practice indicates that panel-mounting breakers shou d not be used on service voltages greater than 2500. For service voltages greater than 2500 remote-control breakers are required.

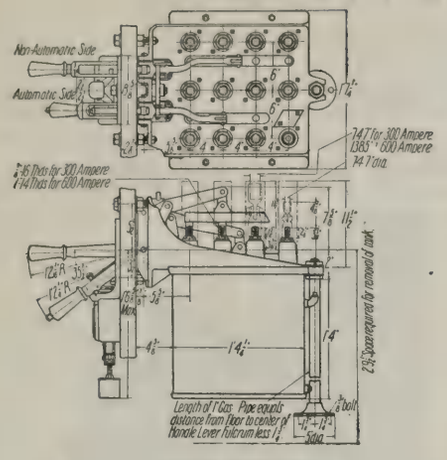
For information as to what material is furnished with these breakers, (nuts, cable terminals, etc.), see "Instructions for Ordering."

†Panel-Mounting breakers are made for mounting on material two inches thick. When they are to be mounted on thinner material spacers must be used on the mounting bolts. The cover plates controlling remote-control manually-operated breakers are designed for mounting on 2-inch material. When these cover plates are to be mounted upon material less than 2 inches thick spacers must be used on mounting bolts; when they are to be mounted on material between 2 and 4 inches thick, longer mounting bolts than standard are required. Spacers or longer mounting bolts will be furnished free of charge when ordered with breakers.

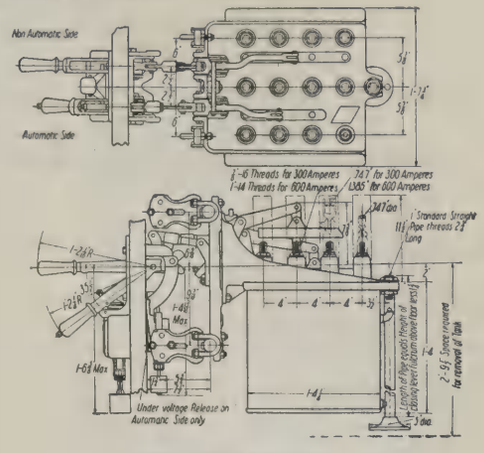
Order by Style Number

TYPE QF MOTOR-STARTING OIL CIRCUIT-BREAKERS—Continued

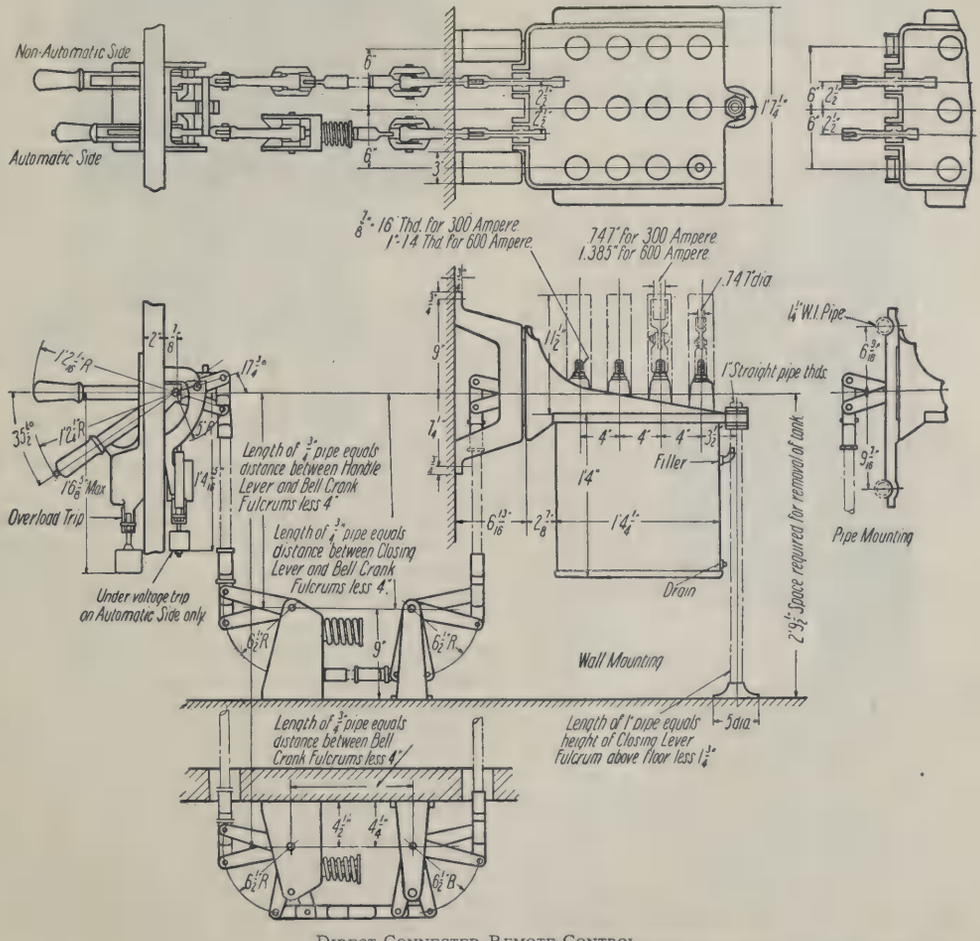
OUTLINE DIMENSIONS


Non-Automatic Side
Automatic Side
.747 for 300 Ampere
1.385" for 600 Ampere
.747 Dia.
Length of 1" Gas Pipe equals distance from floor to center of Handle Lever Fulcrum less 1¼"
Space required for removal of tank

PANEL-MOUNTING


Non Automatic Side
Automatic Side
1"-16 Threads for 300 Amperes
1"-14 Threads for 600 Amperes
.747" for 300 Amperes
1.385" for 600 Amperes
1" Standard Straight Pipe threads 2¼" long
Under voltage Release on Automatic Side only
Space required for removal of Tank

PANEL-FRAME MOUNTING


Non-Automatic Side
Automatic Side
⅞"-16 Thd. for 300 Ampere
1"-14 Thd. for 600 Ampere
.747" For 300 Ampere
1.385" For 600 Ampere
.747 Dia.
4" W.I. Pipe
1" Straight pipe thds.
Length of ¾" pipe equals distance between Handle Lever and Bell Crank Fulcrums less 4"
Length of ¾" pipe equals distance between Closing Lever and Bell Crank Fulcrums less 4"
Overload Trip
Under voltage trip on Automatic Side only
Filler
Drain
Pipe Mounting
Wall Mounting
Space required for removal of tank
Length of ¾" pipe equals distance between Bell Crank Fulcrums less 4"
Length of 1" pipe equals height of Closing Lever Fulcrum above floor less 1¾"
5 dia.

DIRECT-CONNECTED REMOTE-CONTROL

Reverse-connected remote-control breakers are the same as direct-connected remote-control, except that the breaker is mounted on the opposite side of the wall with respect to the coverplate—that is, in order to keep the arrangement of the coverplate the same, the parts of the breaker are reversed from left to right.

These dimensions are for reference only. For official dimensions apply to the nearest district office.

TYPE F OIL CIRCUIT-BREAKERS

MANUALLY AND ELECTRICALLY OPERATED NON-AUTOMATIC AND AUTOMATIC

FOR INDOOR AND OUTDOOR SERVICE—SINGLE AND DOUBLE THROW

For Capacities up to 3000 Amperes 13200 Volts, A. C. Interrupting Capacities at Rated Voltage, 1000 to 15000 Amperes

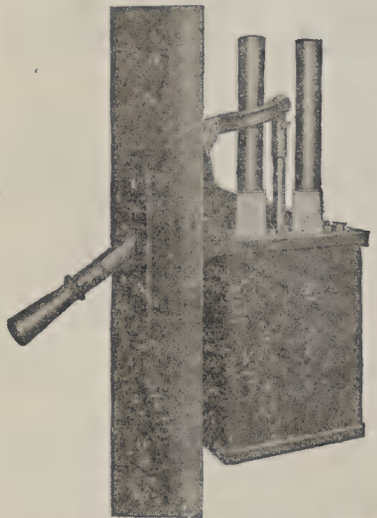
APPLICATION

See also pages on "Oil Circuit-Breaker Application."

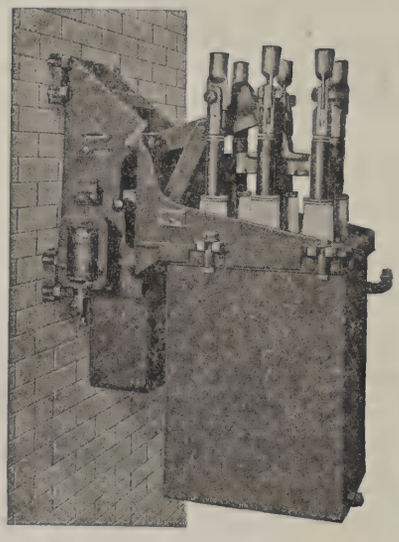
The type F oil circuit-breakers comprise a complete line of moderate-capacity, non-automatic and automatic manually- and electrically-operated breakers. For indoor service, the breakers are made in the panel-mounting, and remote-control wall- or pipe-mounting forms, and for outdoor service in pole- or subway-mounting forms.

Indoor Mounting—The panel-mounting form, as its name indicates, is designed for mounting on the rear of the switchboard panel on frame brackets.

The remote-control wall- or pipe-mounting forms allow the breaker to be mounted at any suitable place and to be operated from a switchboard, or other position, as desired.



TYPE F-2 INDOOR MANUALLY-OPERATED SWITCHBOARD-MOUNTING NON-AUTOMATIC SINGLE-POLE SINGLE-THROW 500-AMPERE 13,200-VOLT (SHOWING MICARTA TUBES ON TERMINALS)



TYPE F-3 INDOOR ELECTRICALLY-OPERATED WALL-MOUNTING AUTOMATIC THREE-POLE SINGLE-THROW 500-AMPERE 13,200-VOLT

Outdoor Mounting—The outdoor form of wall- or pole-mounting breaker is primarily intended for service in exposed places. It is particularly adapted to controlling lines where they enter buildings, for controlling branch feeders from main lines, for sectionalizing feeders, for cutting out transformers, or for any of the other numerous purposes for which an outdoor form of breaker may be utilized on distribution systems. It is also adapted to use with motor installations, because of the ease with which the breaker may be mounted on any vertical support convenient to the motor operator.

The subway form of breaker is intended for mounting in subways, manholes, or other places where a breaker may be required to operate submerged. The subway form of breaker is made two- or three-pole single-throw for capacities up to 300 amperes 7500 volts.

DISTINCTIVE FEATURES

Among the features that distinguish the type F breakers are: Highly efficient form of wedge and finger-type contacts. Auxiliary arcing contacts. Submersion and opening of all contacts under oil. Quick opening of contacts, assisted by arcing tip springs. Open position maintained by gravity. Inability to hold full-automatic breaker in the closed position when an excessive overload or short circuit exists on the line. Strong tanks and tank supports. Tanks removable without disturbing the operating mechanism or contacts, making inspection easy. Ample air space at the top of the tank to allow for gas expansion. Insulating lining in the tanks. Isolation of poles by individual cells. Self contained multipole hand- or electric-operating mechanism on the multipole single-tank breakers.

TYPE F OIL CIRCUIT-BREAKERS—Continued

OPERATION

See also pages on "Oil Circuit-Breakers—General Information."

The type F oil circuit-breakers are non-automatic and full-automatic direct or remote-control manually-operated; and non-automatic and automatic electrically-operated.

Manual Operation—Manually-operated breakers for direct-control panel-mounting and panel-frame-mounting, or for remote-control wall- or pipe-mounting are listed in all standard capacities, poles, and throws of the type F-1, F-2, and F-3 breakers. A coverplate containing the operating handle, and with the full-automatic breakers, the overload-trip mechanism, is supplied for mounting on the panel or frame bracket.

Remote-control manually-operated breakers for either wall- or pipe-mounting are listed for downward pull, with bell cranks either above or below the floor, and for horizontal pull without bell-cranks.

TYPE F-1 INDOOR MANUALLY-OPERATED REMOTE-CONTROL PIPE MOUNTING THREE-POLE SINGLE-THROW 200-AMPERE 4500-VOLT (SHOWING MICARTA TUBES OVER TERMINALS

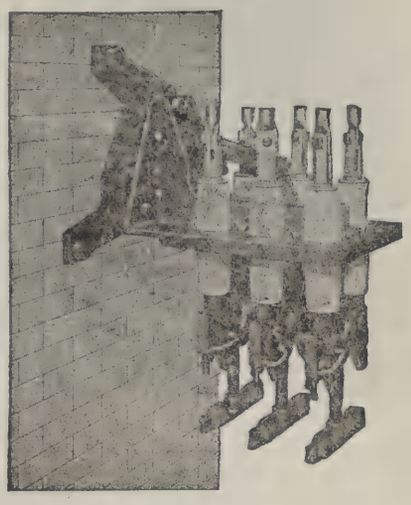
Electrical Operation—Electrically-operated single-throw breakers are listed in the types F-2 and F-3, only.

The automatic breakers, as listed, include one or two 5-ampere coils for tripping directly from current transformers.

The non-automatic breakers, or automatic breakers with current transformer trip coils omitted, can be made automatic or full-automatic (trip-free on overload) through current transformers and relays controlling the direct-current or alternating-current shunt-trip or undervoltage-trip circuit. (Note—For alternating-current voltages above 550, step-down transformers should be used for shunt or undervoltage tripping.)

General Operation

The non-automatic breakers are used where voltage, breaking capacities, and current capacities



TYPE F-2 INDOOR MANUALLY-OPERATED REMOTE-CONTROL WALL-MOUNTING THREE-POLE SINGLE-THROW 300-AMPERE 7500-VOLT

are required greater than those listed for the type D oil switches. They are listed in Types F-1, F-2 (single- and double-throw), and F-3 for switchboard mounting, or for remote-control pipe- or wall-mounting, hand operated, and in types F-2 and F-3 electrically-operated.

Automatic Breakers—All manually-operated automatic breakers listed are full-automatic. The type F-2 multipole-single-tank electrically-operated breakers are listed full-automatic with shunt and current-transformer trips, and the types F-2 multiple-single-pole electrically-operated and F-3 electrically-operated breakers are plain-automatic with shunt and current-transformer trips only.

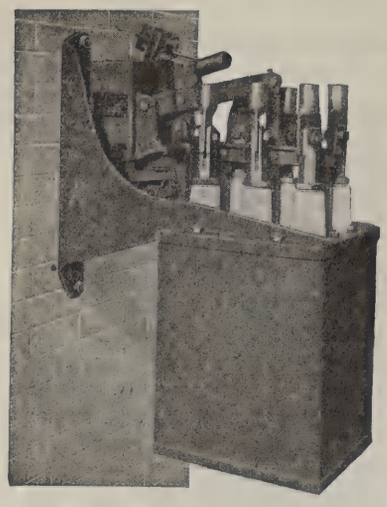
Plain automatic overload-trip breakers, types F-2 and F-3 electrically-operated, when closed with an overload on the line, will remain closed as long as the closing coil is energized, but will not remain closed when the closing circuit is opened.

Full-automatic overload-trip breakers have a mechanism making it impossible to hold the breaker in the closed position while a continued overload condition or a short circuit exists on the line.

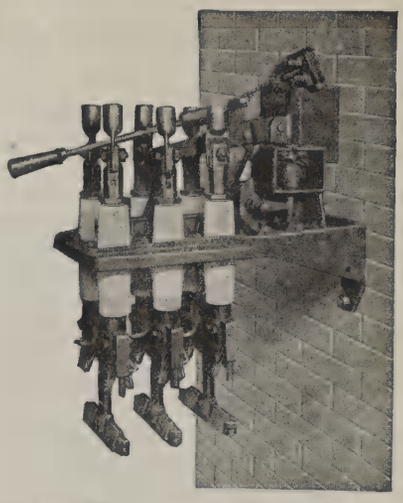
Standard Overload Trip-Range—The standard overload-trip range of these breakers is 80 to 160 per cent of the normal full-load current rating or primary rating of the current transformer in the trip-coil circuit.

Transformer Overload Trip—For transformer tripping, type F automatic breakers are listed with trip coils mounted on the cover-plate of hand-operated breakers or on the electric mechanism of electrically-operated breakers. A single 5-ampere

TYPE F OIL CIRCUIT-BREAKERS—Continued



Closed



Open, With Removable Hand-Closing Handle in Position

TYPE F-2 INDOOR ELECTRICALLY-OPERATED WALL-MOUNTING NON-AUTOMATIC THREE-POLE SINGLE-THROW 500-AMPERE 7500-VOLT

coil is regularly used on single-pole and two-pole breakers, and two 5-ampere coils on three-pole and four-pole breakers. For use on two-phase or three-phase, where accurate overload tripping is not required on a single-phase overload or short circuit, single-coil three- and four-pole breakers having only one special 8.7-ampere overload trip coil, are obtainable on special order. This special trip coil can be connected to two current transformers in "vector parallel," in which case the single-phase overload accuracy is within good operating limits of the polyphase calibration.

On two and three-phase ungrounded systems two transformers connected to either one 8.7-ampere or two 5-ampere coils are recommended for overload protection.

On four-wire three-phase grounded neutral, or four-wire interconnected two-phase systems, three transformers connected in "Z" to two 5-ampere coils, are recommended for overload protection.

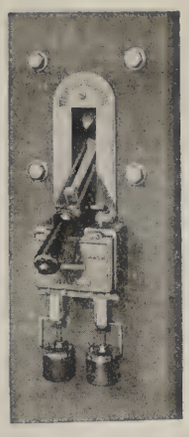
On balanced ungrounded two- or three-phase circuits, one transformer and one 5-ampere trip-coil, supplied on special order, can be used for overload protection.

TYPE F-1 WEATHERPROOF MANUALLY-OPERATED AUTOMATIC SERIES-TRIP WITH INVERSE-TIME-ELEMENT, THREE-POLE SINGLE-THROW 200-AMPERE 4500-VOLT

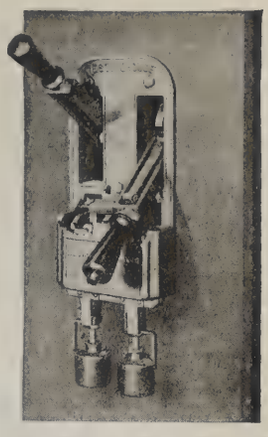
TYPE F-3 WEATHERPROOF ELECTRICALLY- OR MANUALLY-OPERATED WALL- OR PIPE-MOUNTING THREE-POLE SINGLE-THROW 600-AMPERE 7500-VOLT

TYPE F OIL CIRCUIT-BREAKERS—Continued

SINGLE-THROW COVER-PLATE, SINGLE-COIL AUTOMATIC (OPEN POSITION)



SINGLE-THROW COVER-PLATE WITH INVERSE-TIME-ELEMENT DASHPOTS DOUBLE-COIL AUTOMATIC (CLOSED POSITION)



DOUBLE-THROW COVER-PLATE WITH INVERSE-TIME-ELEMENT DASHPOTS, DOUBLE COIL WITH ONE SIDE AUTOMATIC

For three-phase reverse-power protection, three transformers are necessary, and when these are connected direct to current trip coils, three 5-ampere coils are necessary.

Triple-coil overload tripping can be supplied on special order. Prices on application.

Series Overload Trip—For series tripping, type F indoor breakers are listed with alternating-current series-overload trip coils mounted in the switchboard coverplate (dry insulated) for voltages up to 2500 and capacities from 10 to 300 amperes. Although these oil circuit-breakers are insulated for 2500-volt service, engineering practice indicates that panel-mounting breakers having series-trip coils exposed to the air should not be used on voltages greater than 750. For service voltages greater than 750 volts, transformer-trip or series-trip breakers, with the series coil under oil, are recommended. The main-circuit connections to the series trip coils are made through large holes in the panel, these holes being covered by the cover-plate. This method of trip is recommended to be applied only to small, low capacity installations, not having current transformers for meters.

CONSTRUCTION

See also pages on "Oil Circuit-Breakers—General Information."

Indoor Form

Three forms of both the non-automatic and automatic breakers are built; namely, the types F-1, F-2 and F-3. It is to be noted that each form has a different interrupting capacity, maximum voltage, and details of construction.

TYPE F-2 INDOOR MANUALLY-OPERATED SWITCHBOARD-MOUNTING THREE-POLE DOUBLE-THROW 500-AMPERE 7500-VOLT

TYPE F-2 INDOOR MANUALLY-OPERATED REMOTE-CONTROL PIPE-MOUNTING THREE-POLE SINGLE THROW 500-AMPERE 7500-VOLT

TYPE F OIL CIRCUIT-BREAKERS—Continued

Multipole breakers having a single mechanism and tank are listed up to maximum capacities of 800 amperes. In addition, type F-3 breakers, either manually- or electrically-operated remote-control, can be supplied in capacities up to 3000 amperes by using three or four-pole standard units with the contacts connected in multiple for each pole, (multiple-multipole). Type F-3 breaker frames are specially designed for this purpose. Types F-1 and F-2 breakers cannot be used in this manner.

Mounting — Manually - operated direct - control breakers are made either for panel- or panel-frame-mounting, or for remote control wall- or pipe-mounting. The type F-2 multiple-single-pole wall-mounting breakers (a multipole breaker made up of single-pole units), and the type F-3 multiple-multipole wall-mounting breakers (a multipole breaker made up of standard remote-control three- or four-pole units to form one high-capacity multipole breaker), when equipped with appropriate fittings, can be used for cell-mounting, erected in brick, asbestos, lumber, or concrete structure, with each pole enclosed in a separate compartment. Direct-control panel-mounting breakers can be made direct-control pipe-mounting by the use of suitable mounting brackets (see pages on "Oil Circuit-Breaker Accessories.")

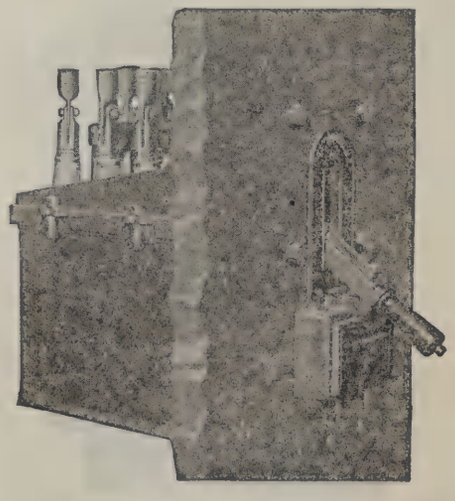
TYPE F-1 INDOOR MANUALLY-OPERATED THREE-POLE SINGLE-THROW 200-AMPERE 4500-VOLT (WITH TANK LOWERED AWAY FROM CONTACTS, SHOWING INSULATED CELL LINING IN TANK)

Electrically-operated multipole-single-tank breakers are made with self-contained mechanisms for either wall-or pipe-mounting. The multiple-single-pole electrically-operated breakers are made for either wall- or pipe-mounting with separate operating mechanisms placed above, below, or behind the breaker, as listed; while the electric operating mechanism of the multiple-multipole breakers can be mounted only below the breaker.

TYPE F-3 INDOOR MANUALLY-OPERATED SWITCHBOARD-MOUNTING THREE-POLE SINGLE-THROW 800-AMPERE 4500-VOLT

Tanks—Multipole-single-tank construction is used on all type F breakers, except the type F-2 multiple-single-pole, and the type F-3 multiple-multipole, which use one tank per pole. The oil tanks are rectangular in shape and are made of heavy sheet iron, with all seams lap-welded, the bottom being flanged and welded on the outside of the tank sides. As an additional protection from arcing, individual insulating cells form separate compartments for each pole where one tank is used on multipole-breakers.

The method of fastening the tank to the frame, while very secure, yet permits an easy removal for the purpose of inspection and repair. The support-



TYPE F-3 INDOOR MANUALLY-OPERATED PANEL-MOUNTING THREE-POLE SINGLE-THROW 800-AMPERE 4500-VOLT

TYPE F OIL CIRCUIT-BREAKERS—Continued

ing frame of the breaker has a flange which encloses the upper end of the tank when in place, thus preventing the tank from distortion under heavy internal pressure.

The tanks are deep to allow ample space above the oil level to act as an expansion chamber for the arc gases and to reduce slopping of the oil from internal disturbances. The gases are vented through the clearance between the wooden operating rods and the frame.

Tank Linings—All breakers, except type F-3, have wooden tank linings. Seamless moulded micarta linings can be supplied for these breakers on special order, similar to the standard linings for type F-3 breakers. Prices on application.

Mechanism—The mechanism for all poles in hand- and electrically-operated multipole-single-tank breakers is self-contained on a single frame.

The mechanism of the manually-operated remote-control type F-2 multiple-single-pole breakers consists of a separate single-pole mechanism for each pole, each mechanism being operated from a common control mechanism and handle. In the manually-operated type F-3 multiple-multipole breakers, standard three- or four-pole units are used per pole, operated from one point, tripped by one set of coils, and closed with one common handle. In the electrically-operated type F-2 multiple-single-pole breakers the electric mechanism is separately mounted below, behind, or above the breaker mechanism, as listed; and on the type F-3 multiple-multipole it is mounted below the breaker; the mechanism closes and trips the several pole-units together.

In the automatic, bell-crank remote-control hand-operated breakers, an accelerating spring device on one bell-crank is used to force the breaker to the open position.

Terminal Bushings and Studs—The terminal studs or bushings with stationary contacts or feet

LINE OF TYPE F STATIONARY-CONTACT PILLAR UNITS WITH TERMINALS

TYPE F STATIONARY-CONTACT PILLAR UNIT WITH TERMINAL, CLAMP, AND LOCATING RING. 300-AMPERE 7500-VOLT

on the lower extremity are supported by one-piece vertical pillar-type porcelain bushings clamped to the framework. The studs and micarta-tube details are clamped to these insulators. This construction avoids the use of babbit and cement, and thus reduces the time and labor of maintenance. Lock washers are used on the clamped bolts and current-carrying parts to prevent them from loosening by vibration or hammer blows, which might occur in the operation of the breaker.

Terminals and Terminal Lugs—Copper tube terminals are supplied on breakers up to and including, the 800-ampere capacity 60-cycle rating. For connecting the terminals to the stud, a brass or copper sleeve is supplied at one end to screw onto the stud and it is split at the other end to receive the flattened end of the tube terminal. The tube terminal is held in the slot of the sleeve by a bolt supplied with a lock washer. On special order, terminals may be omitted or contact nuts, with or without special terminals supplied. For terminals for use with breakers of capacities above 800 amperes 60-cycles and for special terminals or contact nuts, see pages on "Oil Circuit-Breaker Accessories."

The main moving contacts are of an improved wedge type. The main stationary contacts consist of fingers of the "controller" type arranged in pairs facing each other so as to make perfect contact on the two surfaces of the moving contact wedge when the breaker is closed. The contact tips on the end of the fingers are supported on the ends of thin flat steel springs permitting the contact to move in all directions and to automatically align itself on the wedge thus insuring that the

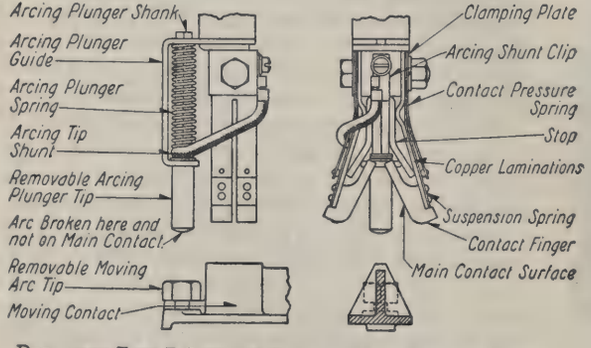
full carrying capacity of the contacts is always available. This spring is shunted by a liberal copper-leaf shunt to conduct the current from the tips to the terminal stud. The contact pressure is obtained by a second and heavier flat steel spring which is provided on the end with a round head and which applies the pressure over the center of the contact tip of the finger. One or more pairs of fingers are used according to the capacity of the breaker, (see illustrations).

A steel stop is mounted between the fingers on the contact stud and serves to hold the fingers in the proper position when the breaker is open so that there is no danger of the moving contacts failing to enter between the stationary fingers upon closing the breaker. This stop also causes the fingers to be under considerable initial tension at the time the moving contact first touches them in closing, or leaves them in opening the breaker, reducing the liability of contact vibration and burning with abnormal currents flowing.

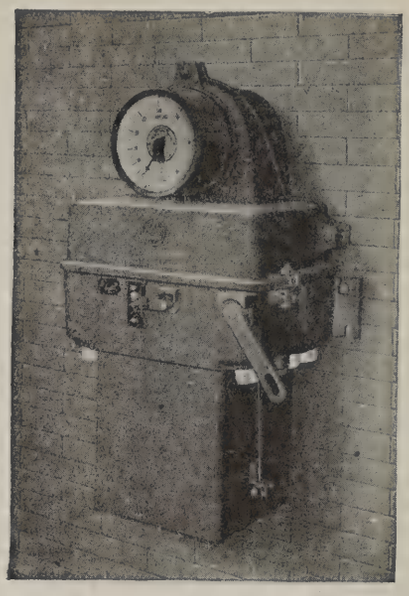
Arcing contacts of the butt type protect the main contact from the action of arcs at breaking. The stationary member consists of a spring plunger and copper arcing tip mounted on the support of the main contact. A flexible copper wire shunt carries the current from the stud to this tip. A copper bolt is carried on the conducting cross-bar of the moving contact element and serves as the moving arcing contact. The auxiliary arcing contacts maintain contact for a considerable distance after the main-contact fingers have broken contact. This time interval is predetermined by the amount of separation of the main contact fingers produced by the steel stop already referred to, and serves to fully protect the main contacts.

The construction is such that the entire breaker may be assembled and lined up and the contacts adjusted from under the frame before placing the tanks in position. This feature of accessibility of contacts is of very material advantage in securing quick and accurate repairs and adjustments.

Breaker with Cover for Mounting an Ammeter—The type F-1 weather-proof breakers with covers for mounting self-contained ammeters are



DETAILS OF TYPE F CONTACTS SHOWING MAIN-CONTACT FINGERS AND ARCING TIPS USED ON 300-AMPERE BREAKERS



TYPE F-1 WEATHERPROOF BREAKER WITH BRACKET FOR MOUNTING AN AMMETER

listed for indoor service only. These ammeter-mounting breakers are dust-proof, but not water-proof. The type SM self-contained ammeter, (the type SR up to, and including, 300 amperes will be shipped until the present stock is exhausted) as described in catalog section 3-B, "Westinghouse Instruments and Relays," is used. The ammeter selected should be such that it will not be injured by the maximum current that may pass through the breaker.

Double-Throw Indoor Breakers

Type F-2 Double-Throw—The type F-2 double-throw breakers have the same features of mountings, contacts, tanks and frames as the hand-operated single-throw type F-2, multipole-single-tank breakers. They have two handles and two moving-contact elements mounted in one tank on one frame. They are regularly supplied with a simple interlocking device, so that only one throw of the breaker can be closed at a time. This interlocking device can be omitted on special order, making possible the transfer of a feeder from one bus to a second bus, which has been synchronized, without opening the feeder circuit.

The double-throw cover-plate on this breaker is approximately of the same dimensions as the single-throw double overload-coil form of plate. It can be equipped with under-voltage or underload device on either or both throws, and either or both throws can be made automatic or non-automatic, as desired.

All the auxiliary features mentioned for use on the single-throw breakers can be used on the double-throw. The double-throw

TYPE F OIL CIRCUIT-BREAKERS—Continued

breakers are not made to be electrically operated.

Special Double-Throw Service—For capacities other than listed as type F-2 double-throw breakers, two single-throw breakers operated remote-control from one (two-handle) double-throw remote-control cover-plate can be supplied with or without interlock and for any of the standard remote-control mountings. For double-throw electrical operation, two single-throw breakers are used, with wiring interlocked; prices on request.

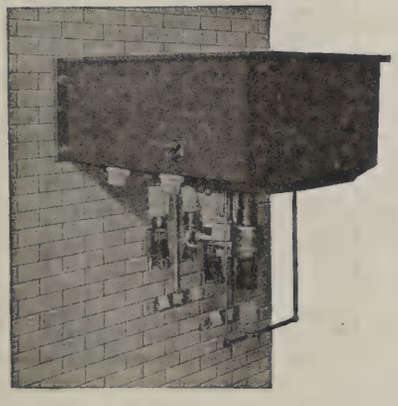
Outdoor Form

The wall-or pole-mounting breakers are listed in the type F-1 and F-3 forms only.

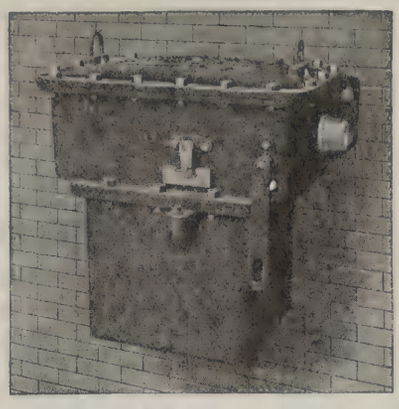
The type F-1 breakers are listed in weatherproof cases, two, three and four-pole. These breakers are manually-operated full-automatic with series-trip coils and adjustable time-element dashpots immersed in the oil, and thus protected from moisture. They can be equipped on special order with a self-resetting undervoltage release device enclosed in the case under the cover. The undervoltage release coils can be connected directly in the circuit on voltages up to 550, but on higher voltages, separate weatherproof voltage transformers are required.

In the 750-volt breakers, the contact support is a slate base and in the 4500-volt it is of vertical porcelain pillars. The terminals are inside the case in the 750-volt breakers, and in the 4500-volt the leads are brought outside the case.

The type F-3 breakers are listed both manually and electrically-operated, in weatherproof case, two and three-pole. They are listed for both full-automatic and non-automatic operation. The full-automatic breakers have series-trip coils and adjustable inverse-time-element dashpots immersed in oil. They can be equipped with 5-ampere coils for use in direct-connection with current transformers or relays for any reasonable tripping range.



TYPE F-2 SUBWAY ELECTRICALLY OPERATED AUTOMATIC SERIES-TRIP WITH INVERSE-TIME-ELEMENT, TWO-POLE SINGLE-THROW 300-AMPERE 7500-VOLT (WITH TANK AND COVER REMOVED)



TYPE F-1 SUBWAY MANUALLY-OPERATED AUTOMATIC SERIES-TRIP WITH REVERSE-TIME-ELEMENT, THREE-POLE SINGLE-THROW 300-AMPERE 7500-VOLT

Subway Form

The subway form of breaker is listed in the type F-1 and F-2 forms only.

The type F-1 breakers are supplied in two and three poles for subway or manhole mounting. They are manually-operated, full-automatic series trip with the trip coils and adjustable inverse-time-element dashpots mounted in the oil inside the case. They are completely waterproof so that they can be immersed, if necessary. The design of contacts and insulating details is similar to the corresponding capacities in the indoor F-1 breakers.

The type F-2 electrically-operated breakers are listed in two and three poles for subway or manhole mounting. They are made for electric operation, full-automatic and non-automatic only, and have series-trip coils and adjustable inverse-time-element dashpots in the oil inside the case.

If desired on special order, 5-ampere trip coils can be supplied and used in connection with current transformers. The electrically-operated non-automatic breakers can be used as automatic by actuating them from appropriate current transformers and shunt trip relays.

Caution—*Care should be taken, when ordering, to specify the proper outlet bushings for subway breakers.*

DETAILS AND ACCESSORIES

See also pages on "Oil Circuit-Breakers—General Information" and pages on "Oil Circuit-Breaker Accessories."

Filler and Drain-Pipe Fittings—The types F-1 and F-2 single-throw breaker tanks are not regularly supplied with filler and drain-pipe fittings. Fittings similar to those furnished on the standard type F-2 double-throw, and type F-3 breakers, can be supplied on special order; prices on request.

TYPE F OIL CIRCUIT-BREAKERS—Continued

INDEX TO TABLES

(According to Application and Method of Mounting)

Service	Type	Operated	Control	Mounting	Trip	Throw	Table
Indoor	F-1	Manually	Direct	Panel	Series, Full-Automatic Transformer, Full-Automatic Non-Automatic	Single	I
			Horizontal-Pull without Bell Cranks	Panel-Frame			
			Remote with Bell Cranks	Wall Pipe	Transformer, Full-Automatic Non-Automatic	Single	II
			Remote Horizontal-Pull without Bell Cranks				
	F-2	Manually	Direct	Panel	Transformer, Full-Automatic Non-Automatic	Single Double	III III
			Remote with Bell Cranks	Wall Pipe	Transformer, Full-Automatic Non-Automatic	Single Double	IV, V* VI
			Remote Horizontal-Pull without Bell Cranks	Wall Pipe	Transformer, Full-Automatic Non-Automatic	Single Double	IV VI
		Electrically	Electric	Wall	Transformer, Plain-Automatic Non-Automatic	Single	VII
				Wall Pipe	Transformer, Plain-Automatic Non-Automatic	Single	VIII*
	F-3	Manually	Direct	Panel	Transformer, Full-Automatic Non-Automatic	Single	IX
			Remote with Bell Cranks	Wall Pipe	Transformer, Full-Automatic Non-Automatic	Single	X, XI†
			Remote Horizontal-Pull without Bell Cranks	Wall Pipe	Transformer, Full-Automatic Non-Automatic	Single	X
		Electrically	Electric	Wall	Transformer, Plain-Automatic Non-Automatic	Single	XII
				Wall Pipe	Transformer, Plain-Automatic Non-Automatic	Single	XIII†
Weather-proof	F-1	Manually	Direct	Wall or Pole	Series, Full-Automatic with Inverse-Time-Limit and Undervoltage	Single	XIV
					Series, Full-Automatic with and without Undervoltage with and without Ammeter-Mounting Bracket	Single	XV
	F-3	Manually	Direct	Wall or Pole	Series, Full-Automatic with Inverse-Time-Limit	Single	XVI
		Electrically	Electric				
Subway	F-1	Manually	Direct	Wall	Series, Full-Automatic with Inverse-Time-Limit	Single	XVII
	F-2	Electrically	Electric				

*Multiple-single-pole.
†Multiple-Multipole.

TYPE F OIL CIRCUIT-BREAKERS—Continued

TABLE I—TYPE F-1 INDOOR MANUALLY-OPERATED SINGLE-THROW

Panel- and Panel-Frame Mounting

Maximum Continuous Amperes	No. Poles	Interrupting Capacity at Rated Voltage Amperes	Gal. Oil	PANEL MOUNTING—Approx. Shipping Wt. Lbs.* Net	Boxed	Style No.	List Price	PANEL-FRAME MOUNTING—HORIZONTAL PULL WITHOUT BELL CRANKS—Approx. Shipping Wt. Lbs.* Net	Boxed	Style No.†	List Price†
Series-Trip Full-Automatic—For Voltages Up to 2500‡											
10	2	1000	4¼	...	149	193603	$125 00	..	161	193627	$134 00
25	2	2500	4¼	...	149	193604	125 00	..	161	193628	134 00
50	2	5000	4¼	...	149	193605	125 00	..	161	192629	134 00
75	2	5700	4¼	...	149	193606	125 00	..	161	193630	134 00
100	2	5700	4¼	...	149	193607	126 00	..	161	193631	134 00
150	2	5700	4¼	...	149	193608	129 00	..	161	193632	137 00
200	2	5700	4¼	...	159	193609	129 00	..	171	193633	137 00
10	3	1000	4¼	...	163	193611	150 00	..	175	193635	161 00
25	3	2500	4¼	...	163	193612	150 00	..	175	193636	161 00
50	3	5000	4¼	...	163	193613	150 00	..	175	193637	161 00
75	3	5700	4¼	...	163	193614	150 00	..	175	193638	161 00
100	3	5700	4¼	...	163	193615	152 00	..	175	193639	161 00
150	3	5700	4¼	...	163	193616	155 00	..	175	193640	165 00
200	3	5700	4¼	...	176	193617	155 00	..	185	193641	165 00
10	4	1000	5½	...	180	193619	200 00	..	194	193643	215 00
25	4	2500	5½	...	180	193620	200 00	..	194	193644	215 00
50	4	5000	5½	...	180	193621	200 00	..	194	193645	215 00
75	4	5700	5½	...	180	193622	200 00	..	194	193646	215 00
100	4	5700	5½	...	180	193623	202 50	..	194	193647	215 00
150	4	5700	5½	...	180	193624	207 50	..	194	193648	220 00
200	4	5700	5½	...	190	193625	207 50	..	204	193649	220 00
Transformer-Trip Full-Automatic—For Voltages Up to 4500§											
Single-Coil											
200	2	2800	4¼	...	147	186234	$120 00	..	...	.....	.....
300	2	2800	4¼	...	157	186246	120 00	..	...	.....	.....
Double-Coil											
200	3	2800	4½	...	163	186235	145 00	..	...	.....	.....
200	4	2800	5½	...	180	186236	193 00	..	...	.....	.....
300	3	2800	4½	...	173	186247	167 00	..	...	.....	.....
300	4	2800	5½	...	190	186248	222 00	..	...	.....	.....
Non-Automatic											
200	2	2800	4¼	...	138	186240	89 50	..	...	.....	.....
200	3	2800	4¼	...	147	186241	108 00	..	...	.....	.....
200	4	2800	5½	...	164	186242	144 00	..	...	.....	.....
300	2	2800	4¼	...	148	186252	107 00	..	...	.....	.....
300	3	2800	4¼	...	158	186253	129 00	..	...	.....	.....
300	4	2800	5½	...	174	186254	172 00	..	...	.....	.....

*Weight does not include oil. Shipping weight of oil is approximately 9 pounds per gallon.

†Style number and price of breaker, include breaker, pipe bracket, and U-bolts for mounting on horizontal pipe 7½ inches back of panel. In addition there will be required panel brackets for pipe or angle frame as listed in catalogue section on "Circuit-Breaker Accessories."

‡Type F-1 Series-Trip Breakers are insulated for 2500-volt service, but it is recommended that their application be limited to service not exceeding 750 volts in accordance with the Electric Power Club Oil Circuit-Breaker Standard Rule Number 151-B. In all cases where series-trip coils would be subjected to heavy voltage surges they must not be used for service in excess of 750 volts.

§Type F-1 transformer-trip and non-automatic circuit-breakers are insulated for 4500-volt service, but it is recommended that their application, as panel or panel frame mounting breakers, be limited to service not exceeding 2500 volts, in accordance with the Electric Power Club Oil Circuit-Breaker Standard Practice Rule Number 150-B.

For information as to what material is furnished with these breakers, see "Instructions for Ordering" on a previous page.

For undervoltage trip, inverse-time limit (dash pots), shunt trip, direct-trip attachments, separate pipe-mounting brackets, see pages following on "Oil Circuit-Breaker Accessories."

Order by Style Number

TYPE F OIL CIRCUIT-BREAKERS—Continued

TABLE II—TYPE F-1 INDOOR MANUALLY-OPERATED SINGLE-THROW

Remote-Control With Bell Cranks

For Voltages Up to 4500

Maximum Continuous Amperes	No. Poles	Interrupting Capacity at Rated Voltage Amperes	Gallons Oil	Approximate Shipping Wt. Lbs.* Net	Approximate Shipping Wt. Lbs.* Boxed	Style No. Bell Cranks Above and Below Floor Wall Mounting	Style No. Bell Cranks Above and Below Floor Pipe Mounting	List Price
Transformer-Trip, Full Automatic								
Single-Coil								
200	2	3600	4¼	...	285	193323	193339	$137 00
300	2	3600	4¼	...	290	193326	193342	137 00
Double-Coil								
200	3	3600	4¼	...	297	193324	193340	165 00
200	4	3600	5½	...	315	193325	193341	220 00
300	3	3600	4¼	...	307	193327	193343	187 00
300	4	3600	5½	...	324	193328	193344	247 00
Non-Automatic								
200	2	3600	4¼	...	243	193317	193333	102 00
200	3	3600	4¼	...	252	193318	193334	123 00
200	4	3600	5½	...	269	193319	193335	164 00
300	2	3600	4¼	...	152	193320	193336	120 00
300	3	3600	4¼	...	162	193321	193337	144 00
300	4	3600	5½	...	179	193322	193338	192 00

Remote-Control, Without Bell Cranks

For Voltages Up to 4500

Maximum Continuous Amperes	No. Poles	Interrupting Capacity at Rated Voltage Amperes	Gallons Oil	Approximate Shipping Wt. Lbs.* Net	Approximate Shipping Wt. Lbs.* Boxed	Style No. Horizontal Pull Wall Mounting	Style No. Horizontal Pull Pipe† Mounting	List Price
Transformer-Trip, Full-Automatic								
Single-Coil								
200	2	2800	4¼	...	169	193355	193398	$130 00
300	2	2800	4¼	...	179	193385	193401	130 00
Double-Coil								
200	3	2800	4¼	...	185	193356	193399	157 00
200	4	2800	5½	...	197	193384	193400	209 00
300	3	2800	4¼	...	200	193386	193402	179 00
300	4	2800	5½	...	212	193387	193403	237 50
Non-Automatic								
200	2	2800	4¼	...	157	193349	193392	99 50
200	3	2800	4¼	...	166	193350	193393	120 00
200	4	2800	5½	...	183	193351	193394	160 00
300	2	2800	4¼	...	167	193352	193395	117 00
300	3	2800	4¼	...	176	193353	193396	141 00
300	4	2800	5½	...	193	193354	193397	188 00

*Weight does not include oil. Shipping weight of oil is approximately 9 pounds per gallon.

†Horizontal-pull pipe-mounting breakers can be made panel-pipe mounting by the use of panel brackets for pipe or angle frame as listed in catalogue section on "Circuit-Breaker Accessories."

For information as to what material is furnished with these breakers, see "Instructions for Ordering" on a previous page.

For undervoltage trip, inverse-time limit (dash pots), shunt trip, direct-trip attachments, separate pipe-mounting bracket, see pages following on "Oil Circuit-Breaker Accessories."

Order by Style Number

TYPE F OIL CIRCUIT-BREAKERS—Continued

TABLE III—TYPE F-2 INDOOR MANUALLY-OPERATED
Panel-Mounting
SINGLE-THROW

Maximum Continuous Amperes	Maximum Volts‡	No. Poles	Interrupting Capacity at Rated Voltage Amperes	Gallons Oil	Approximate Shipping Wt., Lbs.* Net	Boxed	Style No.	List Price
Transformer-Trip, Full-Automatic								
Single-Coil								
300	7500	1	1300	3¼	...	132	186258	$113 00
300	7500	2	1700	6¼	...	172	186259	151 00
500	7500	1	1300	3¼	...	139	186274	139 00
500	7500	2	1700	6¼	...	179	186275	186 00
600	4500	1	2400	3¼	...	142	198804	168 00
600	4500	2	3200	6¼	...	184	198805	222 50
Double-Coil								
300	7500	3	1700	6¼	...	191	186260	182 00
300	7500	4	1700	7½	...	214	186261	242 00
500	7500	3	1700	6¼	...	208	186276	222 50
500	7500	4	1700	7½	...	229	186277	296 00
600	4500	3	3200	6¼	...	217	198806	270 00
600	4500	4	3200	7½	...	246	198807	360 00
Non-Automatic								
300	7500	1	1300	3¼	...	123	186266	90 00
300	7500	2	1700	6¼	...	165	186267	120 00
300	7500	3	1700	6¼	...	175	186268	145 00
300	7500	4	1700	7½	...	298	186269	193 00
500	7500	1	1300	3¼	...	130	186282	115 00
500	7500	2	1700	6¼	...	170	186283	153 50
500	7500	3	1700	6¼	...	192	186284	185 00
500	7500	4	1700	7½	...	218	186285	246 00
600	4500	1	2400	3¼	...	133	198796	143 00
600	4500	2	3200	6¼	...	175	198797	191 00
600	4500	3	3200	6¼	...	201	198798	230 00
600	4500	4	3200	7½	...	230	198799	306 00

DOUBLE-THROW

Transformer-Trip, Full Automatic								
Single-Coil								
300	7500	1	1400	6½	...	248	198828	103 00
300	7500	2	1900	11½	...	284	198829	265 00
500	7500	1	1400	6½	...	260	198832	237 50
500	7500	2	1900	11½	...	302	198833	317 50
600	4500	1	2600	6½	...	266	198836	280 00
600	4500	2	3500	11½	...	310	198837	375 00
Double-Coil								
300	7500	3	1900	11½	...	302	198830	320 00
300	7500	4	1900	15½	...	342	198831	425 00
500	7500	3	1900	11½	...	327	198834	382 50
500	7500	4	1900	15½	...	378	198835	510 00
600	4500	3	3500	11½	...	339	198838	450 00
600	4500	4	3500	15½	...	404	198839	600 00
One Side Full-Automatic Single-Coil and One Side Non-Automatic								
300	7500	1	1400	6½	...	243	198846	194 00
300	7500	2	1900	11½	...	279	198847	260 00
500	7500	1	1400	6½	...	255	198850	232 50
500	7500	2	1900	11½	...	297	198851	312 50
600	4500	1	2600	6½	...	261	198854	275 00
600	4500	2	3500	11½	...	305	198855	367 50
One Side Full-Automatic Double-Coil and One Side Non-Automatic								
300	7500	3	1900	11½	...	297	198848	312 50
300	7500	4	1900	15½	...	337	198849	415 00
500	7500	3	1900	11½	...	322	198852	375 00
500	7500	4	1900	15½	...	373	198853	500 00
600	4500	3	3500	11½	...	334	198856	442 50
600	4500	4	3500	15½	...	399	198857	590 00
Non-Automatic								
300	7500	1	1400	6½	...	227	198816	164 00
300	7500	2	1900	11½	...	263	198817	220 00
300	7500	3	1900	11½	...	281	198818	265 00
300	7500	4	1900	15½	...	321	198819	365 00
500	7500	1	1400	6½	...	238	198820	202 50
500	7500	2	1900	11½	...	289	198821	272 50
500	7500	3	1900	11½	...	306	198822	327 50
500	7500	4	1900	15½	...	357	198823	435 00
600	4500	1	2600	6½	...	244	198824	250 00
600	4500	2	3500	11½	...	289	198825	332 50
600	4500	3	3500	11½	...	318	198826	400 00
600	4500	4	3500	15½	...	383	198827	535 00

*Weight does not include oil. Shipping weight of oil is approximately 9 pounds per gallon.

‡Type F-2 circuit-breakers are insulated for 4500, and 7500 volt service, but it is recommended that their application, as panel mounting breakers, be limited to service not exceeding 2500 volts, in accordance with the Electric Power Club Oil Circuit Breaker Standard Practice Rule Number 150-B.

For information as to what material is furnished with these breakers, see "Instructions for Ordering" on a previous page.

For undervoltage trip, inverse-time limit (dash pots), shunt trip, direct-trip attachments, separate pipe-mounting brackets, see pages following on "Oil Circuit-Breaker Accessories."

Order by Style Number

TYPE F OIL CIRCUIT-BREAKERS—Continued

TABLE IV—TYPE F-2 INDOOR MANUALLY-OPERATED SINGLE-THROW Remote-Control With Bell Cranks

Maximum Continuous Amperes	Max. Volts	No. Poles	Interrupting Capacity At Rated Voltages, Amperes	Gallon Oil	Approx. Shipping Wt., Lb.*	Style No. Bell Cranks Above and Below Floor Wall Mounting	Style No. Bell Cranks Above and Below Floor Pipe Mounting	List Price
Transformer-Trip, Full-Automatic								
Single-Coil								
300	7500	1	1600	3¼	270	208553	208593	$129 00
300	7500	2	2150	6¼	308	208554	208594	172 00
500	7500	1	1600	3¼	275	208561	208601	154 00
500	7500	2	2150	6¼	315	208562	208602	205 00
600	4500	1	3000	3¼	278	208565	208605	183 00
600	4500	2	4000	6¼	320	208566	208606	245 00
Double-Coil								
300	7500	3	2150	6¼	325	208555	208595	207 50
300	7500	4	2150	7½	348	208556	208596	277 50
500	7500	3	2150	6¼	342	208563	208603	247 50
500	7500	4	2150	7½	368	208564	208604	330 00
600	4500	3	4000	6¼	351	208567	208607	295 00
600	4500	4	4000	7½	380	208568	208608	397 50
Non-Automatic								
300	7500	1	1600	3¼	230	208537	208577	100 00
300	7500	2	2150	6¼	270	208538	208578	135 00
300	7500	3	2150	6¼	282	208539	208579	162 50
300	7500	4	2150	7½	305	208540	208580	207 50
500	7500	1	1600	3¼	237	208545	208585	127 00
500	7500	2	2150	6¼	277	208546	208586	170 00
500	7500	3	2150	6¼	299	208547	208587	205 00
500	7500	4	2150	7½	325	208548	208588	272 50
600	4500	1	3000	3¼	240	208549	208589	155 00
600	4500	2	4000	6¼	282	208550	208590	207 50
600	4500	3	4000	6¼	308	208551	208591	250 00
600	4500	4	4000	7½	340	208552	208592	332 50

***Weight does not include oil. Shipping weight of oil is approximately 9 pounds per gallon.**

For information as to what material is furnished with these breakers, see "Instructions for Ordering" on a previous page.

For undervoltage trip, inverse-time limit (dash pots), shunt trip, direct-trip attachments, separate pipe-mounting brackets, see pages following on "Oil Circuit-Breaker Accessories."

Order by Style Number

TYPE H OIL CIRCUIT-BREAKERS—Continued

TABLE IV—TYPE F-2 INDOOR MANUALLY-OPERATED SINGLE-THROW
(Continued)

Remote-Control Without Bell Cranks

Maximum Continuous Amperes	Maximum Volts	No. Poles	Interrupting Capacity at Rated Voltage Amperes	Gallon Oil	Approximate Shipping Wt., Lbs.*	Style No. Horizontal Pull† Wall Mounting	Style No. Horizontal Pull† Pipe Mounting	List Price
Transformer-Trip, Full-Automatic								
Single-Coil								
300	7500	1	1300	3¼	154	208633	208673	$121 00
300	7500	2	1700	6¼	201	208634	208674	162 00
500	7500	1	1300	3¼	161	208641	208681	146 00
500	7500	2	1700	6¼	208	208642	208682	195 00
600	4500	1	2400	3¼	164	208645	208685	177 00
600	4500	2	3200	6¼	213	208646	208686	237 50
Double-Coil								
300	7500	3	1700	6¼	213	208635	208675	195 00
300	7500	4	1700	7½	236	208636	208676	260 00
500	7500	3	1700	6¼	230	208643	208683	235 00
500	7500	4	1700	7½	256	208644	208684	312 50
600	4500	3	3200	6¼	239	208647	208687	285 00
600	4500	4	3200	7½	268	208648	208688	380 00
Non-Automatic								
300	7500	1	1300	3¼	142	208617	208657	98 00
300	7500	2	1700	6¼	182	208618	208658	131 00
300	7500	3	1700	6¼	194	208619	208659	157 50
300	7500	4	1700	7½	217	208620	208660	210 00
500	7500	1	1300	3¼	149	208625	208665	124 00
500	7500	2	1700	6¼	189	208626	208666	186 00
500	7500	3	1700	6¼	211	208627	208667	200 00
500	7500	4	1700	7½	237	208628	208668	266 00
600	4500	1	2400	3¼	152	208629	208669	150 00
600	4500	2	3200	6¼	194	208630	208670	202 50
600	4500	3	3200	6¼	220	208631	208671	242 50
600	4500	4	3200	7½	249	208632	208672	322 50

*Weight does not include oil. Shipping weight of oil is approximately 9 pounds per gallon.

†Horizontal-pull pipe-mounting breakers can be made panel-pipe mounting by the use of panel brackets for pipe or angle frame as listed in catalogue section on "Circuit-Breaker Accessories."

For information as to what material is furnished with these breakers, see "Instructions for Ordering" on a previous page.

For undervoltage trip, inverse-time limit (dash pots), shunt trip, direct-trip attachments, separate pipe-mounting brackets, see pages following on "Oil Circuit-Breaker Accessories."

Order by Style Number

TYPE F OIL CIRCUIT-BREAKERS—Continued

TABLE V—TYPE F-2 INDOOR MANUALLY-OPERATED SINGLE-THROW Remote-Control With Bell Cranks

Multiple-Single-Pole
(Multipole Breakers Using Single-Pole Units)

Maximum Continuous Amperes	Max. Volts	No. Poles	Interrupting Capacity At Rated Voltages, Amperes	Gallon Oil	Approx. Shipping Wt., Lb.*	Style No. Bell Cranks Above and Below Floor Wall Mounting	Style No. Bell Cranks Above and Below Floor Pipe Mounting	List Price
Transformer-Trip, Full-Automatic								
Single-Coil								
300	7500	2	2900	6½	377	198740	198772	$240 00
500	7500	2	2900	6½	391	198746	198778	272 50
600	4500	2	5400	6½	397	198749	198781	305 00
Double-Coil								
300	7500	3	2900	9¾	474	198741	198773	287 50
300	7500	4	2900	13	559	198742	198774	382 50
500	7500	3	2900	9¾	495	198747	198779	327 50
500	7500	4	2900	13	588	198748	198780	435 00
600	4500	3	5400	9¾	504	198750	198782	367 50
600	4500	4	5400	13	600	198751	198783	490 00
Non-Automatic								
300	7500	2	2900	6½	340	194453	198760	202 50
300	7500	3	2900	9¾	430	194454	198761	242 50
300	7500	4	2900	13	515	194455	198762	322 50
500	7500	2	2900	6½	354	194459	198766	235 00
500	7500	3	2900	9¾	451	194460	198767	282 50
500	7500	4	2900	13	543	194461	198768	377 50
600	4500	2	5400	6½	360	194462	198769	270 00
600	4500	3	5400	9¾	460	194463	198770	322 50
600	4500	4	5400	13	555	194464	198771	432 50

*Weight does not include oil. Shipping weight of oil is approximately 9 pounds per gallon.

For information as to what material is furnished with these breakers, see "Instructions for Ordering" on a previous page.

For undervoltage trip, inverse-time limit (dash pots), shunt trip, direct-trip attachments, separate pipe-mounting brackets, [illegible] pages following on "Oil Circuit-Breaker Accessories."

Order by Style Number

TYPE F OIL CIRCUIT-BREAKERS—Continued

TABLE VI—TYPE F-2 INDOOR MANUALLY-OPERATED DOUBLE-THROW

Remote-Control With Bell Cranks

Maximum Continuous Amperes	Max. Volts	No. Poles	Interrupting Capacity At Rated Voltages, Amperes	Gallon Oil	Approx. Shipping Wt., Lb.*	Style No. Bell Cranks Above and Below Floor Wall Mounting	Style No. Bell Cranks Above and Below Floor Pipe Mounting	List Price
Transformer-Trip, Full-Automatic								
Single-Coil								
300	7500	1	1800	6½	410	209289	209331	$215 00
300	7500	2	2400	11½	467	209290	209332	285 00
500	7500	1	1800	6½	422	209293	209335	252 50
500	7500	2	2400	11½	485	209294	209336	340 00
600	4500	1	3400	6½	428	209297	209339	295 00
600	4500	2	4500	11½	493	209298	209340	395 00
Double-Coil								
300	7500	3	2400	11½	486	209291	209333	345 00
300	7500	4	2400	15½	521	209292	209334	460 00
500	7500	3	2400	11½	511	209295	209337	407 50
500	7500	4	2400	15½	557	209296	209338	545 00
600	4500	3	4500	11½	523	209299	209341	475 00
600	4500	4	4500	15½	583	209300	209342	635 00
One Side Full-Automatic Single-Coil and One Side Non-Automatic								
300	7500	1	1800	6½	380	209307	209343	210 00
300	7500	2	2400	11½	437	209308	209344	280 00
500	7500	1	1800	6½	392	209311	209347	250 00
500	7500	2	2400	11½	455	209312	209348	332 50
600	4500	1	3400	6½	398	209315	209351	290 00
600	4500	2	4500	11½	463	209316	209352	390 00
One Side Full-Automatic Double-Coil and One Side Non-Automatic								
300	7500	3	2400	11½	455	209309	209345	337 50
300	7500	4	2400	15½	490	209310	209346	450 00
500	7500	3	2400	11½	480	209313	209349	400 00
500	7500	4	2400	15½	526	209314	209350	535 00
600	4500	3	4500	11½	492	209317	209353	467 50
600	4500	4	4500	15½	552	209318	209354	625 00
Non-Automatic								
300	7500	1	1800	6½	338	209277	209319	180 00
300	7500	2	2400	11½	388	209278	209320	240 00
300	7500	3	2400	11½	406	209279	209321	290 00
300	7500	4	2400	15½	441	209280	209322	385 00
500	7500	1	1800	6½	350	209281	209323	220 00
500	7500	2	2400	11½	406	209282	209324	292 50
500	7500	3	2400	11½	431	209283	209325	352 50
500	7500	4	2400	15½	477	209284	209326	470 00
600	4500	1	3400	6½	356	209285	209327	262 00
600	4500	2	4500	11½	414	209286	209328	352 50
600	4500	3	4500	11½	443	209287	209329	425 00
600	4500	4	4500	15½	503	209288	209330	565 00

*Weight does not include oil. Shipping weight of oil is approximately 9 pounds per gallon.

For information as to what material is furnished with these breakers, see "Instructions for Ordering" on a previous page.

For undervoltage trip, inverse-time limit (dash pots), shunt trip, direct-trip attachments, separate pipe-mounting brackets, see pages following on "Oil Circuit-Breaker Accessories."

Order by Style Number

TYPE F OIL CIRCUIT-BREAKERS—Continued

TABLE VI—TYPE F-2—INDOOR MANUALLY-OPERATED DOUBLE-THROW
(Continued)

Remote-Control Without Bell Cranks

Maximum Continuous Amperes	Maximum Volts	No. Poles	Interrupting Capacity at Rated Voltage Amperes	Gallon Oil	Approximate Shipping Wt., Lbs.*	Style No. Horizontal Pull† Wall Mounting	Style No. Horizontal Pull† Pipe Mounting	List Price
Transformer-Trip, Full Automatic								
Single-Coil								
300	7500	1	1400	6½	268	209397	209439	$217 50
300	7500	2	1900	11½	304	209398	209440	275 00
500	7500	1	1400	6½	280	209401	209443	245 00
500	7500	2	1900	11½	322	209402	209444	327 50
600	4500	1	2600	6½	286	209405	209447	287 50
600	4500	2	3500	11½	330	209406	209448	385 00
Double-Coil								
300	7500	3	1900	11½	322	209399	209441	332 00
300	7500	4	1900	15½	362	209400	209442	442 50
500	7500	3	1900	11½	347	209403	209445	395 00
500	7500	4	1900	15½	398	209404	209446	525 00
600	4500	3	3500	11½	359	209407	209449	462 50
600	4500	4	3500	15½	424	209408	290450	615 00
One Side Full-Automatic Single-Coil and One Side Non-Automatic								
300	7500	1	1400	6½	263	209409	209451	202 50
300	7500	2	1900	11½	299	209410	209452	270 00
500	7500	1	1400	6½	275	209413	209455	240 00
500	7500	2	1900	11½	357	209414	209456	322 50
600	4500	1	2600	6½	281	209417	209459	282 50
600	4500	2	3500	11½	325	209418	209460	377 50
One Side Full-Automatic Double-Coil and One Side Non-Automatic								
300	7500	3	1900	11½	317	209411	209453	325 00
300	7500	4	1900	15½	357	209412	209454	432 50
500	7500	3	1900	11½	342	209415	209457	387 50
500	7500	4	1900	15½	393	209416	209458	515 00
600	4500	3	3500	11½	354	209419	209461	455 00
600	4500	4	3500	15½	419	209420	209462	605 00
Non-Automatic								
300	7500	1	1400	6½	247	209385	209427	172 00
300	7500	2	1900	11½	283	209386	209428	230 00
300	7500	3	1900	11½	301	209387	209429	277 50
300	7500	4	1900	15½	341	209388	209430	370 00
500	7500	1	1400	6½	258	209389	209431	212 50
500	7500	2	1900	11½	301	209390	209432	282 50
500	7500	3	1900	11½	326	209391	209433	340 00
500	7500	4	1900	15½	377	209392	209434	452 50
600	4500	1	2600	6½	264	209393	209435	257 50
600	4500	2	3500	11½	309	209394	209436	342 50
600	4500	3	3500	11½	338	209395	209437	412 50
600	4500	4	3500	15½	403	209396	209438	550 00

*Weight does not include oil. Shipping weight of oil is approximately 9 pounds per gallon.

†Horizontal-pull pipe-mounting breakers can be made panel-pipe mounting by the use of panel brackets for pipe or angle frame as listed in catalogue section on "Circuit-Breaker Accessories".

For information as to what material is furnished with these breakers, see "Instructions for Ordering," on a previous page.

For undervoltage trip, inverse-time limit (dash pots), shunt trip, direct-trip attachments, separate pipe-mounting brackets [illegible] pages following on "Oil Circuit-Breaker Accessories."

Order by Style Number

TYPE F OIL CIRCUIT-BREAKERS—Continued

TABLE VII—TYPE F-2 INDOOR ELECTRICALLY-OPERATED SINGLE-THROW

Maximum Continuous Amperes	Maximum Volts	No. Poles	Interrupting Capacity At Rated Voltage Amperes	Gal. Oil	Approx. Shipping Wt., Lb.*	Style No.	List Price
Wall-Mounting, Transformer-Trip, Full Automatic							
			Single-Coil				
300	7500	1	1300	3¼	178	208817	$185 00
300	7500	2	1700	6¼	236	208818	225 00
500	7500	1	1300	3¼	185	208825	215 00
500	7500	2	1700	6¼	243	208826	260 00
600	4500	1	2400	3¼	188	208829	240 00
600	4500	2	3200	6¼	248	208830	295 00
			Double-Coil				
300	7500	3	1700	6¼	248	208819	265 00
300	7500	4	1700	7½	276	208820	325 00
500	7500	3	1700	6¼	265	208827	305 00
500	7500	4	1700	7½	296	208828	375 00
600	4500	3	3200	6¼	274	208831	350 00
600	4500	4	3200	7½	298	208832	440 00
Wall-Mounting, Non-Automatic							
300	7500	1	1300	3¼	168	208777	160 00
300	7500	2	1700	6¼	226	208778	190 00
300	7500	3	1700	6¼	238	208779	225 00
300	7500	4	1700	7½	266	208780	275 00
500	7500	1	1300	3¼	175	208785	185 00
500	7500	2	1700	6¼	233	208786	220 00
500	7500	3	1700	6¼	255	208787	265 00
500	7500	4	1700	7½	286	208788	325 00
600	4500	1	2400	3¼	178	208789	210 00
600	4500	2	3200	6¼	238	208790	260 00
600	4500	3	3200	6¼	264	208791	310 00
600	4500	4	3200	7½	298	208792	385 00

For omission of current-transformer trip coils from above listed breakers deduct $12.50 from the list price of single-coil breakers and $25.00 from the list price of double-coil breakers.

*Weight does not include oil. Shipping weight of oil is approximately 9 pounds per gallon

Pipe-Mounting

For pipe-mounting breakers order wall-mounting breakers as listed above and, for each breaker order in addition, three U-bolts, Style No. 124586, which will be supplied without additional charge when ordered with a breaker.

For information as to what material is furnished with these breakers, see "Instructions for Ordering" on a previous page.

For undervoltage trip, inverse-time limit (dash pots), shunt trip, direct-trip attachments, separate pipe-mounting brackets, see pages following on "Oil Circuit-Breaker Accessories."

Order by Style Number

TYPE F OIL CIRCUIT-BREAKERS—Continued

TABLE VIII—TYPE F-2 INDOOR ELECTRICALLY-OPERATED SINGLE-THROW

Multiple-Single-Pole

(Multipole Breakers Using Single-Pole Units)

Max. Continuous Amperes	Max. Volts	No. Poles	Interrupting Capacity at Rated Voltage Amperes	Gal. Oil	Approx. Shipping Wt., Lb.*	Style No. Mechanism Mounted Above or Below Breaker Wall Mounting	Style No. Mechanism Mounted Above or Below Breaker Pipe Mounting	Style No. Mechanism Mounted Behind Breaker Wall Mounting	Style No. Mechanism Mounted Behind Breaker Pipe Mounting	List Price
Transformer-Trip, Plain-Automatic										
Single-Coil										
300	7500	2	2900	6½	545	208853	208949	208885	208981	$410 00
500	7500	2	2900	6½	559	208859	208955	208891	208987	442 50
600	4500	2	5400	6½	565	208862	208958	208894	208990	475 00
Double-Coil										
300	7500	3	2900	9¾	635	208854	208950	208886	208982	457 50
300	7500	4	2900	13	720	208855	208951	208887	208983	555 00
500	7500	3	2900	9¾	656	208860	208956	208892	208988	497 50
500	7500	4	2900	13	748	208861	208957	208893	208989	605 00
600	4500	3	5400	9¾	665	208863	208959	208895	208991	535 00
600	4500	4	5400	13	760	208864	208960	208896	208992	660 00
Non-Automatic										
300	7500	2	2900	6½	535	208841	208937	208873	208969	372 50
300	7500	3	2900	9¾	625	208842	208938	208874	208970	412 50
300	7500	4	2900	13	710	208843	208939	208875	208971	492 50
500	7500	2	2900	6½	549	208847	208943	208879	208975	405 00
500	7500	3	2900	9¾	646	208848	208944	208880	208976	452 50
500	7500	4	2900	13	738	208849	208945	208881	208977	547 50
600	4500	2	5400	6½	555	208850	208946	208882	208978	440 00
600	4500	3	5400	9¾	655	208851	208947	208883	208979	492 50
600	4500	4	5400	13	750	208852	208948	208884	208980	600 00

TABLE IX—TYPE F-3 INDOOR MANUALLY-OPERATED SINGLE-THROW

Panel Mounting

Maximum Continuous Amperes	Maximum‡ Volts	No. Poles	Amperes Interrupting Capacity at Rated Voltage	Gal. Oil	Approx. Shipping Wt., Lb.*	Style No.	List Price
Transformer-Trip, Full-Automatic							
Single-Coil							
500	13200	2	1250	10½	284	209583	$215 00
800	4500	2	3600	8	286	209586	265 00
Double-Coil							
500	13200	3	1250	10½	299	209584	267 50
500	13200	4	1250	14	338	209585	332 50
800	4500	3	3600	8	302	209587	327 50
800	4500	4	3600	11	342	209588	402 50
Non-Automatic							
500	13200	2	1250	10½	275	209577	181 00
500	13200	3	1250	10½	283	209578	230 00
500	13200	4	1250	14	322	209579	295 00
800	4500	2	3600	8	277	209580	230 00
800	4500	3	3600	8	286	209581	290 00
800	4500	4	3600	11	326	209582	365 00

*Weight does not include oil Shipping weight of oil is approximately 9 pounds per gallon.

‡Type F-3 circuit-breakers are insulated for 4500 and 13200-volt service, but it is recommended that their application as panel-mounting breakers be limited to service not exceeding 2500 volts, in accordance with the Electric Power Club Oil Circuit-Breaker Standard Practice Rule Number 150-B.

For information as to what material is furnished with these breakers, see "Instructions for Ordering" on a previous page. For undervoltage trip, inverse-time limit (dash pots), shunt trip, direct-trip attachments, separate pipe-mounting brackets, see pages following on "Oil Circuit-Breaker Accessories."

Order by Style Number

TYPE F OIL CIRCUIT-BREAKERS—Continued

TABLE X—TYPE F-3 INDOOR MANUALLY-OPERATED SINGLE-THROW

Remote-Control With Bell Cranks

Maximum Continuous Amperes	Max. Volts	No. Poles	Interrupting Capacity At Rated Voltages, Amperes	Gallon Oil	Approx. Shipping Wt., Lb.*	Style No. Bell Cranks Above and Below Floor Wall Mounting	Style No. Bell Cranks Above and Below Floor Pipe Mounting	List Price
Transformer-Trip, Full-Automatic								
Single-Coil								
500	13200	2	1500	10½	425	209631	209647	$245 00
800	4500	2	4400	■	427	209634	209650	295 00
Double-Coil								
500	13200	3	1500	10½	440	209632	209648	305 00
500	13200	4	1500	14	479	209633	209649	370 00
800	4500	3	4400	8	443	209635	209651	365 00
800	4500	4	4400	11	483	209636	209652	440 00
Non-Automatic								
500	13200	2	1500	10½	387	209625	209641	200 00
500	13200	3	1500	10½	395	209626	209642	250 00
500	13200	4	1500	14	434	209627	209643	315 00
800	4500	2	4400	■	389	209628	209644	250 00
800	4500	3	4400	■	398	209629	209645	310 00
800	4500	4	4400	11	438	209630	209646	385 00

Remote-Control Without Bell Cranks

Maximum Continuous Amperes	Maximum Volts	No. Poles	Interrupting Capacity at Rated Voltage Amperes	Gallon Oil	Approximate Shipping Wt., Lbs.*	Style No. Horizontal Pull† Wall Mounting	Style No. Horizontal Pull† Pipe Mounting	List Price
Transformer-Trip, Full-Automatic								
Single-Coil								
500	13200	2	1250	10½	304	209663	209679	$215 00
800	4500	2	3600	8	306	209666	209682	265 00
Double-Coil								
500	13200	3	1250	10½	320	209664	209680	265 00
500	13200	4	1250	14	358	209665	209681	330 00
800	4500	3	3600	■	322	209667	209683	325 00
800	4500	4	3600	11	363	209668	209684	400 00
Non-Automatic								
500	13200	2	1250	10½	295	209657	209673	187 00
500	13200	3	1250	10½	303	209658	209674	237 00
500	13200	4	1250	14	342	209659	209675	302 50
800	4500	2	3600	■	297	209660	209676	237 00
800	4500	3	3600	■	306	209661	209677	297 50
800	4500	4	3600	11	346	209662	209678	372 50

*Weight does not include oil. Shipping weight of oil is approximately 9 pounds per gallon.

†Horizontal-pull pipe mounting breakers can be made panel-pipe mounting by the use of panel brackets for pipe or angle frame as listed in catalogue section on "Circuit Breaker Accessories."

For information as to what material is furnished with these breakers, see "Instructions for Ordering" on ■ previous page.

For undervoltage trip, inverse-time limit (dash pots), shunt trip, direct-trip attachments, separate pipe-mounting brackets see pages following on "Oil Circuit-Breaker Accessories."

Order by Style Number

TYPE F OIL CIRCUIT-BREAKERS—Continued

TABLE XI—TYPE F-3 INDOOR MANUALLY-OPERATED SINGLE-THROW Multiple-Multipole

Maximum Continuous Amperes 25 Cycle	Maximum Continuous Amperes 60 Cycle	Maximum Volts	Poles	‡Interrupting Capacity at Rated Voltages Amperes	Each Pole of Complete Breaker Made Up of One Type F-3 Standard Unit‡ as Follows Poles	Each Pole of Complete Breaker Made Up of One Type F-3 Standard Unit‡ as Follows Amperes	Style No. Bell Cranks Above and Below Floor Wall Mounting	Style No. Bell Cranks Above and Below Floor Pipe Mounting	List Price
§Transformer-Trip, Full-Automatic With Single-Handle									
1500	1200	13200	2	2600	3	500	234181	234193	$ 650 00
1500	1200	13200	3	2600	3	500	234182	234194	950 00
1500	1200	13200	4	2600	3	500	234183	234195	1240 00
2000	1600	13200	2	3500	4	500	234184	234196	790 00
2000	1600	13200	3	3500	4	500	234185	234197	1150 00
2000	1600	13200	4	3500	4	500	234186	234198	1520 00
2400	2000	4500	2	7600	3	800	234187	234199	790 00
2400	2000	4500	3	7600	3	800	234188	234200	1140 00
2400	2000	4500	4	7600	3	800	234189	234201	1510 00
3000	2400	4500	2	10100	4	800	234190	234202	965 00
3000	2400	4500	3	10100	4	800	234191	234203	1380 00
3000	2400	4500	4	10100	4	800	234192	234204	1880 00
Non-Automatic With Single Handle									
1500	1200	13200	2	2600	3	500	234277	234289	560 00
1500	1200	13200	3	2600	3	500	234278	234290	820 00
1500	1200	13200	4	2600	3	500	234279	234291	1060 00
2000	1600	13200	2	3500	4	500	234280	234292	700 00
2000	1600	13200	3	3500	4	500	234281	234293	1020 00
2000	1600	13200	4	3500	4	500	234282	234294	1340 00
2400	2000	4500	2	7600	3	800	234283	234295	700 00
2400	2000	4500	3	7600	3	800	234284	234296	1010 00
2400	2000	4500	4	7600	3	800	234285	234297	1330 00
3000	2400	4500	2	10100	4	800	234286	234298	875 00
3000	2400	4500	3	10100	4	800	234287	234299	1250 00
3000	2400	4500	4	10100	4	800	234288	234300	1700 00

‡Standard three- or four-pole remote-control units as listed in table X are used.

§Two-pole forms are single coil; three and four-pole forms are double coil. Single or three-coil coverplates can be supplied on three and four-pole forms on special order, prices on application.

Oil and Shipping Weights—For amount of oil and total shipping weight use the figure specified in table X for standard type F-3 units used as shown in the sixth and seventh columns above, and multiply by the number of poles.

Outlines and Dimensions—For outlines of operating mechanism see "Index to Outline Dimensions" on following pages. For outlines and dimensions of breaker units see dimensions applying to the style numbers of individual units used. Overall dimensions of the combinations of several units and of the operating mechanism supplied on request.

TABLE XII—TYPE F-3 INDOOR ELECTRICALLY-OPERATED SINGLE-THROW

Maximum Continuous Amperes	Maximum Volts	No. Poles	Interrupting Capacity At Rated Voltage Amperes	Gal Oil	Approx. Shipping Wt., Lb.	Style No.	List Price
Wall Mounting							
Transformer-Trip, Plain-Automatic							
Single-Coil							
500	13200	2	1250	10½	429	209727	$415 00
500	13200	3	1250	10½	432	209733	465 00
500	13200	4	1250	14	471	209734	530 00
800	4500	2	3600	8	431	209730	465 00
800	4500	3	3600	8	435	209735	525 00
800	4500	4	3600	11	475	209736	600 00
Double-Coil							
500	13200	3	1250	10½	437	209728	485 00
500	13200	4	1250	14	476	209729	550 00
800	4500	3	3600	8	440	209731	545 00
800	4500	4	3600	11	480	209732	620 00
Non-Automatic							
500	13200	2	1250	10½	425	209721	365 00
500	13200	3	1250	10½	432	209722	415 00
500	13200	4	1250	14	471	209723	480 00
800	4500	2	3600	8	426	209724	415 00
800	4500	3	3600	8	435	209725	475 00
800	4500	4	3600	11	475	209726	550 00

Pipe-Mounting

For Pipe-mounting breakers order wall-mounting breakers as listed above, and for each breaker order in addition, three U-bolts, Style No. 124586, which will be supplied without additional charge when ordered with breaker.

For information as to what material is furnished with these breakers, see "Instructions for Ordering" on a previous page.

For undervoltage trip, inverse-time limit (dash pots), shunt trip, direct-trip attachments, separate pipe-mounting brackets, see pages following on "Oil Circuit-Breaker Accessories."

Order by Style Number

TYPE F OIL CIRCUIT-BREAKERS—Continued

TABLE XIII—TYPE F-3 INDOOR ELECTRICALLY-OPERATED SINGLE-THROW

Mutliple-Multipole

With Floor-Mounting Mechanism and Bell Cranks

Maximum Continuous Amperes 25 Cycle	Maximum Continuous Amperes 60 Cycle	Maximum Volts	§Poles	‡Interrupting Capacity at Rated Voltages Amperes	Each Pole of Complete Breaker Made Up of One Type F-3 Standard Unit‡ as Follows Poles	Each Pole of Complete Breaker Made Up of One Type F-3 Standard Unit‡ as Follows Amperes	—— Style No. —— Bell Cranks Above and Below Floor Wall Mounting	—— Style No. —— Bell Cranks Above and Below Floor Pipe Mounting	List Price
‡Transformer-Trip, Full-Automatic									
1500	1200	13200	2	2600	3	500	234373	234385	$1210 00
1500	1200	13200	3	2600	3	500	234374	234386	1480 00
1500	1200	13200	4	2600	3	500	234375	234387	1710 00
2000	1600	13200	2	3500	4	500	234376	234388	1350 00
2000	1600	13200	3	3500	4	500	234377	234389	1680 00
2000	1600	13200	4	3500	4	500	234378	234390	2000 00
2400	2000	4500	2	7600	3	800	234379	234391	1350 00
2400	2000	4500	3	7600	3	800	234380	234392	1670 00
2400	2000	4500	4	7600	3	800	234381	234393	1980 00
3000	2400	4500	2	10100	4	800	234382	234394	1530 00
3000	2400	4500	3	10100	4	800	234383	234395	1910 00
3000	2400	4500	4	10100	4	800	234384	234396	2360 00
Non-Automatic									
1500	1200	13200	2	2600	3	500	234421	234433	1130 00
1500	1200	13200	3	2600	3	500	234422	234434	1400 00
1500	1200	13200	4	2600	3	500	234423	234435	1630 00
2000	1600	13200	2	3500	4	500	234424	234436	1270 00
2000	1600	13200	3	3500	4	500	234425	234437	1600 00
2000	1600	13200	4	3500	4	500	234426	234438	1920 00
2400	2000	4500	2	7600	3	800	234427	234439	1270 00
2400	2000	4500	3	7600	3	800	234428	234440	1590 00
2400	2000	4500	4	7600	3	800	234429	234441	1900 00
3000	2400	4500	2	10100	4	800	234430	234442	1450 00
3000	2400	4500	3	10100	4	800	234431	234443	1830 00
3000	2400	4500	4	10100	4	800	234432	234444	2280 00

‡Standard three- or four-pole remote-control units as listed in table XII are used.

§Two-pole forms are single coil; three and four-pole are double coil.

Oil and Shipping Weights—For amount of oil and total shipping weight use the figure supplied in table XII for standard type F-3 units used as shown in the sixth and seventh columns above, and multiply by the number of poles.

Outline Dimensions—For outlines of operating mechanism see "Index to Outline Dimensions" on following pages. For outline and dimensions of breaker units see dimensions applying to the style numbers of individual units used. Overall dimensions of the combinations of several units and of the operating mechanism supplied on request.

For information as to what material is furnished with these breakers, see "Instructions for Ordering" on a previous page.

For undervoltage trip, inverse-time limit (dash pots), shunt trip, direct-trip attachments, separate pipe-mounting brackets see pages following on "Oil Circuit-Breaker Accessories."

Order by Style Number

TYPE F OIL CIRCUIT-BREAKERS—Continued

TABLE XIV—TYPE F-1 WEATHERPROOF MANUALLY-OPERATED SINGLE-THROW

Series-Trip Full-Automatic With Inverse-Time-Limit Attachment

Maximum Continuous Amperes	Interrupting Capacity At Rated Voltage, Amperes	Two-Pole Style No.	Two-Pole List Price	Three-Pole Style No.	Three-Pole List Price	Four-Pole Style No.	Four-Pole List Price
		For Voltages up to 750					
5	500	205192	$112 00	205202	$135 00	205212	$180 00
10	1000	205193	112 00	205203	135 00	205213	180 00
15	1500	205194	112 00	205204	135 00	205214	180 00
25	2500	205195	112 00	205205	135 00	205215	180 00
50	5000	205196	112 00	205206	135 00	205216	180 00
75	7500	205197	112 00	205207	135 00	205217	180 00
100	10000	205198	112 00	205208	135 00	205218	180 00
150	10000	205199	128 00	205209	155 00	205219	205 00
200	10000	205200	131 00	205210	157 00	205220	210 00
300	15000	205201	134 00	205211	160 00	205221	215 00
		For Voltages up to 4500					
5	500	205222	141 00	205231	170 00	205240	225 00
10	1000	205223	141 00	205232	170 00	205241	225 00
15	1500	205224	141 00	205233	170 00	205242	225 00
25	1600	205225	141 00	205234	170 00	205243	225 00
50	1600	205226	143 00	205235	173 00	205244	230 00
75	1600	205227	143 00	205236	173 00	205245	230 00
100	1600	205228	143 00	205237	173 00	205246	230 00
150	1600	205229	158 00	205238	190 00	205247	250 00
200	1600	205230	162 00	205239	195 00	205248	260 00

	For Voltages up to 750		For Voltages up to 4500	
Poles	Gallons Oil	Approximate Shipping Wt., *Lb.	Gallons Oil	Approximate Shipping Wt., * Lb.
2	4½	150	4½	155
3	4½	155	4½	160
4	6	175	6	182

Ammeter-Mounting Covers ‡

These covers replace the covers ordinarily furnished and provide a suitable mounting for an ammeter as previously described.

Description	Additional List Price
For 2 and 3-pole breakers	$15 00
For 4-pole breakers	16 50

Undervoltage Release Attachments †‡

For Use Only When Ordered Complete with Breaker

Description	Style No.	Additional List Price — Mechanism Complete With Coil, Voltage 110–220	Additional List Price — Mechanism Complete With Coil, Voltage 440–550
Mechanism with cover for 2 and 3-pole, 750 volt breakers above	205249	$37 00	$39 00
Mechanism with cover for 4-pole 750 volt breakers above	205250	37 00	39 00
Mechanism for 2, 3, and 4-pole, 4500-volt breakers above	205251	37 00	39 00

*Weight does not include oil. Shipping weight of oil is approximately 9 pounds per gallon.

†In ordering undervoltage release specify style number and state voltage and frequency of circuit. The standard voltage coils are 110, 220, 440, and 550 volts for 25 and 60-cycle circuits. Other voltages and frequencies are special with prices on application. For use on voltages over 750, specify 110-volt coil and order in addition the necessary voltage transformer. See pages on "Voltage Transformers" in section on "Instruments and Relays" for style number and price.

‡Table XV lists style numbers of complete breakers with and without ammeter-mounting cover and with and without undervoltage release attachment.

For information as to what material is furnished with these breakers, see "Instructions for Ordering" on a previous page

For undervoltage trip, inverse-time limit (dash pots), shunt trip, direct-trip attachments, separate pipe-mounting brackets see pages following on "Oil Circuit-Breaker Accessories."

Order by Style Number

TYPE F OIL CIRCUIT-BREAKERS—Continued

TABLE XV—TYPE F-1 WEATHERPROOF MANUALLY-OPERATED SINGLE-THROW

Series-Trip Automatic-Overload With Inverse-Time-Limit Attachment

Rating of Under Voltage Trip Coil 25-Cycle	60-Cycle	Poles	Ap'rox. Shipping Wt.* Lb. Net	Style No. 5-amp.	10-amp.	15-amp.	25-amp.	50-amp.	75-amp.	100-amp.	150-amp.	200-amp.	300-amp.	List Price
Without Ammeter Mounting Cover—With Undervoltage Release Attachment‡														
For Voltages up to 750														
110	220	2	150	268761	268762	268763	268764	268765	268766	268767	268768	268769	268770	§
110	220	3	165	268771	268772	268773	268774	268775	268776	268777	268778	268779	268780	§
110	220	4	185	268781	268782	268783	268784	268785	268786	268787	268788	268789	268790	§
220	(440 or 550)	2	150	268791	268792	268793	268794	268795	268796	268797	268798	268799	268800	§
220	(440 or 550)	3	165	268801	268802	268803	268804	268805	268806	268807	268808	268809	268810	§
220	(440 or 550)	4	185	268811	268812	268813	268814	268815	268816	268817	268818	268819	268820	§
440	.....	2	150	268821	268822	268823	268824	268825	268826	268827	268828	268829	268830	§
440	.....	3	165	268831	268832	268833	268834	268835	268836	268837	268838	268839	268840	§
440	.....	4	185	268841	268842	268843	268844	268845	268846	268847	268848	268849	268850	§
550	.....	2	150	268851	268852	268853	268854	268855	268856	268857	268858	268859	268860	§
550	.....	3	165	268861	268862	268863	268864	268865	268866	268867	268868	268869	268870	§
550	.....	4	185	268871	268872	268873	268874	268875	268876	268877	268878	268879	268880	§
.....	110	2	150	268881	268882	268883	268884	268885	268886	268887	268888	268889	268890	§
.....	110	3	165	268891	268892	268893	268894	268895	268896	268897	268898	268899	268900	§
.....	110	4	185	268901	268902	268903	268904	268905	268906	268907	268908	268909	268910	§
For Voltages up to 4500														
110	.....	2	165	268911	268912	268913	268914	268915	268916	268917	268918	268919	None	§
110	.....	3	170	268920	268921	268922	268923	268924	268925	268926	268927	268928	None	§
110	.....	4	192	268929	268930	268931	268932	268933	268934	268935	268936	268937	None	§
.....	110	2	165	268938	268939	268940	268941	268942	268943	268944	268945	268946	None	§
.....	110	3	170	268947	268948	268949	268950	268951	268952	268953	268954	268955	None	§
.....	110	4	192	268956	268957	268958	268959	268960	268961	268962	268963	268964	None	§
With Ammeter Mounting† Cover—With Undervoltage Release Attachment ‡														
For Voltages up to 750														
110	220	2	180	268965	268966	268967	268968	268969	268970	268971	268972	268973	268974	§
110	220	3	185	268975	268976	268977	268978	268979	268980	268981	268982	268983	268984	§
110	220	4	205											
220	(440 or 550)	2	180	268985	268986	268987	268988	268989	268990	268991	268992	268993	268994	§
220	(440 or 550)	3	185	268995	268996	268997	268998	268999	269000	269001	269002	269003	269004	§
220	(440 or 550)	4	205											
440	.....	2	180	269005	269006	269007	269008	269009	269010	269011	269012	269013	269014	§
440	.....	3	185	269015	269016	269017	269018	269019	269020	269021	269022	269023	269024	§
440	.....	4	205											
550	.....	2	180	269025	269026	269027	269028	269029	269030	269031	269032	269033	269034	§
550	.....	3	185	269035	269036	269037	269038	269039	269040	269041	269042	269043	269044	§
550	.....	4	205											
.....	110	2	180	269045	269046	269047	269048	269049	269050	269051	269052	269053	269054	§
.....	110	3	185	269055	269056	269057	269058	269059	269060	269061	269062	269063	269064	§
.....	110	4	205											
For Voltages up to 4500														
110	.....	2	185	269085	269086	269087	269088	269089	269090	269091	269092	269093	None	§
110	.....	3	190	269094	269095	269096	269097	269098	269099	269100	269101	269102	None	§
110	.....	4	210											
.....	110	2	185	269103	269104	269105	269106	269107	269108	269109	269110	269111	None	§
.....	110	3	190	269112	269113	269114	269115	269116	269117	269118	269119	269120	None	§
.....	110	4	210											
With Ammeter Mounting† Cover—Without Undervoltage Release Attachment														
For Voltages up to 750														
None		2	170	269065	269066	269067	269068	269069	269070	269071	269072	269073	269074	§
None		3	175	269075	269076	269077	269078	269079	269080	269081	269082	269083	269084	§
For Voltages up to 4500														
None		2	175	269121	269122	269123	269124	269125	269126	269127	269128	269129	None	§
None		3	180	269130	269131	269132	269133	269134	269135	269136	269137	269138	None	§

Interrupting Capacity—For interrupting capacity at rated voltage see corresponding Breakers on previous page.

Oil—Two and three-pole breakers require 4½ gallons of oil, four-pole, 6 gallons.

*Weight does not include oil. Shipping weight of oil is approximately 9 pounds per gallon.

†Breaker style numbers and weights do not include ammeter. Select type SM Ammeter from catalog section on "Instruments and Relays." List prices do not include the ammeters. Breakers with ammeter-mounting cover are not weather-proof—see description on previous page.

‡Other voltages and frequencies of undervoltage are special; prices on request. For use on voltages over 600 specify breaker with 110-volt coil and order in addition the necessary voltage transformers. See voltage transformers in section on "Instruments and Relays" for style number and prices.

§List price is the sum of the list prices of the corresponding breaker, ammeter-mounting cover, and undervoltage-release attachment listed in Table XIV.

For information as to what material is furnished with these breakers, see "Instructions for Ordering" on a previous page.

For undervoltage trip, inverse-time limit (dash pots), shunt trip, direct-trip attachments, separate pipe-mounting brackets, see pages following on "Oil Circuit-Breaker Accessories."

Order by Style Number

TYPE F OIL CIRCUIT-BREAKERS—Continued

TABLE XVI—TYPE F-3 WEATHERPROOF SINGLE-THROW

Max. Continuous Amp.	Max. Volts	Amperes Interrupting Capacity at Rated Voltage	Manually-Operated Two-Pole Style No.	Manually-Operated Two-Pole List Price	Manually-Operated Three-Pole Style No.	Manually-Operated Three-Pole List Price	Electrically-Operated Two-Pole Style No.	Electrically-Operated Two-Pole List Price	Electrically-Operated Three-Pole Style No.	Electrically-Operated Three-Pole List Price
Series-Trip, Full-Automatic With Inverse Time Element†										
5	7500	500	248236	$467 50	248237	$500 00	248238	$565 00	248239	$585 00
10	7500	1000	216951	467 50	216962	500 00	216901	565 00	216912	585 00
25	7500	2500	216952	467 50	216963	500 00	216902	565 00	216913	585 00
50	7500	2900	216953	467 50	216964	500 00	216903	565 00	216914	585 00
75	7500	2900	216954	467 50	216965	500 00	216904	565 00	216915	585 00
100	7500	2900	216955	467 50	216966	500 00	216905	565 00	216916	585 00
150	7500	2900	216956	467 50	216967	500 00	216906	565 00	216917	585 00
200	7500	2900	216957	467 50	216968	500 00	216907	565 00	216918	585 00
300	7500	2900	216958	467 50	216969	500 00	216908	565 00	216919	585 00
500	7500	2900	216959	517 50	216970	590 00	216909	625 00	216920	690 00
600	7500	2900	216960	555 00	216971	645 00	216910	680 00	216921	760 00
800	4500	4800	216961	600 00	216972	700 00	216911	745 00	216922	825 00
5	15000	500	216973	500 00	216982	590 00	216931	620 00	216940	675 00
10	15000	1000	216974	500 00	216983	590 00	216932	620 00	216941	675 00
15	15000	1400	216975	500 00	216984	590 00	216933	620 00	216942	675 00
25	15000	1400	216976	500 00	216985	590 00	216934	620 00	216943	675 00
50	15000	1400	216977	500 00	216986	590 00	216935	620 00	216944	675 00
75	15000	1400	216978	500 00	216987	590 00	216936	620 00	216945	675 00
100	15000	1400	216979	500 00	216988	590 00	216937	620 00	216946	675 00
150	15000	1400	216980	500 00	216989	590 00	216938	620 00	216947	675 00
200	15000	1400	216981	500 00	216990	590 00	216939	620 00	216948	675 00
Non-Automatic[1]										
200	7500	2900	248240	415 00	248241	445 00	248242	505 00	248243	525 00
300	7500	2900	221970	415 00	221974	445 00	216923	505 00	216927	525 00
500	7500	2900	221971	440 00	221975	470 00	216924	530 00	216928	550 00
600	7500	2900	221972	460 00	221976	520 00	216925	550 00	216929	600 00
800	4500	4800	221973	530 00	221977	600 00	216926	640 00	216930	680 00
200	15000	1400	.....	.....	.....	.....	216949	580 00	216950	650 00

Electrically Operated Breakers

4500 Volts and 7500 Volts ‡

Poles	Gallons Oil	Approx. Shipping Wt.*Lb.
2	13	600
3	13	613

*Weight does not include oil. Shipping weight of oil is approximately 9 pounds per gallon.

†Full-automatic breakers can be supplied on special order with 5-ampere trip coils for transformer trip. List price same as listed for 10 ampere series trip breaker above.

‡Dimensions, weights, and amount of oil for 15000-volt breakers will be supplied on request.

For information as to what material is furnished with these breakers, see "Instructions for Ordering" on a previous page. For undervoltage trip, inverse-time limit, (dash pots), shunt trip, direct-trip attachments, separate pipe-mounting brackets see pages following on "Oil Circuit-Breaker Accessories."

Order by Style Number

TYPE F OIL CIRCUIT-BREAKERS—Continued

TABLE XVII—SUBWAY SINGLE-THROW
Wall-Mounting Series-Trip Full-Automatic† With Inverse-Time-Limit Attachment

For Voltages Up to 7500

Maximum‡ Continuous Amperes	Amperes Interrupting Capacity at Rated Voltage	Two-Pole Style No.	Two-Pole List Price	Three-Pole Style No.	Three-Pole List Price
Type F-1 Manually-Operated					
10	960	193579	$357 50	193587	$417 50
25	960	193580	357 50	193588	417 50
50	960	193581	357 50	193589	417 50
75	960	193582	357 50	193590	417 50
100	960	193583	357 50	193591	417 50
150	960	193584	357 50	193592	417 50
200	960	193585	370 00	193593	445 00
300	960	193586	370 00	193594	445 00
Type F-2‡ Electrically-Operated					
5	500	216991	555 00	217000	650 00
10	1000	216992	555 00	217001	650 00
25	1700	216993	555 00	217002	650 00
50	1700	216994	555 00	217003	650 00
75	1700	216995	555 00	217004	650 00
100	1700	216996	555 00	217005	650 00
150	1700	216997	555 00	217006	650 00
200	1700	216998	570 00	217007	680 00
300	1700	216999	570 00	217008	680 00

Poles	Type F-1 Gallons Oil	Type F-1 Approx. Shipping Wt.*Lb.	Type F-2 Gallons Oil	Type F-2 Approx. Shipping Wt.*Lb.
2	8	240	9½	...
3	8	260	9½	...

NOTE—Style number and list price of subway breakers do not include cable bushings. These bushings should be ordered extra as follows:

One per lead of proper size for cable, or, 2 per breaker of proper size that each will take all leads on one side.

Cable Bushings for Subway Breakers

Diameter of Hole	Style No.	List Price
⅝	219970	$5 00
¾	47608	5 00
1	60010	5 00
1¼	47969	5 50
1½	59932	6 00

*Weight does not include oil. Shipping weight of oil is approximately 9 pounds per gallon.

†Type F-1 hand-operated 300-ampere and type F-2 electrically-operated 300, 500, and 600-ampere non-automatic breakers can be supplied on special order at the same price as the automatic breakers.

‡Type F-2 automatic breakers can be supplied on special order in capacities of 500 amperes for use on circuits of voltages up to 7500 and 600 amperes on circuits up to 4500. Prices on application.

For information as to what material is furnished with these breakers, see "Instructions for Ordering" on a previous page.

For undervoltage trip, inverse-time limit (dash pots), shunt trip, direct-trip attachments, separate pipe-mounting brackets see pages following on "Oil Circuit-Breaker Accessories."

Order by Style Number

TYPE F OIL CIRCUIT-BREAKERS—Continued

INDEX TO OUTLINE DIMENSIONS

Figure Numbers Refer to Figures on Pages Following

Dimensions of Style Numbers not shown in this Index, will be supplied on Request

Style No.	Listed in Table	Figure: Breaker	Operating Handle	Pipe or Wall Bracket	Bell-Crank Mechanism	Cover-plate
186234	I	1	5	..	..	26
186235	I	2	5	..	..	27
186236	I	3	5	..	..	27
186240	I	1	6	..	..	30
186241	I	2	6	..	..	30
186242	I	3	6	..	..	30
186246	I	1	5	..	..	26
186247	I	2	5	..	..	27
186248	I	3	5	..	..	27
186252	I	1	6	..	..	30
186253	I	2	6	..	..	30
186254	I	3	6	..	..	30
186258	III	4	5	..	..	32
186259	III	1	5	..	..	26
186260	III	2	5	..	..	27
186261	III	3	5	..	..	27
186266	III	4	6	..	..	33
186267	III	1	6	..	..	30
186268	III	2	6	..	..	30
186269	III	3	6	..	..	30
186274	III	4	5	..	..	32
186275	III	1	5	..	..	26
186276	III	2	5	..	..	27
186277	III	3	5	..	..	27
186282	III	4	6	..	..	33
186283	III	1	6	..	..	30
186284	III	2	6	..	..	30
186285	III	3	6	..	..	30
193317	II	1	12	18	24	31
193318	II	2	12	18	24	31
193319	II	3	12	18	24	31
193320	II	1	12	18	24	31
193321	II	2	12	18	24	31
193322	II	3	12	18	24	31
193323	II	1	11	18	22	28
193324	II	2	11	18	22	29
193325	II	3	11	18	22	29
193326	II	1	11	18	22	28
193327	II	2	11	18	22	29
193328	II	3	11	18	22	29
193333	II	1	12	14	24	31
193334	II	2	12	14	24	31
193335	II	3	12	14	24	31
193336	II	1	12	14	24	31
193337	II	2	12	14	24	31
193338	II	3	12	14	24	31
193339	II	1	11	14	22	28
193340	II	2	11	14	22	29
193341	II	3	11	14	22	29
193342	II	1	11	14	22	28
193343	II	2	11	14	22	29
193344	II	3	11	14	22	29
193349	II	1	8	17	..	31
193350	II	2	8	17	..	31
193351	II	3	8	17	..	31
193352	II	1	8	17	..	31
193353	II	2	8	17	..	31
193354	II	3	8	17	..	31
193355	II	1	7	17	..	28
193356	II	2	7	17	..	29
193384	II	3	7	17	..	29
193385	II	1	7	17	..	28
193386	II	2	7	17	..	29
193387	II	3	7	17	..	29
193392	II	1	8	13	..	31
193393	II	2	8	13	..	31
193394	II	3	8	13	..	31
193395	II	1	8	13	..	31
193396	II	2	8	13	..	31
193397	II	3	8	13	..	31
193398	II	1	7	13	..	28
193399	II	2	7	13	..	29
193400	II	3	7	13	..	29
193401	II	1	7	13	..	28
193402	II	2	7	13	..	29
193403	II	3	7	13	..	29
193579 to 193594	I	110	..	..	..	..
193603 to 193609	I	1	5	..	..	119
193611 to 193617	I	2	5	..	..	120
193619 to 193625	I	3	5	..	..	120
193627 to 193633	I	1	7	13	..	121
193635 to 193641	I	2	7	13	..	122
193643 to 193649	I	3	7	13	..	122
194453	V	125	12	..	127	31
194454	V	125	12	..	127	31
194455	V	125	12	..	127	31
194459	V	125	12	..	127	31
194460	V	125	12	..	127	31
194461	V	125	12	..	127	31
194462	V	125	12	..	127	31
194463	V	125	12	..	127	31
194464	V	125	12	..	127	31
198740	V	125	11	..	129	32
198741	V	125	11	..	129	29
198742	V	125	11	..	129	29
198746	V	125	11	..	129	32
198747	V	125	11	..	129	29
198748	V	125	11	..	129	29
198749	V	125	11	..	129	32
198750	V	125	11	..	129	29
198751	V	125	11	..	128	29
198760	V	126	12	..	128	31
198761	V	126	12	..	128	31
198762	V	126	12	..	128	31
198766 to 198771	V	126	12	..	121	31
198772	V	126	11	..	129	32
198773	V	126	11	..	129	29
198774	V	126	11	..	129	29
198778	V	126	11	..	129	32
198779	V	126	11	..	129	29
198780	V	126	11	..	129	29
198781	V	126	11	..	129	32
198782	V	126	11	..	129	29
198783	V	126	11	..	129	29
198796	III	4	6	..	..	33
198797	III	1	6	..	..	30
198798	III	2	6	..	..	30
198799	III	3	6	..	..	30
198804	III	4	5	..	..	32
198805	III	1	5	..	..	26
198806	III	2	5	..	..	27
198807	III	3	5	..	..	27
198816	III	34	39	..	..	68
198817	III	35	40	..	..	65
198818	III	35	40	..	..	65
198819	III	36	40	..	..	65
198820	III	34	39	..	..	68
198821	III	35	40	..	..	65
198822	III	35	40	..	..	65
198823	III	36	40	..	..	65
198824	III	34	39	..	..	68
198825	III	35	40	..	..	65
198826	III	35	40	..	..	65
198827	III	36	40	..	..	65
198828	III	34	37	..	..	64
198829	III	35	38	..	..	66
198830	III	35	38	..	..	66
198831	III	36	38	..	..	66
198832	III	34	37	..	..	64
198833	III	35	38	..	..	66
198834	III	35	38	..	..	66
198835	III	36	38	..	..	66
198836	III	34	37	..	..	64
198837	III	35	38	..	..	66
198838	III	35	38	..	..	66
198839	III	36	38	..	..	66
198846	III	34	37	..	..	64
198847	III	35	38	..	..	66
198848	III	35	38	..	..	66
198849	III	36	38	..	..	66
198850	III	34	37	..	..	64
198851	III	35	38	..	..	66
198852	III	35	38	..	..	66
198853	III	36	38	..	..	66
198854	III	34	37	..	..	64
198855	III	35	38	..	..	66
198856	III	35	38	..	..	66
198857	III	36	38	..	..	66
205192 to 205221	XIV	107	..	..	..	..
205222 to 205248	XIV	108	..	..	..	..
208537	IV	4	12	18	24	31
208538	IV	1	12	18	24	31
208539	IV	2	12	18	24	31
208540	IV	3	12	18	24	31
208545	IV	4	12	18	24	31
208546	IV	1	12	18	24	31
208547	IV	2	12	18	24	31
208548	IV	3	12	18	24	31
208549	IV	4	12	18	24	31
208550	IV	1	12	18	24	31
208551	IV	2	12	18	24	31
208552	IV	3	12	18	24	31
208553	IV	4	11	18	22	28
208554	IV	1	11	18	22	28
208555	IV	2	11	18	22	29
208556	IV	3	11	18	22	29
208561	IV	4	11	18	22	28
208562	IV	1	11	18	22	28
208563	IV	2	11	18	22	29
208564	IV	3	11	18	22	29
208565	IV	4	11	18	22	28
208566	IV	1	11	18	22	28
208567	IV	2	11	18	22	29
208568	IV	3	11	18	22	29
208577	IV	4	12	14	24	31
208578	IV	1	12	14	24	31
208579	IV	2	12	14	24	31
208580	IV	3	12	14	24	31
208585	IV	4	12	14	24	31
208586	IV	1	12	14	24	31
208587	IV	2	12	14	24	31
208588	IV	3	12	14	24	31
208589	IV	4	12	14	24	31
208590	IV	1	12	14	24	31
208591	IV	2	12	14	24	31
208592	IV	3	12	14	24	31
208593	IV	4	11	14	22	28
208594	IV	1	11	14	22	28
208595	IV	2	11	14	22	29
208596	IV	3	11	14	22	29
208601	IV	4	11	14	22	28
208602	IV	1	11	14	22	28
208603	IV	2	11	14	22	29
208604	IV	3	11	14	22	29
208605	IV	4	11	14	22	28
208606	IV	1	11	14	22	28
208607	IV	2	11	14	22	29
208608	IV	3	11	14	22	29
208617	IV	4	8	17	..	31
208618	IV	1	8	17	..	31
208619	IV	2	8	17	..	31
208620	IV	3	8	17	..	31
208625	IV	4	8	17	..	31
208626	IV	1	8	17	..	31
208627	IV	2	8	17	..	31
208628	IV	3	8	17	..	31
208629	IV	4	8	17	..	31
208630	IV	1	8	17	..	31
208631	IV	2	8	17	..	31
208632	IV	3	8	17	..	31
208633	IV	4	7	17	..	28
208634	IV	1	7	17	..	28
208635	IV	2	7	17	..	29
208636	IV	3	7	17	..	29
208641	IV	4	7	17	..	28
208642	IV	1	7	17	..	28
208643	IV	2	7	17	..	29
208644	IV	3	7	17	..	29
208645	IV	4	7	17	..	28
208646	IV	1	7	17	..	28
208647	IV	2	7	17	..	29
208648	IV	3	7	17	..	29
208657	IV	4	8	13	..	31
208658	IV	1	8	13	..	31
208659	IV	2	8	13	..	31
208660	IV	3	8	13	..	31
208665	IV	4	8	13	..	31
208666	IV	1	8	13	..	31
208667	IV	2	8	13	..	31
208668	IV	3	8	13	..	31
208669	IV	4	8	13	..	31
208670	IV	1	8	13	..	31
208671	IV	2	8	13	..	31
208672	IV	3	8	13	..	31
208673	IV	4	7	13	..	28
208674	IV	1	7	13	...	28
208675	IV	2	7	13	...	29
208676	IV	3	7	13	...	29
208681	IV	4	7	13	...	28
208682	IV	1	7	13	...	28
208683	IV	2	7	13	...	29
208684	IV	3	7	13	...	29
208685	IV	4	7	13	...	28
208686	IV	1	7	13	...	28
208687	IV	2	7	13	...	29
208688	IV	3	7	13	...	29
208777	VII	102*	..	102*	...	..
208778	VII	103*	..	103*	...	..
208779	VII	103*	..	103*	...	..
208780	VII	104*	..	104*	...	..
208785	VII	102*	..	102*	...	..
208786	VII	103*	..	103*	...	..

*See footnote on next page.

TYPE F OIL CIRCUIT-BREAKERS—Continued

Index to Outline Dimensions—Continued

Style No.	Listed in Table	Figure: Breaker	Operating Handle	Pipe or Wall Bracket	Bell-Crank Mechanism	Cover-plate
208787	VII	103*	..	103*	...	..
208788	VII	104*	..	104*	...	..
208789	VII	102*	..	102*	...	..
208790	VII	103*	..	103*	...	..
208791	VII	103*	..	103*	...	..
208792	VII	104*	..	104*	...	..
208817	VII	102	..	102	...	..
208818	VII	103	..	103	...	..
208819	VII	103	..	103	...	..
208820	VII	104	..	104	...	..
208825	VII	102	..	102	...	..
208826	VII	103	..	103	...	..
208827	VII	103	..	103	...	..
208828	VII	104	..	104	...	..
208829	VII	102	..	102	...	..
208830	VII	103	..	103	...	..
208831	VII	103	..	103	...	..
208832	VII	104	..	104	...	..
208841	VIII	125	..	...	128	..
208842	VIII	125	..	...	128	..
208843 to 208855	VIII	125	..	...	128	..
208859 to 208864	VIII	125	..	...	128	..
208873	VIII	123	..	123	...	..
208874	VIII	123	..	123	...	..
208875	VIII	123	..	123	...	..
208879 to 208887	VIII	123	..	123	...	..
208891 to 208896	VIII	123	..	123	...	..
208937	VIII	126	..	...	128	..
208938	VIII	126	..	...	128	..
208939	VIII	126	..	...	128	..
208943 to 208951	VIII	126	..	...	128	..
208955 to 208960	VIII	126	..	...	128	..
208969	VIII	124	..	124	...	..
208970	VIII	124	..	124	...	..
208971	VIII	124	..	124	...	..
208975 to 208983	VIII	124	..	124	...	..
208987 to 208992	VIII	124	..	124	...	..
209277	VI	4*	46	55	62	68
209278	VI	35	46	56	62	68
209279	VI	35	46	56	62	68
209280	VI	36	46	56	62	68
209281	VI	4*	46	55	62	68
209282	VI	35	46	56	62	68
209283	VI	35	46	56	62	68
209284	VI	36	46	56	62	68
209285	VI	4*	46	55	62	68
209286	VI	35	46	56	62	68
209287	VI	35	46	56	62	68
209288	VI	36	46	56	62	68
209289	VI	4*	45	55	60	67
209290	VI	35	45	56	60	67
209291	VI	35	45	56	60	67
209292	VI	36	45	56	60	67
209293	VI	4*	45	55	60	67
209294	VI	35	45	56	60	67
209295	VI	35	45	56	60	67
209296	VI	36	45	56	60	67
209297	VI	4*	45	55	60	67
209298	VI	35	45	56	60	67
209299	VI	35	45	56	60	67
209300	VI	36	45	56	60	67
209307	VI	4*	45	55	60	67
209308	VI	35	45	56	60	67
209309	VI	35	45	56	60	67
209310	VI	36	45	56	60	67
209311	VI	4*	45	55	60	67
209312	VI	35	45	56	60	67
209313	VI	35	45	56	60	67
209314	VI	36	45	56	60	67
209315	VI	4*	45	56	60	67
209316	VI	35	45	56	60	67
209317	VI	35	45	56	60	67
209318	VI	36	45	56	60	67
209319	VI	4*	46	49	62	68
209320	VI	35	46	49	62	68
209321	VI	35	46	49	62	68
209322	VI	36	46	49	62	68
209323	VI	4*	46	49	62	68
209324	VI	35	46	49	62	68
209325	VI	35	46	49	62	68
209326	VI	36	46	49	62	68
209327	VI	4*	46	49	62	68
209328	VI	35	46	49	62	68
209329	VI	35	46	49	62	68
209330	VI	36	46	49	62	68
209331	VI	4*	45	49	60	67
209332	VI	35	45	49	60	67
209333	VI	35	45	49	60	67
209334	VI	36	45	49	60	67
209335	VI	4*	45	49	60	67
209336	VI	35	45	49	60	67
209337	VI	35	45	49	60	67
209338	VI	36	45	49	60	67
209339	VI	4*	45	49	60	67
209340	VI	35	45	49	60	67
209341	VI	35	45	49	60	67
209342	VI	36	45	49	60	67
209343	VI	4*	45	49	60	67
209344	VI	35	45	49	60	67
209345	VI	35	45	49	60	67
209346	VI	36	45	49	60	67
209347	VI	4*	45	49	60	67
209348	VI	35	45	49	60	67
209349	VI	35	45	49	60	67
209350	VI	36	45	49	60	67
209351	VI	4*	45	49	60	67
209352	VI	35	45	49	60	67
209353	VI	35	45	49	60	67
209354	VI	36	45	49	60	67
209385	VI	4*	42	53	...	68
209386	VI	35	42	54	...	68
209387	VI	35	42	54	...	68
209388	VI	35	42	54	...	68
209389	VI	4*	42	53	...	68
209390	VI	35	42	54	...	68
209391	VI	35	42	54	..	68
209392	VI	36	42	54	...	68
209393	VI	4*	42	53	...	68
209394	VI	35	42	54	...	68
209395	VI	35	42	54	...	68
309396	VI	36	42	54	...	68
209397	VI	4*	41	53	...	67
209398	VI	35	41	54	...	67
209399	VI	35	41	54	...	67
209400	VI	36	41	54	...	67
209401	VI	4*	41	53	...	67
209402	VI	35	41	54	...	67
209403	VI	35	41	54	...	67
209404	VI	36	41	54	...	67
209405	VI	4*	41	53	...	67
209406	VI	35	41	54	...	67
209407	VI	35	41	54	...	67
209408	VI	36	41	54	...	67
209409	VI	4*	41	53	...	67
209410	VI	35	41	54	...	67
209411	VI	35	41	54	...	67
209412	VI	36	41	54	...	67
209413	VI	4*	41	53	...	67
209414	VI	35	41	54	...	67
209415	VI	35	41	54	...	67
209416	VI	36	41	54	...	67
209417	VI	4*	41	53	..	67
209418	VI	35	41	54	...	67
209419	VI	35	41	54	...	67
209420	VI	36	41	54	...	67
209427	VI	4*	42	47*	...	68
209428	VI	35	42	48	...	68
209429	VI	35	42	48	...	68
209430	VI	36	42	48	...	68
209431	VI	4*	42	47*	...	68
209432	VI	35	42	48	...	68
209433	VI	35	42	48	...	68
209434	VI	36	42	48	...	68
209435	VI	4*	42	47*	...	68
209436	VI	35	42	48	...	68
209437	VI	35	42	48	...	68
209438	VI	36	42	48	...	68
209439	VI	4*	41	47*	...	67
209440	VI	35	41	48	...	67
209441	VI	35	41	48	...	67
209442	VI	36	41	48	...	67
209443	VI	4*	41	47*	...	67
209444	VI	35	41	48	...	67
209445	VI	35	41	48	...	67
209446	VI	36	41	48	...	67
209447	VI	4*	41	47*	...	67
209448	VI	35	41	48	...	67
209449	VI	35	41	48	...	67
209450	VI	36	41	48	...	67
209451	VI	4*	41	47*	...	67
209452	VI	35	41	48	...	67
209453	VI	35	41	48	...	67
209454	VI	36	41	48	...	67
209455	VI	4*	41	47*	..	67	..
209456	VI	35	41	48	..	67	..
209457	VI	35	41	48	..	67	..
209458	VI	36	41	48	..	67	..
209459	VI	4*	41	47*	..	67	..
209460	VI	35	41	48	..	67	..
209461	VI	35	41	48	..	67	..
209462	VI	36	41	48	..	67	..
209577	IX	69	76	..	..	93	..
209578	IX	70	76	..	..	93	..
209579	IX	71	76	..	..	93	..
209580	IX	69	76	..	..	93	72
209581	IX	70	76	..	..	93	73
209582	IX	71	76	..	..	93	74
209583	IX	69	75	..	..	91	..
209584	IX	70	75	..	..	92	..
209585	IX	71	75	..	..	92	..
209586	IX	69	75	..	..	91	72
209587	IX	70	75	..	..	92	73
209588	IX	71	75	..	..	92	74
209625	X	69	80	86	24	96	..
209626	X	70	80	86	24	96	..
209627	X	71	80	86	24	96	..
209628	X	69	80	86	24	96	72
209629	X	70	80	86	24	96	73
209630	X	71	80	86	24	96	74
209631	X	69	79	86	87	94	..
209632	X	70	79	86	87	95	..
209633	X	71	79	86	87	95	..
209634	X	69	79	86	87	94	72
209635	X	70	79	86	87	95	73
209636	X	71	79	86	87	95	74
209641	X	69	80	83	24	96	..
209642	X	70	80	83	24	96	..
209643	X	71	80	83	24	96	..
209644	X	69	80	83	24	96	72
209645	X	70	80	83	24	96	73
209646	X	71	80	83	24	96	74
209647	X	69	79	83	87	94	..
209648	X	70	79	83	87	95	..
209649	X	71	79	83	87	95	..
209650	X	69	79	83	87	94	72
209651	X	70	79	83	87	95	73
209652	X	71	79	83	87	95	74
209657	X	69	77	84	..	96	..
209658	X	70	77	84	..	96	..
209659	X	71	77	84	..	96	..
209660	X	69	77	84	..	96	72
209661	X	70	77	84	..	96	73
209662	X	71	77	84	..	96	74
209663	X	69	78	84	..	94	..
209664	X	70	78	84	..	95	..
209665	X	71	78	84	..	95	..
209666	X	69	78	84	..	94	72
209667	X	70	78	84	..	95	73
209668	X	71	78	84	..	95	74
209673	X	69	77	81	..	96	..
209674	X	70	77	81	..	96	..
209675	X	71	77	81	..	96	..
209676	X	69	77	81	..	96	72
209677	X	70	77	81	..	96	73
209678	X	71	77	81	..	96	74
209679	X	69	78	81	..	94	..
209680	X	70	78	81	..	95	..
209681	X	71	78	81	..	95	..
209682	X	69	78	81	..	94	72
209683	X	70	78	81	..	95	73
209684	X	71	78	81	..	95	74
209721	XII	97	..	97	..	..	..
209722	XII	97	..	97	..	..	..
209723	XII	98	..	98	..	..	..
209724	XII	97	..	97	..	..	72
209725	XII	97	..	97	..	..	73
209726	XII	98	..	98	..	..	74
209727	XII	97	..	97	..	..	..
209728	XII	97	..	97	..	..	..
209729	XII	98	..	98	..	..	..
209730	XII	97	..	97	..	..	72
209731	XII	97	..	97	..	..	73
209732	XII	98	..	98	..	..	74
209733	XII	97	..	97	..	..	..
209734	XII	98	..	98	..	..	..
209735	XII	97	..	97	..	..	73
209736	XII	98	..	98	..	..	74
216901 to 216950	XVI	109	..	..	..	..	..
216991 to 217008	XVII	111	..	..	..	..	..
234181 to 234204	XI	..	..	..	112	..	..

*Consists of two standard single-throw breaker units, each as shown in these figures, and should be mounted with 5¾-inch center spacing.

TYPE F OIL CIRCUIT-BREAKERS—Continued

Dimension Figs. 1 to 4

For references see pages preceding Figs.

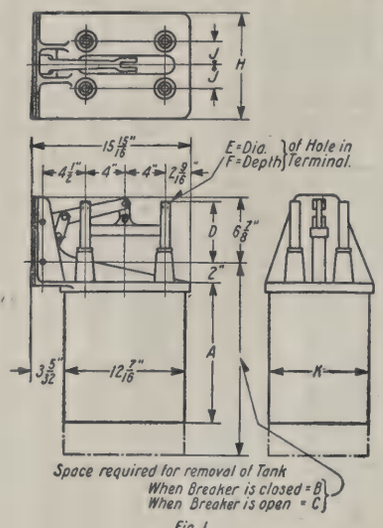


Fig. 1

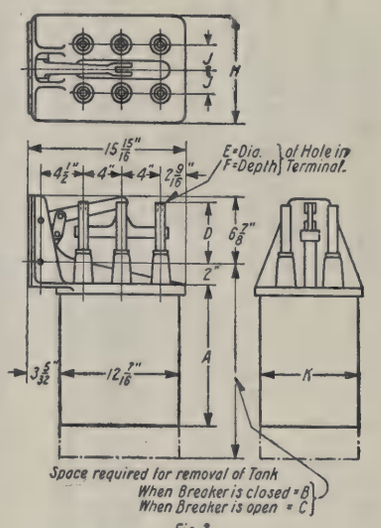


Fig. 2

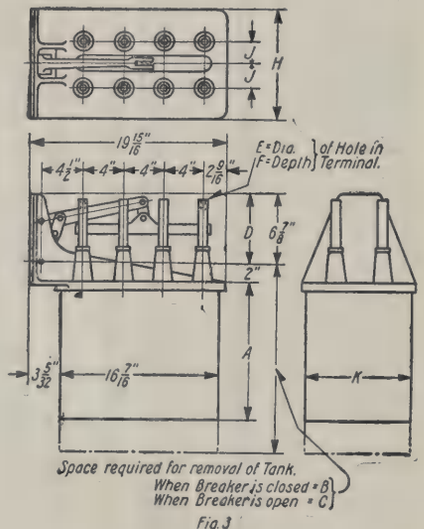


Fig. 3

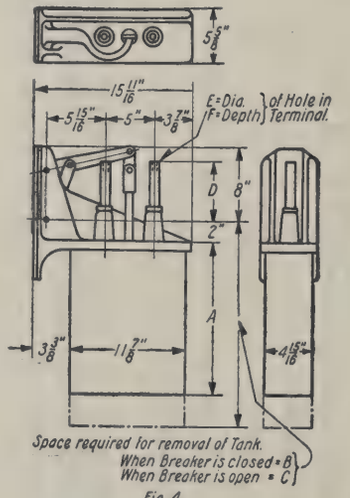


Fig. 4

Fig.	Breaker Type	Max. Amp.	Max. Volts	Dimensions, Inches								
				A	B	C	D	E	F	H	J	K
1, 2, 3	F-1	Up to 200	2500 and 4500	13 5/8	23 7/8	28 1/8	4 3/8	0.521	11/16	9 1/8	2	8 1/32
1, 2, 3	F-1	300	4500	13 5/8	23 7/8	28 1/8	4 7/8	0.747	1	9 1/8	2	8 1/32
1, 2, 3	F-2	300	7500	15 1/8	26 7/8	31 1/8	5 15/16	0.747	1	11 1/16	2 3/8	10 1/16
1, 2, 3	F-2	500	7500	15 1/8	26 7/8	31 1/8	7 11/16	1.151	1 11/16	11 1/16	2 3/8	10 1/16
1, 2, 3	F-2	600	4500	15 1/8	26 7/8	31 1/8	7 11/16	1.385	1 13/16	11 1/16	2 3/8	10 1/16
1, 2, 3	F-2	300	13200	18 1/8	32 7/8	37 1/8	9 3/4	0.747	1	11 1/16	2 3/8	10 1/16
4	F-2	300	7500	16 1/8	27 7/8	33 1/8	5 11/16	0.747	1	....	....	....
4	F-2	500	7500	16 1/8	27 7/8	33 1/8	7 11/16	1.151	1 11/16	....	....	....
4	F-2	600	4500	16 1/8	27 7/8	33 1/8	7 11/16	1.385	1 13/16	....	....	....
4	F-2	300	13200	19 1/8	33 7/8	39 1/8	9 3/4	0.747	1	....	....	....

These dimensions are for reference only. For official dimensions apply to the nearest district office.

TYPE F OIL CIRCUIT-BREAKERS—Continued

Dimension Figs. 5 to 24

For references ▬ pages preceding Figs.

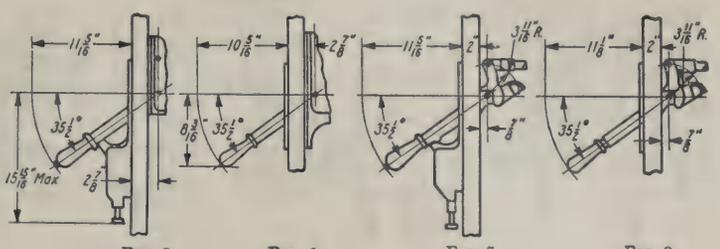


FIG. 5 FIG. 6 FIG. 7 FIG. 8

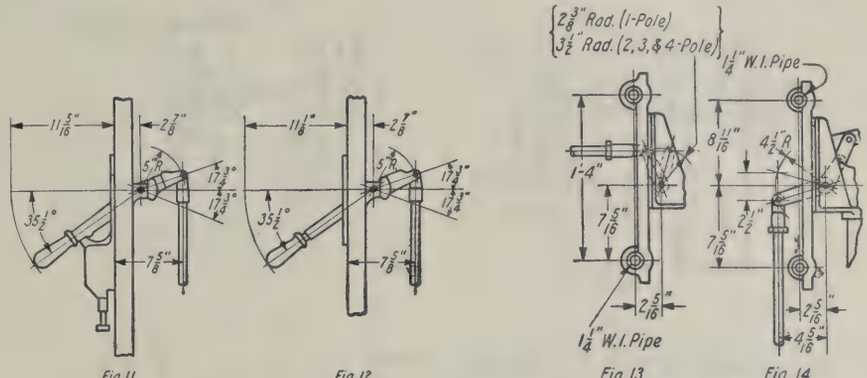


Fig. 11 Fig. 12 Fig. 13 Fig. 14

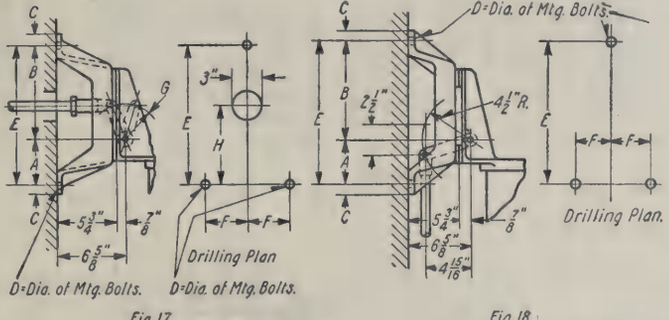


Fig. 17 Fig. 18

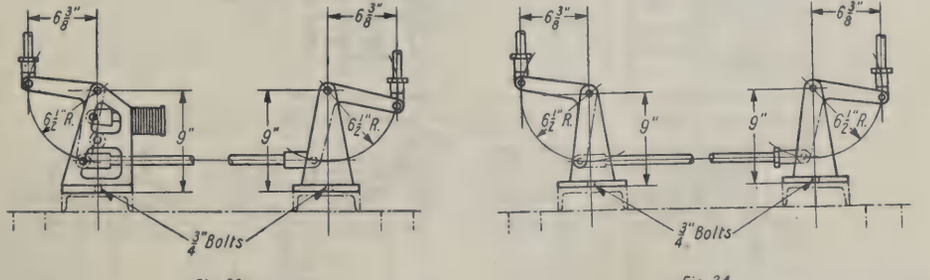


Fig. 22 Fig. 24

Figs.	Poles	Dimensions, Inches							
		A	B	C	D	E	F	G	H
17, 18, 17, 18,	1 2, 3, and 4	8 1/16 4 1/2	10 3/8 9 1/2	3/4 1 1/16	1/2 5/8	18 1/2 14	2 3 1/16	2 3/8 3 1/2	10 1/4 7 3/4

These dimensions are for reference only. For official dimensions apply to the nearest district office.

TYPE F OIL CIRCUIT-BREAKERS—Continued

Dimension Figs. 26 to 35

For references see pages preceding Figs.

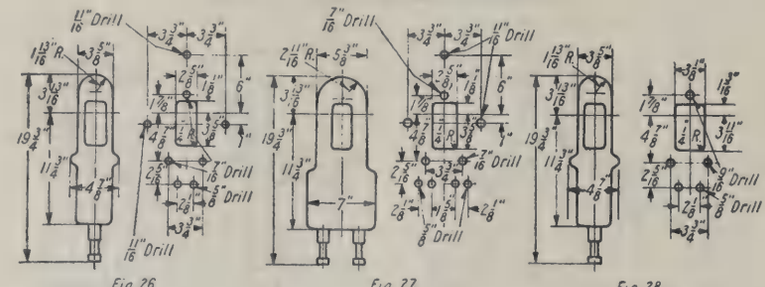


Fig. 26 Fig. 27 Fig. 28

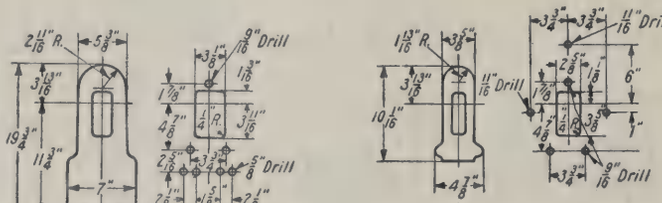


Fig. 29 Fig. 30

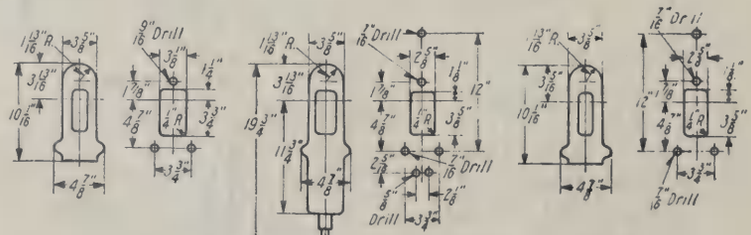


Fig. 31 Fig. 32 Fig. 33

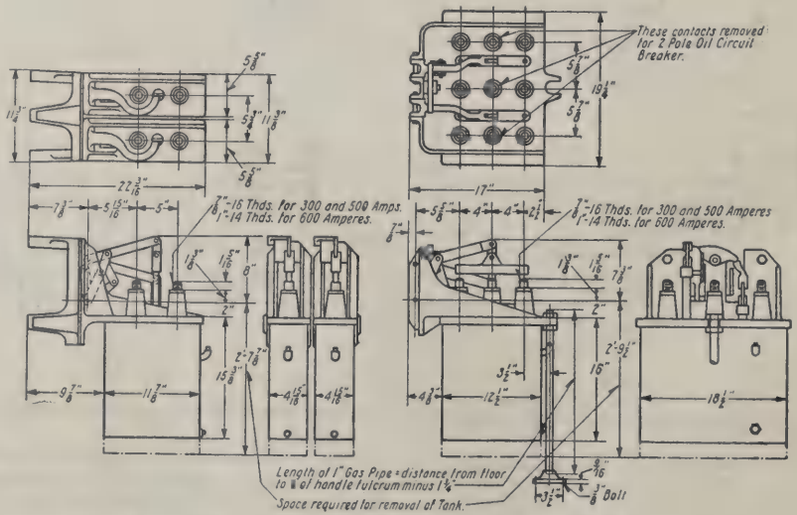

These contacts removed for 2 Pole Oil Circuit Breaker.
7/8"-16 Thds. for 300 and 500 Amps.
1"-14 Thds. for 600 Amperes.
Length of 1" Gas Pipe + distance from floor to 1st oil handle fulcrum minus 1 1/4"
Space required for removal of Tank.
3/8" Ball

Fig. 34 Fig. 35

These dimensions are for reference only. For official dimensions apply to the nearest district office.

TYPE F OIL CIRCUIT-BREAKERS—Continued

Dimension Figs. 36 to 61

For reference see pages preceding Figs.

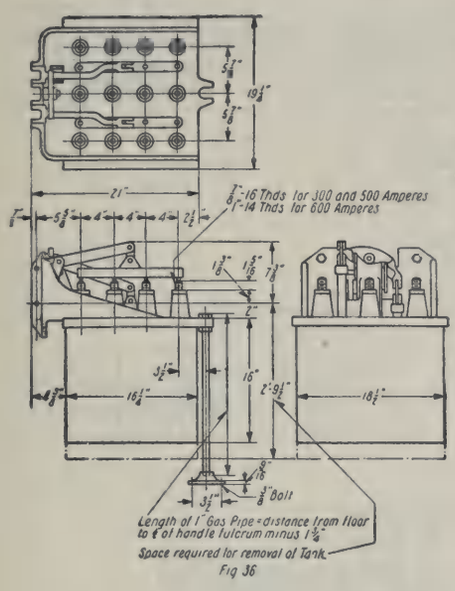

5/16" Thds for 300 and 500 Amperes
1/4" Thds for 600 Amperes
3/8" Bolt
Length of 1" Gas Pipe = distance from floor to ℄ of handle fulcrum minus 1 3/4"
Space required for removal of Tank

Fig 36

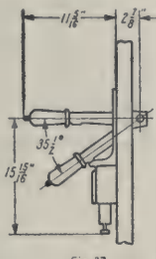


Fig 37

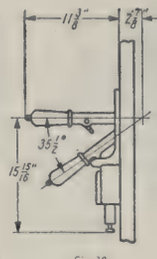


Fig 38

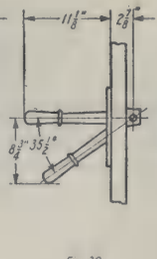


Fig 39

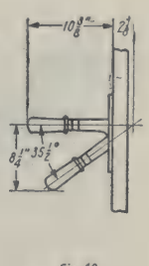


Fig 40

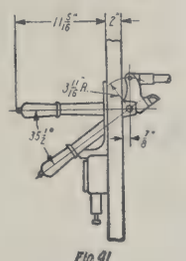


Fig 41

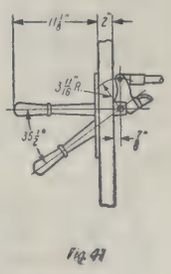


Fig 42

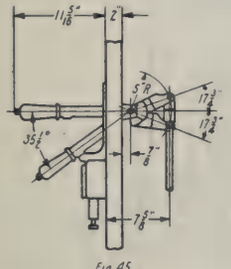


Fig 45

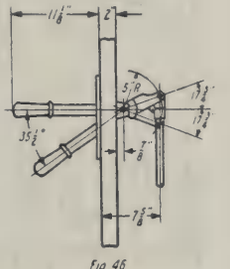


Fig 46

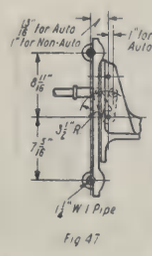


Fig 47

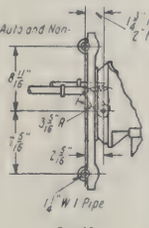


Fig 48

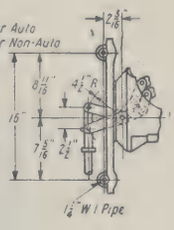


Fig 49

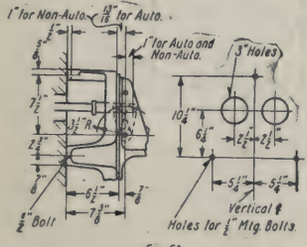


Fig 53

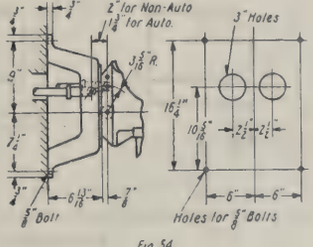


Fig 54

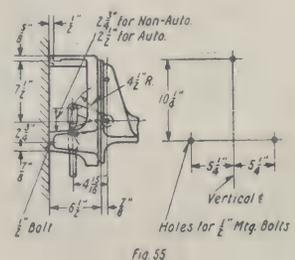


Fig 55

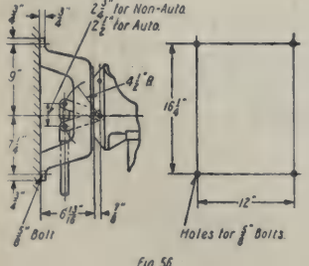


Fig 56

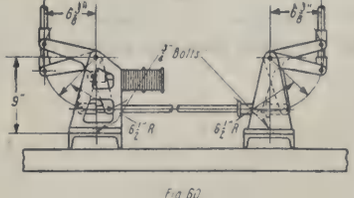


Fig 60

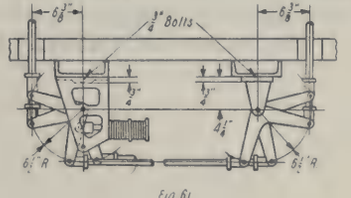


Fig 61

These dimensions are for reference only. For official dimensions apply to the nearest district office.

TYPE F OIL CIRCUIT-BREAKERS—Continued

Dimension Figs. 62 to 70

For references see pages preceding Figs.

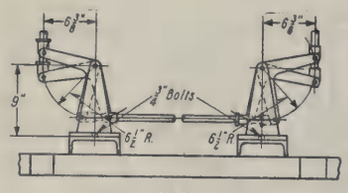


Fig. 62

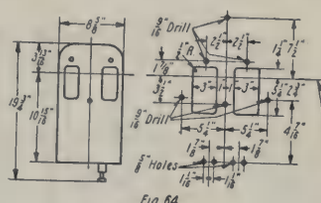


Fig. 64

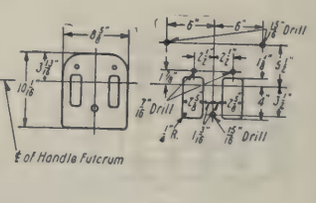


Fig. 65

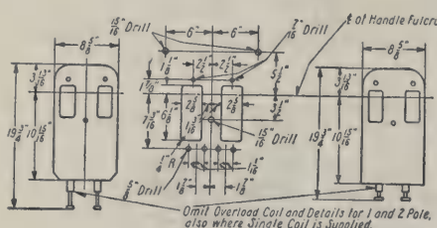


Fig. 66

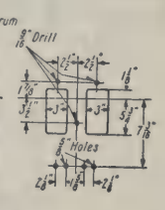


Fig. 67

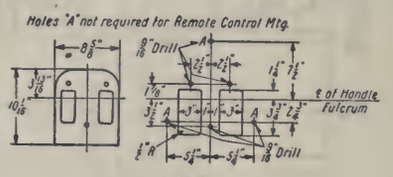


Fig. 68

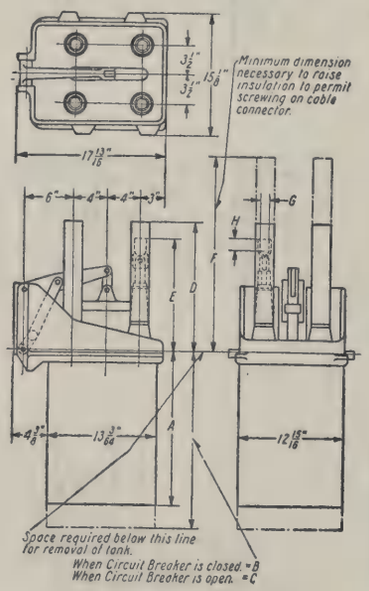

Minimum dimension necessary to raise insulation to permit screwing on cable connector.
Space required below this line for removal of tank.
When Circuit Breaker is closed, = B
When Circuit Breaker is open, = C

FIG. 69

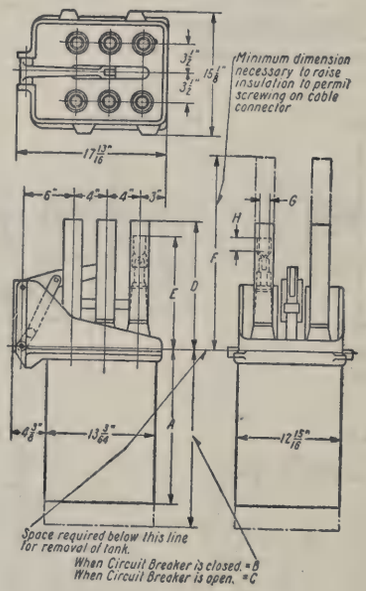

Minimum dimension necessary to raise insulation to permit screwing on cable connector
Space required below this line for removal of tank.
When Circuit Breaker is closed, = B
When Circuit Breaker is open, = C

FIG. 70

Fig.	Max. Amp.	Max. Volts	Dimensions in Inches							
			A	B	C	D	E	F	G	H
69, 70, 71	500	1500	19 13/16	33 3/4	38 1/4	16	13 13/16	24	1.157	1 11/16
69, 70, 71	800	4500	15 7/16	26 1/4	30 3/4	..	....	..	....	...

These dimensions are for reference only. For official dimensions apply to the nearest district office.

TYPE F OIL CIRCUIT-BREAKERS—Continued

Dimension Figs. 71 to 87

For references see pages preceding Figs.

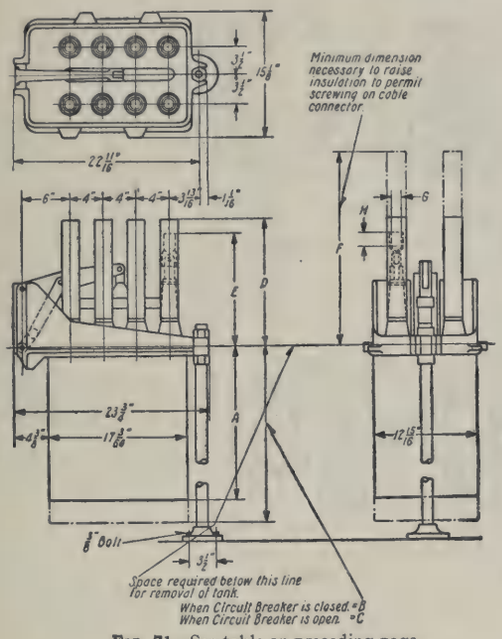


FIG. 71—See table on preceding page.

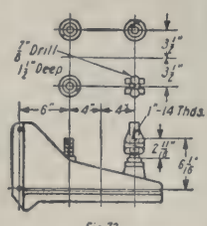


Fig. 72

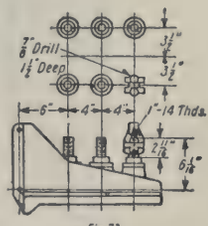


Fig. 73

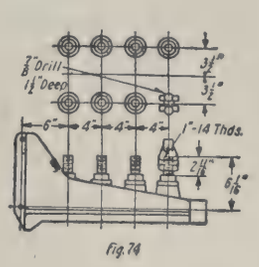


Fig. 74

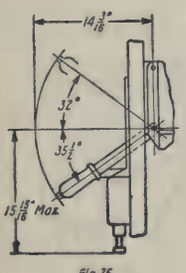


Fig. 75

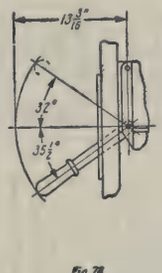


Fig. 76

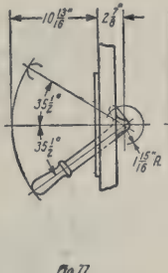


Fig. 77

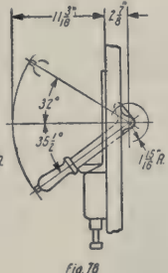


Fig. 78

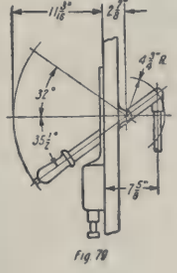


Fig. 79

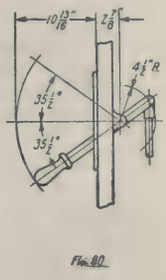


Fig. 80

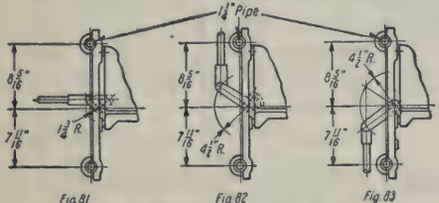


Fig. 81 Fig. 82 Fig. 83

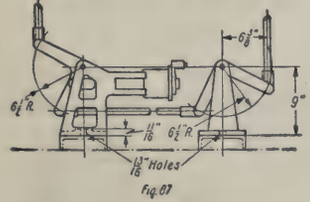


Fig. 87

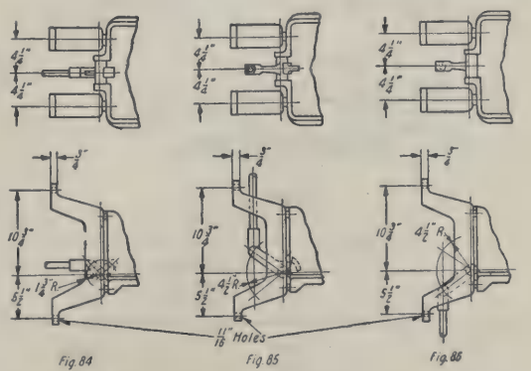


Fig. 84 Fig. 85 Fig. 86

These dimensions are for reference only. For official dimensions apply to the nearest district office.

TYPE F OIL CIRCUIT-BREAKERS—Continued

Dimension Figs. 91 to 98

For References see pages preceding Figs.

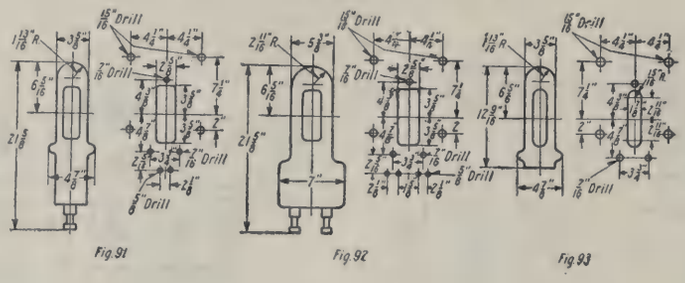


Fig. 91 Fig. 92 Fig. 93

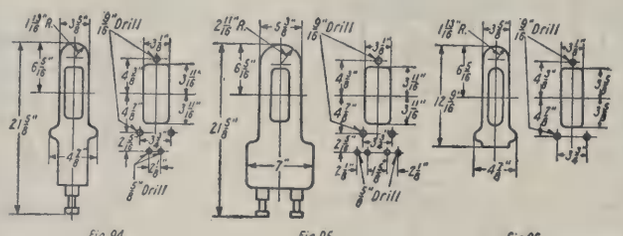


Fig. 94 Fig. 95 Fig. 96

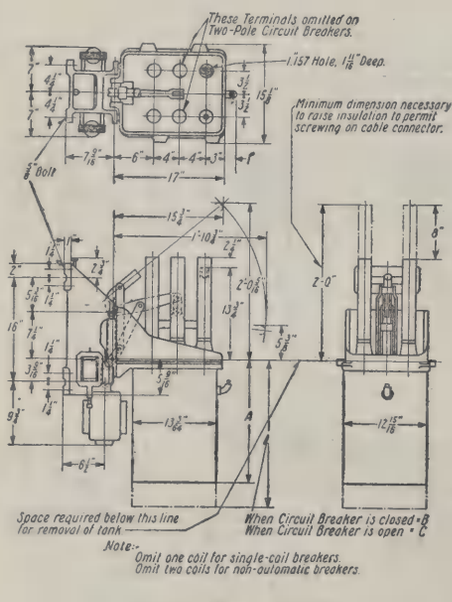

These Terminals omitted on Two-Pole Circuit Breakers.
1.157 Hole, 1 1/8" Deep.
Minimum dimension necessary to raise insulation to permit screwing on cable connector.
Bolt
Space required below this line for removal of tank
When Circuit Breaker is closed = B
When Circuit Breaker is open = C
Note:-
Omit one coil for single-coil breakers.
Omit two coils for non-automatic breakers.

FIG. 97

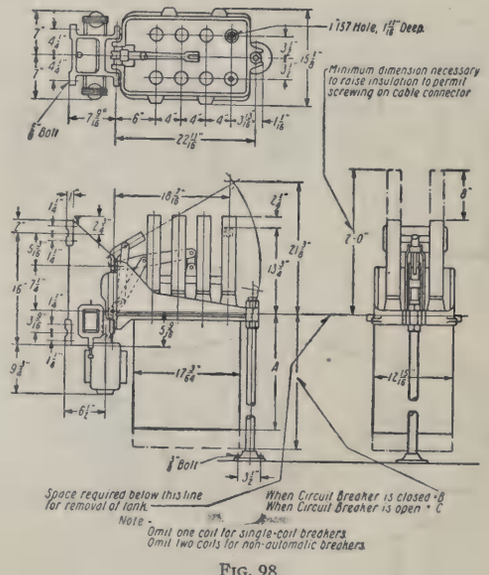

1.157 Hole, 1 1/8" Deep.
Minimum dimension necessary to raise insulation to permit screwing on cable connector
Bolt
Space required below this line for removal of tank
When Circuit Breaker is closed = B
When Circuit Breaker is open = C
Note -
Omit one coil for single-coil breakers.
Omit two coils for non-automatic breakers.

FIG. 98

Fig.	Max. Amp.	Max. Volts	Dimensions in Inches		
			A	B	C
97, 98	500	15000	19 1/16	33	37 1/2
97, 98	800	4500	15 7/16	26 1/4	30 3/4

These dimensions are for reference only. For official dimensions apply to the nearest district office.

TYPE F OIL CIRCUIT-BREAKERS—Continued

Dimension Figs. 102 to 108

For references see pages preceding Figs

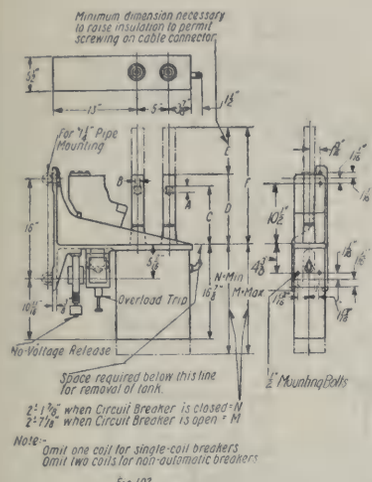

Minimum dimension necessary to raise insulation to permit screwing on cable connector
For ¾" Pipe Mounting
Overload Trip
No-Voltage Release
Space required below this line for removal of tank
Z=1 7/8" when Circuit Breaker is closed=N
Z=7 7/8" when Circuit Breaker is open = M
Note:-
Omit one coil for single-coil breakers
Omit two coils for non-automatic breakers
½" Mounting Bolts

Fig. 102.

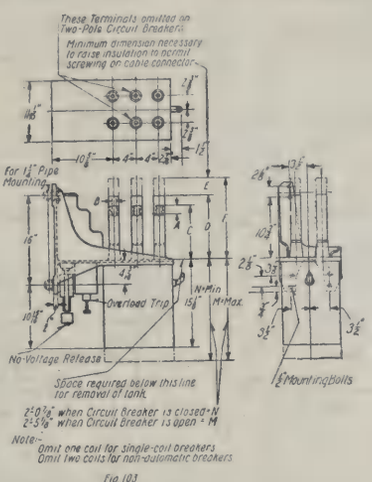

These Terminals omitted on Two-Pole Circuit Breakers
Minimum dimension necessary to raise insulation to permit screwing on cable connector
For 1½" Pipe Mounting
Overload Trip
No-Voltage Release
Space required below this line for removal of tank
Z=0 7/8" when Circuit Breaker is closed=N
Z=5 7/8" when Circuit Breaker is open = M
Note:-
Omit one coil for single-coil breakers
Omit two coils for non-automatic breakers
½" Mounting Bolts

Fig. 103

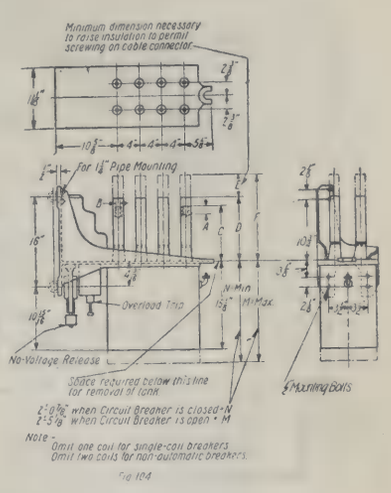

Minimum dimension necessary to raise insulation to permit screwing on cable connector
For 1½" Pipe Mounting
Overload Trip
No-Voltage Release
Space required below this line for removal of tank
Z=0 7/8" when Circuit Breaker is closed=N
Z=5 7/8" when Circuit Breaker is open = M
Note:-
Omit one coil for single-coil breakers
Omit two coils for non-automatic breakers
½" Mounting Bolts

Fig. 104

NOTE—No-voltage release is furnished only on special order.

Fig.	Max. Amp.	Max. Volts	Dimensions in Inches					
			A	B	C	D	E	F
102, 103, 104	300	7500	1	.747	$7\frac{15}{16}$	10	$6\frac{1}{4}$	$16\frac{1}{4}$
102, 103, 104	500	7500	$1\frac{1}{16}$	1.157	$9\frac{11}{16}$	$11\frac{1}{2}$	$6\frac{3}{4}$	$18\frac{1}{4}$
102, 103, 104	600	4500	$1\frac{1}{16}$	1.385	$9\frac{11}{16}$	$11\frac{1}{2}$	$6\frac{3}{4}$	$18\frac{1}{4}$

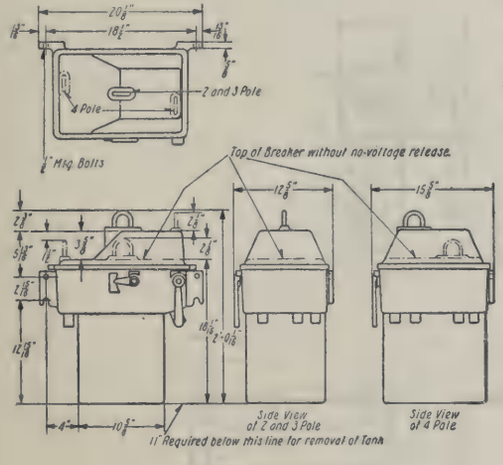

2 and 3 Pole
4 Pole
Top of Breaker without no-voltage release.
Mtg. Bolts
Side View of 2 and 3 Pole
Side View of 4 Pole
Required below this line for removal of tank

Fig. 107

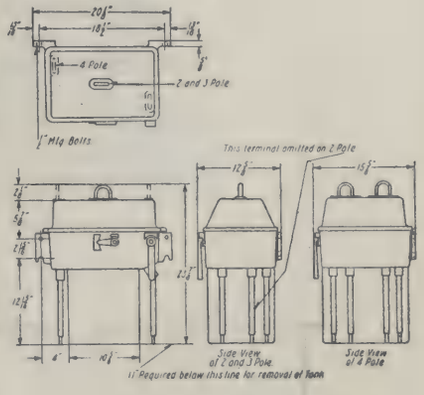

4 Pole
2 and 3 Pole
Mtg. Bolts
This terminal omitted on 2 Pole
Side View of 2 and 3 Pole
Side View of 4 Pole
Required below this line for removal of tank

Fig. 108

These dimensions are for reference only. For official dimensions apply to the nearest district office.

TYPE F OIL CIRCUIT-BREAKERS—Continued

Dimension Figs. 109 to 111

For references see pages preceding Figs.

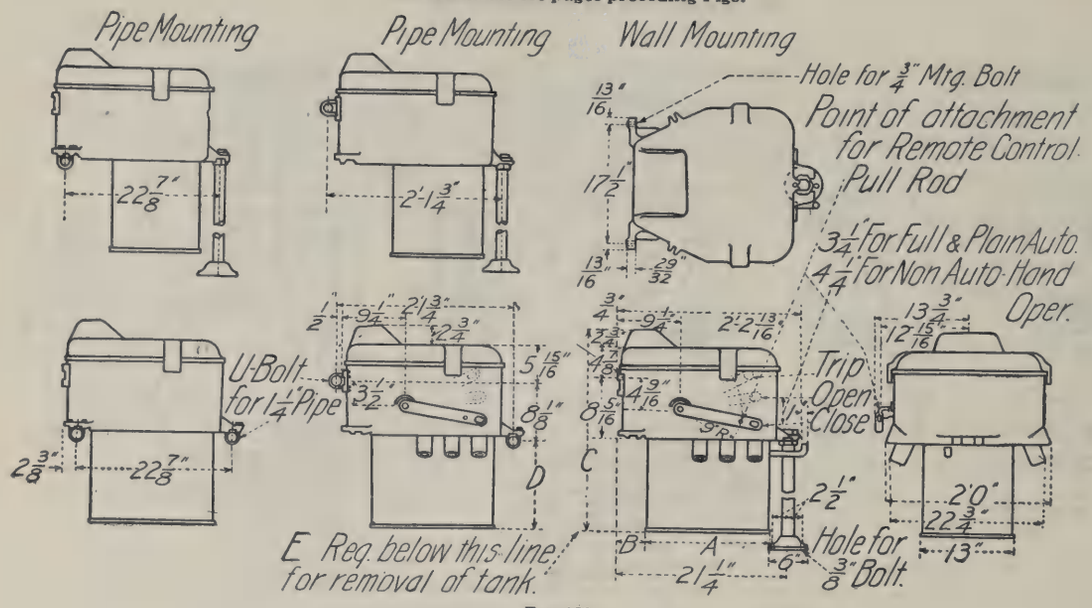

Pipe Mounting
Pipe Mounting
Wall Mounting
Hole for 3/4" Mtg. Bolt
Point of attachment for Remote Control Pull Rod
3 1/4" For Full & Plain Auto.
4 1/4" For Non Auto-Hand Oper.
U-Bolt for 1 1/4" Pipe
Trip
Open
Close
E Req. below this line for removal of tank.
Hole for 3/8" Bolt

FIG. 109

Style No.	Dimensions in Inches A	B	C	D	E
216901 to 216922	18 3/8	4 3/8	31	14 3/16	14 1/2
216923 to 216930	13	9 3/4	31	14 3/16	14 1/2
216931 to 216948	18 3/8	4 3/8	34	17 1/8	17 1/2
216949 and 216950	13	9 3/4	34	17 1/8	17 1/2

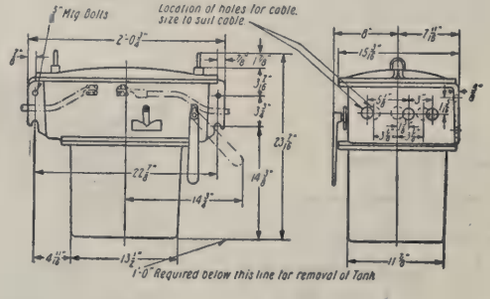


FIG. 110

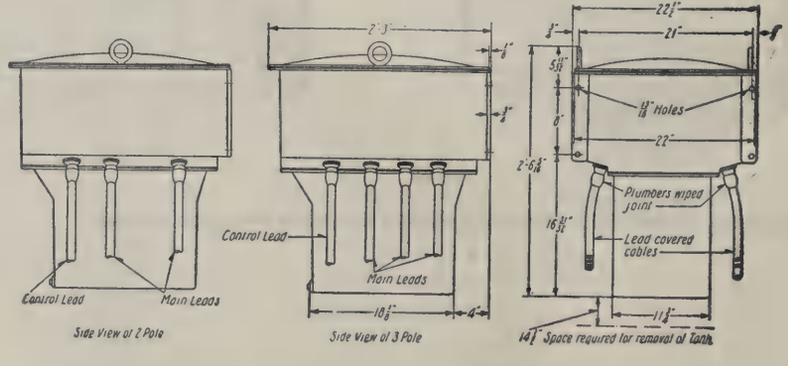


FIG. 111

These dimensions are for reference only. For official dimensions apply to the nearest district office.

TYPE F OIL CIRCUIT-BREAKERS—Continued

Dimension Figs. 112 to 122

For references ▬ pages preceding Figs.

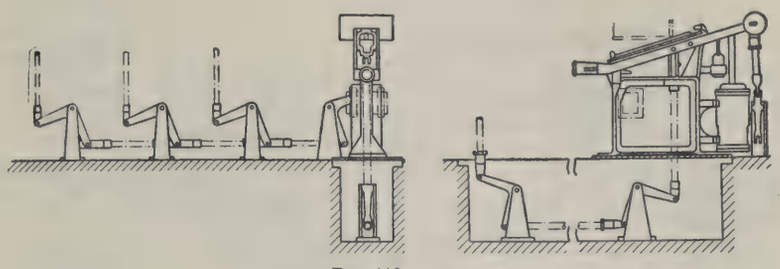


FIG. 112

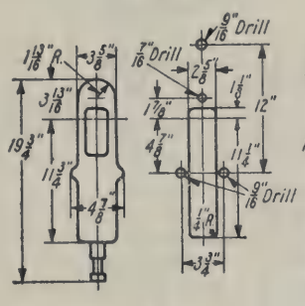


Fig. 118

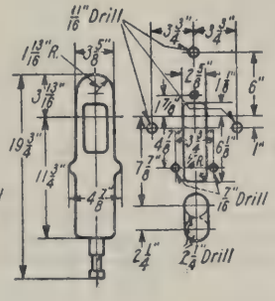


Fig. 119

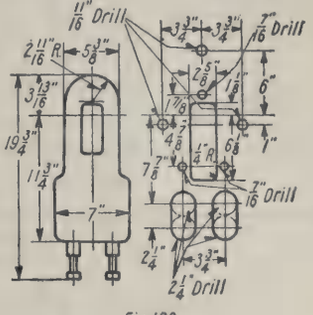


Fig. 120

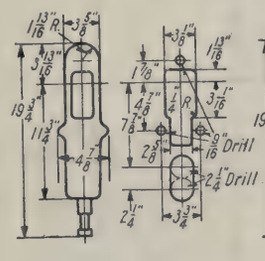


Fig. 121

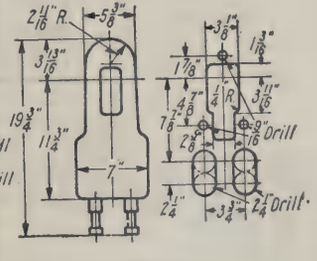


Fig. 122

These dimensions are for reference only. For official dimensions apply to nearest district office.

TYPE F OIL CIRCUIT-BREAKERS—Continued

Dimension Figs. 123 to 126

For references see pages preceding Figs.

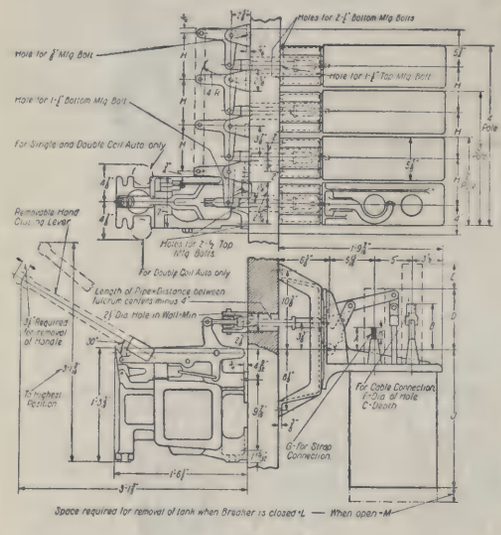

Holes for 2-⅞" Bottom Mtg. Bolts
Hole for ⅞" Mtg. Bolt
Hole for 1-⅞" Top Mtg. Bolt
Hole for 1-⅞" Bottom Mtg. Bolt
For Single and Double Coil Auto only
Removable Hand Closing Lever
Holes for 2-⅞ Top Mtg. Bolts
For Double Coil Auto only
Length of Pipe=Distance between fulcrum centers minus 4"
2½" Dia. Hole in Wall-Min.
31" Required for removal of Handle
To Highest Position
For Cable Connection F-Dia. of Hole C-Depth
G-for Strap Connection
4 Pole
Space required for removal of tank when Breaker is closed-L — When open-M

FIG. 123

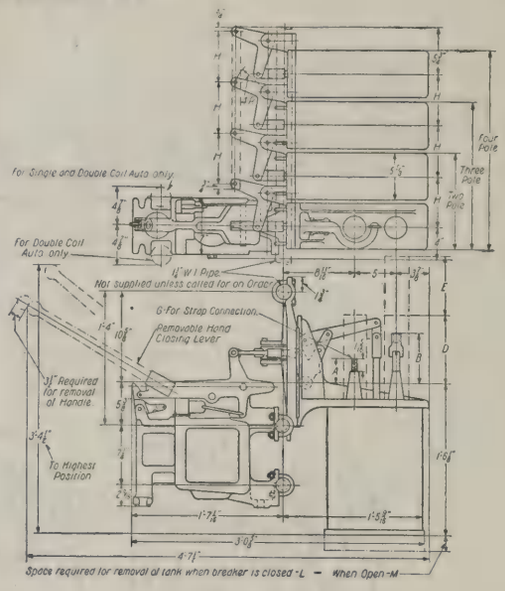

For Single and Double Coil Auto only
For Double Coil Auto only
4" W I Pipe
Not supplied unless called for on Order
G-For Strap Connection
Removable Hand Closing Lever
31" Required for removal of Handle
To Highest Position
Four Pole
Three Pole
Two Pole
Space required for removal of tank when breaker is closed-L — When Open-M

FIG. 124

Fig. No.	Volts	Amps.	Dimensions in Inches Corresponding to Letters in Outline Views										
			A	B	C	D	E	F	G Thds.	H	J	K	L	M
123-4	7500	300	$2\frac{11}{16}$	$5\frac{15}{16}$	1	8	$6\frac{5}{8}$	.747	$\frac{7}{8}$—16	9	$18\frac{1}{8}$	$1\frac{5}{16}$	$9\frac{3}{4}$	15
123-4	7500	500	$2\frac{11}{16}$	$7\frac{11}{16}$	$1\frac{11}{16}$	$9\frac{1}{2}$	$7\frac{1}{4}$	1.157	$\frac{7}{8}$—16	9	$18\frac{1}{8}$	$1\frac{5}{16}$	$9\frac{3}{4}$	15
123-4	4500	600	$2\frac{3}{4}$	$7\frac{15}{16}$	$1\frac{13}{16}$	$9\frac{1}{2}$	$7\frac{1}{4}$	1.385	1—14	6	$18\frac{1}{8}$	$1\frac{5}{16}$	$9\frac{3}{4}$	15
125	7500	300	$2\frac{11}{16}$	$5\frac{15}{16}$	.747	1	8	$6\frac{5}{8}$	$\frac{7}{8}$—16	9	$18\frac{1}{8}$	$1\frac{5}{16}$	$9\frac{3}{4}$	15
125	7500	500	$2\frac{11}{16}$	$7\frac{11}{16}$	1.157	$1\frac{11}{16}$	$9\frac{1}{2}$	$7\frac{1}{4}$	$\frac{7}{8}$—16	9	$18\frac{1}{8}$	$1\frac{5}{16}$	$9\frac{3}{4}$	15
125	4500	600	$2\frac{3}{4}$	$7\frac{15}{16}$	1.385	$1\frac{13}{16}$	$9\frac{1}{2}$	$7\frac{1}{4}$	1—14	6	$18\frac{1}{8}$	$1\frac{5}{16}$	$9\frac{3}{4}$	15
126	7500	300	$2\frac{11}{16}$	$5\frac{15}{16}$	1	8	$6\frac{5}{8}$	.747	$\frac{7}{8}$—16	9	....	....	....	..
126	7500	500	$2\frac{11}{16}$	$7\frac{11}{16}$	$1\frac{11}{16}$	$9\frac{1}{2}$	$7\frac{1}{4}$	1.157	$\frac{7}{8}$—16	9	....	....	....	..
126	4500	600	$2\frac{3}{4}$	$7\frac{15}{16}$	$1\frac{13}{16}$	$9\frac{1}{2}$	$7\frac{1}{4}$	1.385	1—14	6	....	....	....	..

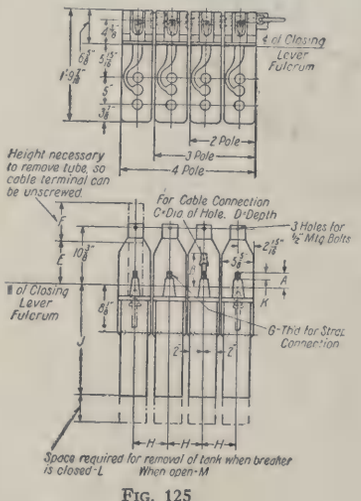

℄ of Closing Lever Fulcrum
2 Pole
3 Pole
4 Pole
Height necessary to remove tube, so cable terminal can be unscrewed
For Cable Connection C-Dia of Hole, D-Depth
3 Holes for ½" Mtg. Bolts
℄ of Closing Lever Fulcrum
G-Thd. for Strap Connection
Space required for removal of tank when breaker is closed-L When open-M

FIG. 125

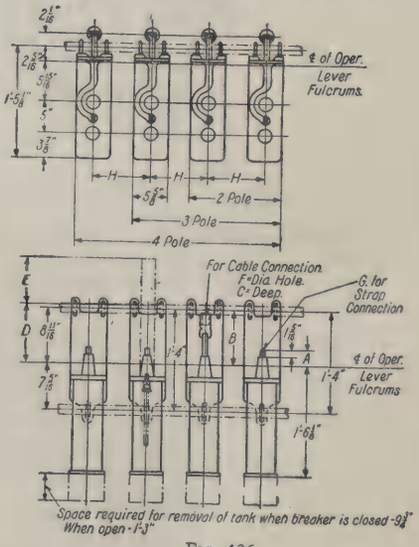

℄ of Oper. Lever Fulcrums
2 Pole
3 Pole
4 Pole
For Cable Connection F-Dia. Hole. C-Deep.
G. for Strap Connection
℄ of Oper. Lever Fulcrums
Space required for removal of tank when breaker is closed-9¾" When open-1'-3"

FIG. 126

These dimensions are for reference only. For official dimensions apply to the nearest district office.

TYPE F OIL CIRCUIT-BREAKERS—Continued

Dimension Figs. 127 to 129

For references see pages preceeding Figs.

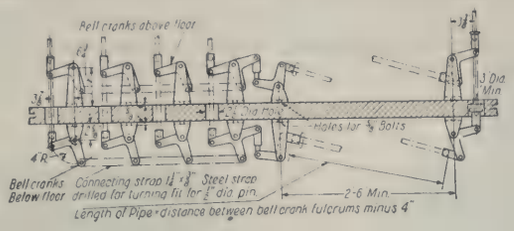

Bell cranks above floor
Holes for ⅝ Bolts
Bell cranks Below floor
Connecting strap 1¼"×⅜" Steel strap drilled for turning fit for ½" dia pin
2'-6 Min
Length of Pipe + distance between bell crank fulcrums minus 4"

FIG. 127

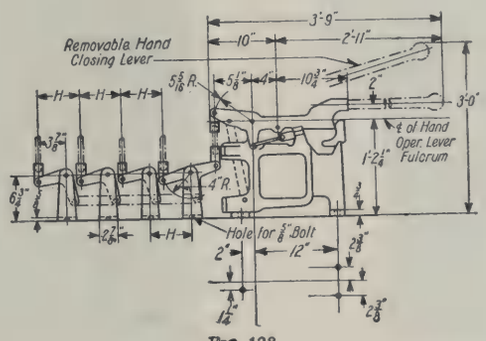


FIG. 128

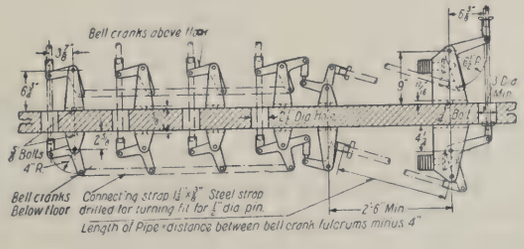

Bell cranks above floor
⅝ Bolts
4" R
Bell cranks Below floor
Connecting strap 1¼"×⅜" Steel strap drilled for turning fit for ½" dia pin
2'-6" Min
Length of Pipe + distance between bell crank fulcrums minus 4"

FIG. 129

These dimensions are for reference only. For official dimensions apply to the nearest district office.

OIL CIRCUIT-BREAKER ACCESSORIES

FOR TYPES I, D, H, QF, AND F BREAKERS

For additional accessories—terminals, control relays, controllers — see Section 2-B on "Switchboard Accessories."

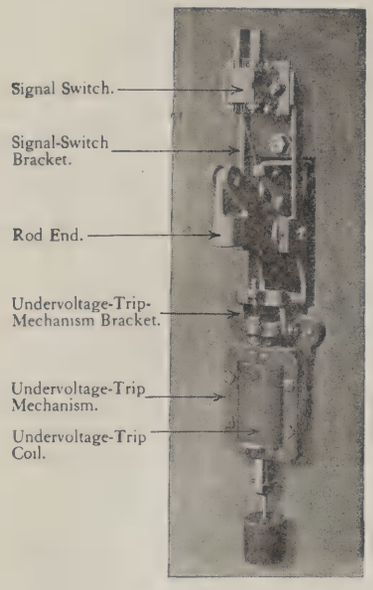


FIG. 1—REAR OF LONG-THROW COVERPLATE FOR SINGLE-THROW UPWARD-PULL BREAKER, SHOWING ACCESSORIES INSTALLED

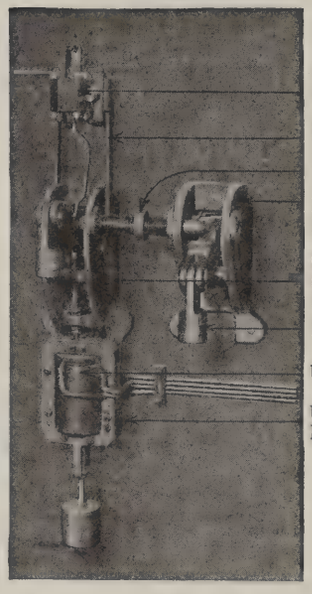


FIG. 2—REAR OF SINGLE-HANDLE COVERPLATE OF TWO INTERLOCKED BREAKERS—SHOWING ARRANGEMENT OF INTERLOCKING, ALSO SHOWING ACCESSORIES INSTALLED ON ONE COVERPLATE

On the following pages are listed attachments and auxiliaries adapted particularly for use with Westinghouse types I, D, H, QF, and F oil circuit-breakers. In some cases one or more of these are included with the standard circuit-breaker as noted and listed on pages on the various types of oil circuit-breakers; in general these accessories should be ordered as separate items—in all cases they should be ordered at the same time that the breaker is ordered; they will then be shipped mounted on the breaker. Their application to any particular breaker can be determined definitely only by reference to the Company.

One or more of the oil circuit-breaker tripping accessories listed can be used without or in combination with the current overload trip coils mounted on the operating-handle coverplate as stated for the various types of oil circuit-breakers.

The coils in the accessories listed will carry their full-rated current continuously with a **temperature rise** not to exceed 50 degrees Centigrade above the surrounding atmosphere; corrections to be made as specified by A. I. E. E. rules when the temperature of the surrounding atmosphere is other than 25 degrees Centigrade.

Approximate weights and dimensions (where not shown) will be furnished on request. In general, the weight of the accessory will not materially affect the shipping weight of any breaker.

Current and voltage transformers and relays are described and listed in catalogue 3-B on "Instruments and Relays," and control relays, on another page of this section.

For **diagrams** of typical connections of circuit-breakers and circuit-breaker accessories, see pages on "Oil Circuit-Breakers,—General Information" and "Switchboard Data Book".

TRIP-MAGNET FRAMES

These trip-magnet frames (laminated or solid, depending upon whether the application is for alternating-current or direct-current) are for mounting the trip coils specified to the breaker mechanism. Each includes the bracket (frame proper), the trip mechanism, and the magnetic circuit complete for one coil—but does not include the coil, (for which see following page).

Alternating-Current Underload-Trip Attachment—The underload trip attachment listed (made up of an underload trip-magnet frame and underload trip coil) trips the breaker at approximately 50 per cent of normal load or less. Five-ampere trip coils should be used with 5-ampere-secondary current transformers; these coils are connected in the circuit the same as the overload coils (see diagrams of connections under "Oil Circuit-Breakers—General Information."

Undervoltage-Trip Attachment—The standard undervoltage-trip attachment (made up of undervoltage trip-magnet frame and undervoltage trip coil) trips the breaker at approximately 50 per cent of normal voltage or less.

Style number includes frame complete without coil. List price includes mechanism complete with trip coil which must be specified from tables on the following.

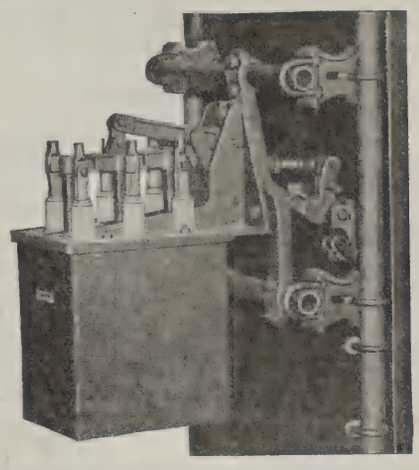


FIG. 3—PIPE-MOUNTING BRACKETS SUPPORTING A PANEL-FRAME-MOUNTING TYPE F-1 OIL CIRCUIT-BREAKER

Trip Magnet Frames for Alternating-Current Underload or Undervoltage-Trip Mechanisms on Manually-Operated Types F-1, F-2 and F-3 Oil Circuit-Breakers

Operation of Reset	For Breaker: Description	For Breaker: Type	For Breaker: Number Poles	Style No.	List Price
Automatic†	Single-throw panel-mounting	F-2	1	214077	$33 50
		F-1, F-2	2, 3, 4	214078	33 50
		F-3	2, 3, 4	214079	33 50
Automatic†	Single-throw remote-control with bracket for interlocking bar	F-2, F-1	1, 2, 3, 4	214081	35 00
		F-3	2, 3, 4	214083	35 00
Automatic†	Single-throw remote-control without bracket for interlocking bar	F-2, F-2	1, 2, 3, 4	214080	33 50
		F-3	2, 3, 4	214082	33 50
Automatic	Double-throw panel-mounting	F-2	1	214858*	61 00
			2, 3, 4	214135*	61 00
Hand	Double-throw panel-mounting	F-2	1	214859	61 00
			2, 3, 4	On Request	On Request
Automatic	Double-throw remote-control	F-1, F-2	2, 3, 4	214858*	61 00
		F-3	2, 3, 4	214860*	61 00
Hand	Double-throw remote-control	F-1, F-2	2, 3, 4	214859	61 00
		F-3	2, 3, 4	214861	61 00

†Hand reset can be supplied on special order. *Two required for each double-throw breaker.

Trip Magnet Frames for Alternating-Current Overload, Shunt, or Overvoltage Trip on Electrically-Operated Types F-2 and F-3 Oil Circuit-Breakers

Trip	For Breaker: Type	For Breaker: Number Poles	Style No.	List Price
Overload, Shunt, or Overvoltage	F-2	1	214140	$26 50
	F-2	2, 3, 4	214141	29 00
	F-3	2, 3, 4	214142	29 00
Undervoltage	F-2	1	214133	34 50
	F-2	2, 3, 4	214134	34 50
	F-3	2, 3, 4	214084	34 50

OIL CIRCUIT-BREAKER ACCESSORIES—Continued

TRIP COILS

These coils are for mounting in the proper trip-magnet frames listed above for obtaining on types QF and F manually-operated or type F electrically-operated oil circuit-breakers the method of trip designated. Some of these coils can be mounted on the standard automatic-overload coverplate of the types QF and F breakers. The coils must be ordered separately.

Style number and list price include complete coil but do not include frame or coverplate.

Note—Frame list prices on the previous page include the necessary trip coil.

Trip Coils for Overload, Underload, and Undervoltage Trip

Trip	Volts	Amperes	25 Cycle		60 Cycle	
			Style No.	List Price	Style No.	List Price
Overload or Underload	...	5	224185	$6 00	224185	$6 00
Undervoltage	110	.....	148909	.....	148908	.....
	220	.....	148907	.....	148909	.....
	440	.....	165220	.....	148907	.....
	550	.....	201482	.....	241504	.....

Trip Coils for Shunt Trip

Nominal Volts	Standard Operating Range		For Direct-Current Circuits		For Alternating-Current Circuits			
					25-Cycle		60-Cycle	
	Minimum Volts	Maximum Volts	Style No.	List Price	Style No.	List Price	Style No.	List Price
110	60	125	256857	$8 10	148908	$6 00	256859	$7 75
220	120	250	201482	11 60	148909	5 45	148908	6 00
440	240	500	256858	8 85	148907	7 30	148906	5 00
550	600	630	201397	10 20	241504	8 00	148909	5 45

Trip Coils for Overvoltage Trip

The overvoltage coils listed are calibrated (coils cold) between the standard calibration range shown. An error of approximately 20 per cent maximum is possible within the permissible temperature rise.

The scales on the overvoltage trip magnets can be marked to compensate for any given working temperature on special order; price on request.

Nominal Volts	Standard Calibration Range		For Alternating-Current Circuits Only			
			25-Cycle		60-Cycle	
	Minimum Volts	Maximum Volts	Style No.	List Price	Style No.	List Price
110	110	220	148909	$5 45	148908	$6 00
220	220	440	148907	7 30	148909	5 45
440	440	880	165220	7 90	148907	7 30
550	550	1100	201482	15 00	241504	8 00

Trip Coils for Series Trip

On Types F-1 and F-2 Circuit-Breakers Only
For Voltages Up to 2500‡

These dry-type series coils can be mounted in the standard overload-trip magnet frame listed on a preceding page or on the standard panel or remote control automatic coverplate of the types F-1 and F-2 breakers.

Amps.	Style No.	List Price	Amps.	Style No.	List Price
10	214144	$10 00	100	214148	$10 00
25	214145	10 00	150	214149	11 00
50	214146	10 00	200	214150	11 00
75	214147	10 00	300	214151	11 50

‡*Although these coils are for 2500-volt service, engineering practice indicates that panel-mounting series trip coils exposed to the air should not be used on service voltages exceeding 750 volts. For service voltages greater than 750 volts transformer trip-coils or series-trip coils under oil are recommended.*

Order by Style Number

INVERSE-TIME-LIMIT ATTACHMENTS

For Illustration see fourth page of Type F Circuit-Breakers

Adjustable inverse-time limit attachments are listed for direct mounting on the current trip magnets of the overload-trip coverplates and electric-operating-mechanism of all type F automatic oil circuit-breakers except the manually operated multiple multipole.

The attachments for use on coverplates of manually-operated breakers are of the disc-type and are adjustable by varying the area of the moving disc that is directly opposed to the stationary disc. On 100 per cent overload a time-element of approximately 5 seconds is obtainable, and by adjustment this may be varied downwards to 0. A longer time-element may be obtained up to approximately 10 seconds by using a heavier oil than that provided with the attachment; but the heavier oils are affected to a much greater extent by differences of temperature than the standard oil furnished, and do not allow of as quick resetting of the discs. Instructions for mixing heavier oil and for adjustment are furnished with the attachment.

The attachment for use on electrically operated breakers is on the plunger type. The time adjustment on this form is made by varying the opening of the valve discs on the plunger. For mounting this attachment on electrically-operated breakers having floor-mounted operating-magnet mechanisms, it will be necessary with some breakers to mount the mechanism higher than its normal position on the floor.

The use of the inverse-time-limit attachment does away with the necessity for relays where an inverse-time-limit characteristic on the overload feature is desired.

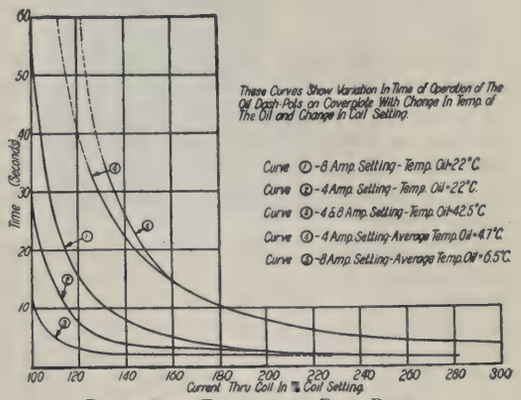

These Curves Show Variation In Time of Operation of The Oil Dash-Pots on Coverplate With Change In Temp. of The Oil and Change in Coil Setting.
Curve ①-8 Amp. Setting-Temp. Oil-22°C.
Curve ②-4 Amp. Setting-Temp. Oil-22°C.
Curve ③-4 & 8 Amp. Setting-Temp. Oil-42.5°C.
Curve ④-4 Amp. Setting-Average Temp. Oil-4.7°C.
Curve ⑤-8 Amp. Setting-Average Temp. Oil-6.5°C.
Time (Seconds)
60
50
40
30
20
10
100 120 140 160 180 200 220 240 260 280 300
Current Thru Coil In % Coil Setting.

FIG. 4—TIME ELEMENT OF DASH-POTS

Style number and list price include attachment complete for use with an alternating-current overload coil of either panel-mounting or manual or electric remote-control type F oil circuit-breakers.

Style No.	Description	List Price
214143	For manually-operated breaker	$12 00
256852	For electrically-operated breaker	32 00

Order by Style Number

DIRECT-TRIP ATTACHMENTS

Conditions are often found where a reliable source of direct-current or alternating-current is not available for operating the shunt-trip coils of alternating-current breakers through contact-closing relays; for this purpose the direct-trip attachment is provided. This attachment consists of a retaining magnet mounted on the alternating-current trip magnets of the switchboard coverplate or the electrical operating mechanism of an automatic breaker. It operates to prevent the tripping plunger from acting to trip the breaker until the circuit-closing relay operates to cut out the attachment magnet. It requires no separate power circuit and is applicable with circuit-closing relays in place of series-trip relays of the circuit-opening type. It is operated from the same current transformers as operate the relays and the breaker trip coils, and may be used with either overload relays or reverse-power relays.

FIG. 5—DIRECT-TRIP ATTACHMENT APPLIED ON SINGLE-HANDLE TWO-COIL COVERPLATE

Under conditions of extreme secondary current in the current transformers, the direct-trip attachment will not always prevent the breaker from operating until the relay contacts have closed. This condition applies when this current is over 100 amperes. The determination of whether such excessive currents will apply to any particular installation depends upon the amount of power which can be fed into the breaker on short-circuit (similar to the ultimate interrupting capacity of a circuit-breaker) and the type of current transformer used. Certain current transformers, while limiting the amount of secondary current which could flow regardless of the amount of primary current, are not satisfactory for use in connection with the direct-trip device in view of their inaccuracy under the additional load imposed by the direct-trip device, and also because accurate relay operation cannot be obtained from such transformers. On the other hand, the transformers which have sufficient capacity to provide accurate operation with this extra load in the secondary circuit, are such as to pass more than 100 amperes through the secondary circuit if sufficient power is connected to the primary circuit, thus requiring the use of inductive shunts under such conditions.

OIL CIRCUIT-BREAKER ACCESSORIES—Continued

In view of the above conditions the transformers which may or may not be used are as follows:

Current transformers types A, KR and FR, all capacities; types FS and FB under 1600 amperes primary capacity; and all bushing-type transformers operating from circuit-breaker terminals, should not be used in connection with the direct-trip attachment.

Current transformers, types FS and FB of 1600 amperes primary capacity and above, and all capacity transformers types KA, KB, KC, OA, OB and OC may be used to operate the direct-trip attachment, and will provide for accurate operation of the types CO or CR relays, and an ammeter in connection therewith.

As the allowable transformers may, under certain conditions, all deliver over 100 amperes secondary, it is necessary to provide inductive shunts, of which there are two sizes. These shunts divert a portion of the current from the trip coil so that the holding

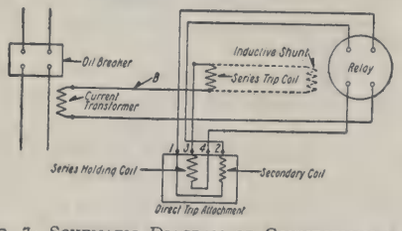


FIG. 7—SCHEMATIC DIAGRAM OF CONNECTIONS FOR SINGLE-PHASE CIRCUITS

coil is strengthened at the expense of the tripping coil, to the end that the holding coil prevails, regardless of current flowing, until the relay contacts may be closed when tripping occurs. Expressed in terms of the primary rating of the current transformers, the three methods of application can be stated as follows:

First; direct-trip attachment to be used without shunt when the primary current will not reach 20 times the rated primary of the transformer.

Second; direct-trip attachment to be used with small shunt Style No. 232714, where the primary current may reach 20 times and not exceed 35 times the rated primary of the transformer.

Third; the direct-trip attachment to be used with large shunt Style No. 232715, where the primary current may be in excess of 35 times the rated primary current of the transformer.

An example of the above is as follows:

When applying the device connected to transformers of 80 to 5 amperes ratio where the short-circuit current in the system may reach 2000 amperes, the small shunt must be used since 2000 amperes is 25 times 80, the rated primary of the transformer. If the short-circuit current could reach as high as 3200 amperes the large shunt would be required, as this is 40 times 80 amperes.

In considering the primary current to which the transformer may be subjected under short-circuit conditions, apply the same rules as for determining the circuit-breaker capacity, or submit all possible data as to the connected power and the reactance of the generators, transformers, and line, and any other modifying conditions, to the company, when entering an order for these attachments.

FIG. 6—DIRECT-TRIP ATTACHMENT

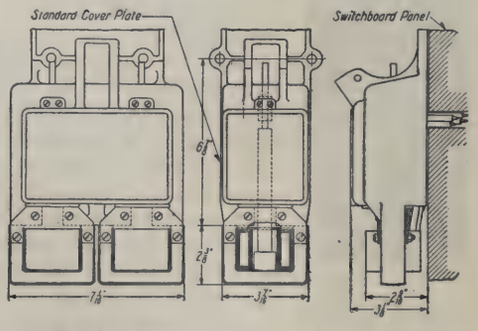
It is recommended that the device be ordered with the breaker or coverplate upon which it is to be used. When there is any doubt as to the feasibility of a particular application of this attachment under any conditions whatever, it is preferable to submit the proposition to the company for a recommendation

Where reliable shunt tripping can be obtained, this will generally be considered preferable to the direct-trip attachment but the direct-trip attachment will generally be more satisfactory than any form of series-trip relay so far placed on the market.

List price includes the direct-trip attachment applied to standard Westinghouse circuit-breaker coverplates or sold separately from breaker. One attachment with or without shunt is required for each current trip coil.

Style No	Description	List Price
209741	Direct-Trip Attachment	$13 00
232714	Small Inductive Shunt	7 20
232715	Large Inductive Shunt	11 50

Order by Style Number



DIRECT-TRIP ATTACHMENT SHOWN APPLIED TO DOUBLE-COIL-BREAKER COVERPLATE

DIRECT-TRIP ATTACHMENT SHOWN APPLIED TO SINGLE COIL-BREAKER COVERPLATE

FIG. 8—APPROXIMATE DIMENSIONS

OIL CIRCUIT-BREAKER ACCESSORIES—Continued

SIGNAL AND SHUNT-TRIP CUT-OUT SWITCHES

These are double-pole double-throw switches used for controlling the signal-lamp circuit, and for electrically interlocking or tripping other circuit-breaker apparatus. The standard switches are for mounting on the rear of the remote-control single or double-handle coverplate of the remote-control oil breakers or on the frame of the panel-mounting breakers.

While insulated for 250 volts and capable of conducting 15 amperes, these switches will not open the circuit with more than 5 amperes at 250 volts or 10 amperes at 125 volts.

Style number and list price include switch, bracket, connecting link, and bolts complete for mounting—one switch is required per handle.

FIG. 9—SIGNAL SWITCH COMPLETE WITH BRACKET MOUNTED ON TOP OF PANEL-MOUNTING TYPE F-2 BREAKER

FOR MOUNTING ON COVER PLATE OF BREAKER	Type	Number Poles	Throw	Style No.	List Price
PANEL MOUNTING	F-1	2, 3, 4	Single	240477	$11 00
	F-2	1, 2, 3, 4	Single	240477	11 00
	F-2	2, 3	Double	240475	11 00
	F-2	4	Double	240476	11 00
	F-3	2, 3, 4	.....	240478	11 00
	QF	4	Double	240475	11 00
REMOTE CONTROL	F-3	2, 3, 4	Single	214857	$9 35
	F-1	2, 3, 4	Single	214856	9 35
	F-2	1, 2, 3, 4	Single		
	F-3	2, 3, 4	Double	214857	9 35
	F-1 F-2	1, 2, 3, 4	Double	214856	9 35

BELL-ALARM SIGNAL-CONTACT ATTACHMENTS

Bell-alarm signal-contact attachments are used for closing a low-voltage signal circuit when the breaker trips automatically (the breaker can be tripped by hand without actuating this attachment).

This attachment can be mounted directly on all the automatic-over-load trip coverplates of the manually-operated panel mounting or remote-control oil circuit-breakers.

Style number and list price include device complete for either panel-mounting or remote-control type QF oil circuit-breakers.

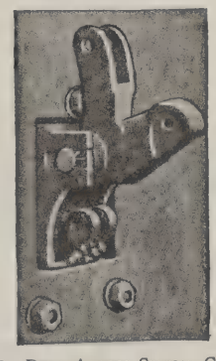


FIG. 10—BELL-ALARM SIGNAL-CONTACT ATTACHMENT ON REAR OF COVER-PLATE OF SINGLE-THROW HORIZONTAL-PULL BREAKER

Style No.	List Price
214182	$10 00

Order by Style Number

MICARTA TERMINAL-INSULATING TUBES

It is recommended on the pages on the various types of oil circuit-breakers that all terminals be insulated (after installation) on breakers used on circuits of 2200 volts and higher. This can be done most easily and satisfactorily by slipping over the terminal and lead one moisture-proof micarta tube per terminal, such tubes being made especially for this purpose. These tubes are not closed at the end so that a cap at the top (made by taping or otherwise) should preferably be added to keep out dirt. Wood caps, for use with any tube listed, can be supplied on special order for any given cable diameters; prices on request.

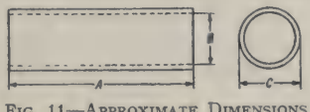


FIG. 11—APPROXIMATE DIMENSIONS

OIL CIRCUIT-BREAKER ACCESSORIES—Continued

Breaker			Dimensions, Inches			Style No.	List Price
Type	Amps.	Volts	A	B	C		
D	300	7500	10	2⅜	2⅝	199124	$1 90
F-1	200–300	4500	9	1⅝	1⅞	199123	1 60
F-2	300	7500	10	2⅜	2⅝	199124	1 90
F-2	500 600	7500 4500	11½	2⅜	2⅝	199125	2 20
F-3	500	13200	12¾	1⅞	2⅛	211846	2 30
F-3	800	4500	11½	2⅜	2⅝	199125	2 20

SPECIAL MOUNTING BRACKETS

Fig. 12—Wall-Mounting Bracket Supporting Type F-1 Panel-Mounting Breaker with Remote-Control Coverplate

Separate Wall-Mounting

For mounting standard panel-mounting breakers with remote-control coverplate directly on the wall. In the case of the type D oil breaker only the breaker may be mounted with direct control handle.

Style number and list price include bracket complete with U-bolts or mounting bolts.

For Remote-Control Breaker					Bracket		List Price
Type	Throw	Poles	Amps.	Volts	Number Required Per Breaker	Style No.	
D	Single	2, 3, 4	200	4500	1	219947	$8 85
			300	1500	1	219948	8 85
			300	7500	1	219943	9 25
D	Double	2, 3, 4	200	4500	1	219955	9 00
			300	1500	1	219856	9 25
			300	7500	1	219943	9 25
F-1 F-2	.....	2, 3, 4	all	all	1	217881	7 50
F-2	.....	1	all	all	1	207243	6 80
F-3	.....	2, 3, 4	all	all	2	33151	4 00

Order by Style Number

Separate Pipe-Mounting Brackets

For mounting standard panel-mounting breakers with remote-control coverplate directly on two parallel pipes, horizontally mounted, one 16 inches above the other. These parallel pipes (1¼-inch standard pipe size) are to be supplied by the user and may be supported in any manner desirable (by pipe or angle iron frame work properly braced)as no other support is required for the breaker, except in some cases the addition of the rear pipe support for breaker as is required in other methods of mounting.

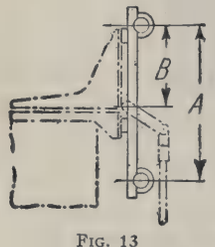


Fig. 13

This style of mounting provides a means of support accessible from all sides, and makes unnecessary mounting the apparatus on the station wall.

Style number and list price include bracket complete with U-bolts for 1¼-inch pipe stringers.

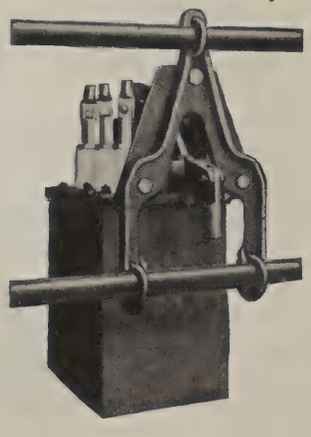


Fig. 14—Pipe-Mounting Bracket Supporting Type F-2 Panel-Mounting Breaker with Remote-Control Coverplate

OIL CIRCUIT-BREAKER ACCESSORIES—Continued

For Breaker					Dimensions, Inches		Bracket		List Price
Type	Number Poles	Throw	Amps.	Volts	A	B	Style No.	Number Required Per Breaker	
For Remote-Control Manually-Operated Breakers									
D	.....	Single	100–200	....	16	7½	127520	1	$5 70
D	.....	Double	100–200	....	16	7 11/16	127520	1	5 70
D	2, 3, 4	Single	200	4500	16	...	219945	1	6 40
D	2, 3, 4	Double	200	4500	16	...	219945	1	6 40
D	2, 3, 4	Single	300	1500	16	7 11/16	219946	1	5 70
D	2, 3, 4	Double	300	1500	16	8 3/16	219946	1	5 70
D	2, 3, 4	Single	300	7500	16	...	219944	1	5 70
D	2, 3, 4	Double	300	7500	16	...	219944	1	5 70
D	.....	Single	300	7500	10	4 13/16	187785	1	5 10
D	.....	Double	300	7500	16	6 3/8	187785	1	5 10
F-1, F-2	2, 3, 4	.....	.....	....	16	...	215183	1	13 00
F-1, F-2	2, 3, 4	.....	.....	....	16	...	187785	1	5 10
F-1, F-2	2, 3, 4	Single	.....	....	16	8 11/16	127520	1	5 70
F-2	1	Single	.....	....	16	8 11/16	207244	1	4 00
F-3	2, 3, 4	.....	.....	....	16	...	215184	1	13 00
F-3	2, 3, 4	Single	.....	....	16	8 5/16	127529	2	43 15

Separate Pipe-Mounting Brackets

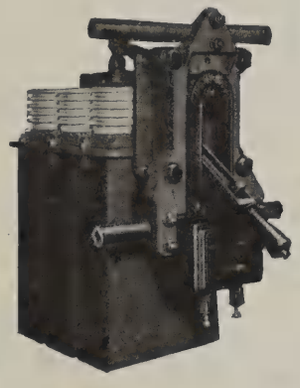


Fig 15—Pipe-Mounting Bracket Supporting Panel-Mounting Breaker and Coverplate

For mounting the standard panel-mounting breakers with coverplate directly on two parallel pipes, horizontally mounted 16 inches center to center.

Style number and list price include bracket complete with U-bolts for 1¼-inch pipe stringers.

For Panel-Mounting Breaker		Bracket		List Price
Type	Poles	Style No.	Number Required Per Breaker	
F-1, F-2	2, 3, 4	215185	1	$13 20
F-2	1	215186	1	13 20
F-3	2, 3, 4	215187	1	13 20

Mounting Bolts

Style number and list price include finished bolt with nut for mounting breakers direct on special mounting brackets or panels.

Type	For Use With Oil Circuit-Breaker		Volts	Style No.	Number Required Per Breaker	List Price
	Poles	Amps.				
D	2, 3, 4	200	4500	219154	3	$0 40
D	2, 3, 4	300	1500–7500	219153	3	40
F-1, F-2	2, 3, 4	...	.....	214582	3	40
F-2	1	...	.....	214121	3	40
F-3	2, 3, 4	...	.....	33112	4	2 85

Order by Style Number

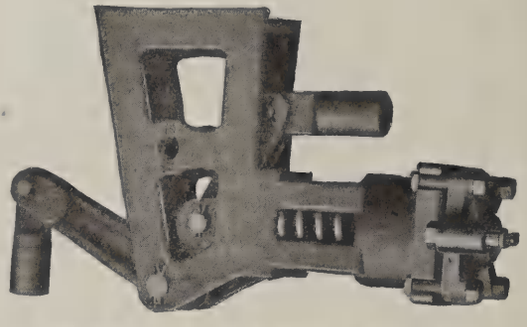
REMOTE-CONTROL DETAILS FOR OIL CIRCUIT-BREAKERS

A line of automatic and non-automatic coverplates with handles and coils, coverplate mounting bolts, levers, accelerating devices, and bell cranks, is listed to supply the need for the most common arrangements of type F manually-operated single and double-throw remote-control oil circuit-breakers. For description of methods of mounting and limiting conditions of operation of remote-control circuit-breakers, see pages on "Oil Circuit-Breakers—General Information" and the sections on the different types of breakers.

Attachments necessary for less common remote-control arrangements and for special conditions will be supplied on special order, prices on request.

BELL-CRANK ACCELERATING AUXILIARIES

Above and Below Floor Mounting



Above and Below-Floor Mounting with Dashpot

Fig. 16—Bell-Crank Accelerating Auxiliaries

Style number and list price include auxiliary complete with bracket, bell crank, and spring.

For Oil Circuit-Breaker Type	Style No.		List Price
	For Mounting Above Floor	For Mounting Below Floor	
F-1, F-2	214061	214060	$10 00
F-3	210527	208925	21 50

REMOTE-CONTROL COVERPLATES

Style number and list price include coverplate complete with mounting bolts and with overload-trip coils on automatic coverplates.

For Use with Oil Circuit-Breakers			FOR AUTOMATIC CIRCUIT-BREAKERS			FOR NON-AUTOMATIC CIRCUIT-BREAKERS	
			Number 5-Ampere Trip Coils Required Per Coverplate	Coverplate			
Type	Throw	Poles		Style No.	List Price	Style No.	List Price
D	Single	2, 3, 4	..	.....	.....	216063	$4 60
	Double	2, 3, 4	..	.....	.....	216064	5 20
F-1	Single	2	1	209832	$13 60	215127	4 60
	Single	3, 4	2	209834	17 30	215127	4 60
	Double	2, 3, 4	1	214159†	18 00	209836	8 80
	Double	2, 3, 4	2	214165‡	22 00	209836	8 80
F-2	Single	1	1	209832	13 20	215127	4 60
	Single	2, 3, 4	2	209834	17 30	215127	4 60
	Double	2, 3, 4	1	214159†	18 00	209836	8 80
	Double	2, 3, 4	2	214165‡	22 00	209836	8 80
F-3	Single	2	1	209833	13 25	215128	5 20
	Single	3, 4	2	209835	17 00	215128	5 20
	Double	2, 3, 4	1	214160†	18 00	211840	8 60
	Double	2, 3, 4	2	214166‡	22 00	211840	8 60

†With one overload trip coil.
‡With two overload trip coils.

Order by Style Number

OIL CIRCUIT-BREAKER ACCESSORIES—Continued

REMOTE CONTROL BELL-CRANK ATTACHMENTS

Data convering similar attachments for Type F-3 Multiple-Multipole Breakers furnished upon request. These devices are usable on all other Type F Breakers.

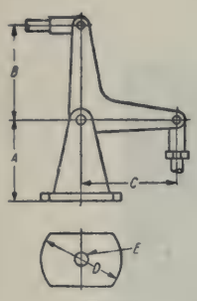


FIG. 17

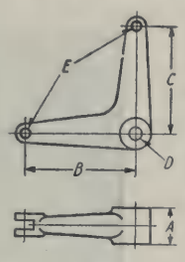


FIG. 18

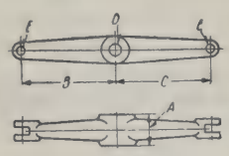


FIG. 19

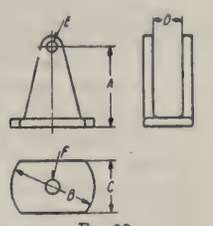


FIG. 20

Style number and list price of complete attachment include one bell crank, one bearing bracket, one non-adjustable rod end and one adjustable rod end.

Fig.	Dimensions, Inches								Style No.	List Price
	A	B	C	D	E	F	G	H		
Complete Attachment										
17	4¼	4	9½	4	13/16	...	...	...	175749	$6 45
17	4¼	4	6⅞	4	13/16	...	...	...	175748	6 30
17	4¼	4	10¼	4	13/16	...	...	...	175750	6 45
17	4¼	6½	6½	4	13/16	...	...	...	33149	5 30
17	4¼	6½	14 9/16	4	13/16	...	...	...	142736	6 45
17	9	6½	6½	4	13/16	...	...	...	210526	6 30
17	9	6½	6½	6	13/16	...	...	...	214596	6 80
Bell Cranks Only										
18	1 11/16	4	6⅞	43/64	43/64	...	...	...	175745	2 10
18	1 11/16	4	9	43/64	43/64	...	...	...	226509	2 10
18	1 11/16	4	9½	43/64	43/64	...	...	...	175746	2 40
18	1 11/16	4	10¼	43/64	43/64	...	...	...	175747	2 40
18	1 11/16	4	11⅛	43/64	43/64	...	...	...	226510	2 30
18	1 11/16	4	15⅜	43/64	43/64	...	...	...	226511	2 65
18	1 11/16	6½	6½	43/64	43/64	...	...	...	159667	1 90
18	1 11/16	6½	10½	43/64	43/64	...	...	...	205314	2 30
18	1 11/16	6½	14 9/16	43/64	43/64	...	...	...	175744	3 75
18	1 11/16	6½	14¾	43/64	43/64	...	...	...	226512	4 20
18	1 11/16	8	8	43/64	43/64	...	...	...	226513	3 30
Lever Only										
19	1⅝	4	4	49/64	33/64	...	...	...	230312	4 00
19	1⅝	4	9½	49/64	33/64	...	...	...	230313	3 20
19	1¼	6½	6½	49/64	33/64	...	...	...	214850	3 10
19	1 11/16	6½	10½	49/64	33/64	...	...	...	230315	3 60
19	1 11/16	6½	14¾	49/64	33/64	...	...	...	230316	3 60
Vertical Bearing Bracket										
20	4¼	4	3	1¾	49/64	13/16	...	...	159666	1 60
20	9	4	3	1¾	49/64	13/16	...	...	182368	2 30
20	9	6	3¾	1¾	49/64	13/16	...	...	191835	2 20
Horizontal Bearing Bracket										
21	4¼	3¾	4	1½	1½	1 11/16	¾	17/32	226514	4 85
22	4	...	...	...	6⅞	1 11/16	¾	17/32	226515	4 50
Rod End for Standard ¾-Inch W. I. Pipe										
23	1½	2¼	11/32	1⅞	1⅜	¾-Inch Std. Thrd.	33/64	5/8	72281	90
23	1½	1½	11/32	1⅛	1⅜		33/64	5/8	83129	70
24	2½	1½	1½	1⅛	1⅜		33/64	11/32	235962	3 25

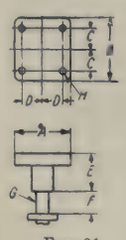


FIG. 21

FIG. 22

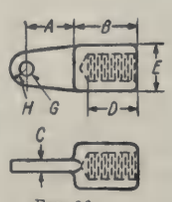


FIG. 23

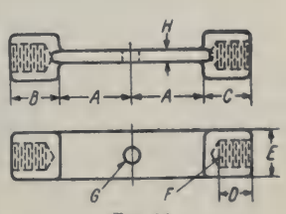


FIG. 24

Order by Style Number

OIL CIRCUIT-BREAKER ACCESSORIES—Continued

MECHANICAL INTERLOCKING ATTACHMENTS

For interlocking a pair of breakers of the same type, mounted in the same plane and on given center, these mechanical interlocking devices are to prevent both breakers being closed at the same time. Special mechanical interlocks can be supplied on special order for interlocking pairs of breakers of different types and for interlocking three or more breakers of the same or differnet types. In fact, there is practially no limit to the amount of interlocking possible on special order. Send your problems to the nearest district office of the Company for complete information.

Style number and list price include mechanism complete.

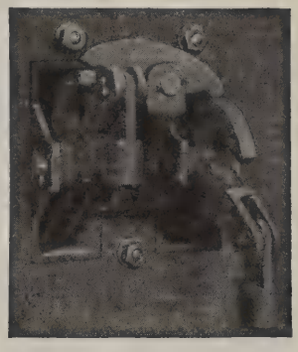


FIG. 25—REAR OF DOUBLE-HANDLE COVERPLATE SHOWING INTERLOCKING ATTACHMENT

For Breaker				Distance Between Centers of Breakers Inches	Description	Style No.	List Price
Type	Mounting	Throw	With Complete				
F-1	Panel	Single	1, 2, or 3 Coil	10	Interlock Complete	221979	$ 2 45
F-2	Panel	Single	1, 2, or 3 Coil	12	Interlock Complete	214852	2 75
F-2	Panel	Double	Double-Handle	....	Bar Only	208926	95
F-3	Panel	Single	1, 2, or 3 Coil	16	Interlock Complete	214591	3 75
F-3	Panel	Single	1, 2, or 3 Coil	10	Interlock Complete	214853	3 75
F-1, F-2	Remote	Single	1 or 2 Coil	8	Interlock Complete	214592	14 00
F-1, F-2	Remote	Single	3 Coil	9½	Interlock Complete	214854	14 00
F-1, F-2	Remote	Double	Double-Handle With Undervoltage Coil	9½	Interlock Complete	241448	2 10
F-1, F-2	Remote	Double	Double-Handle Without Undervoltage Coil	9½	Interlock Complete	241450	9 00
F-1, F-2	Remote	Single	1, 2, or 3 Coil	11	Interlock Complete	241452	13 00
F-1, F-2	Remote	Double	Between Handles on Double-Coil Coverplate	....	Interlock Complete	214862	3 00
F-3	Remote	Single	1 or 2 Coil	8	Interlock Complete	214593	9 30
F-3	Remote	Single	3 Coil	9½	Interlock Complete	214855	9 30
F-3	Remote	Double	Double-Handle with Undervoltage Coil	9½	Interlock Complete	241449	2 10
F-3	Remote	Double	Double-Handle without Undervoltage Coil	9½	Interlock Complete	241451	8 00
F-3	Remote	Single	1, 2, or 3 Coil	11	Interlock Complete	241453	12 00
F-3	Remote	Double	Between Handles on Double-Coil Coverplate	....	Interlock Complete	214863	3 15

HAND CLOSING HANDLES

FIG. 26

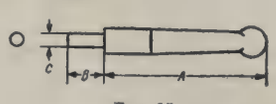


FIG. 27

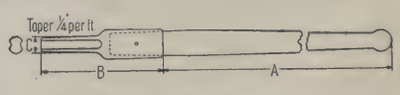


FIG. 28

Hand-closing handles are listed for closing the electrically-operated breakers of different types and sizes in case of failure of the operating current. Style number and list price include handle complete.

For Breaker, Type	Fig.	Dimensions, Inches			Style No.	List Price
		A	B	C		
F-2	26	3 13/16	10	½	214068	$ 1 45
F-3	27	16	3	¾	105696	3 15
F-2 Mult.-Single-Pole	27	24	4	⅞	229280	10 00
F-3 Mult.- 2 P.	28	31	11½	1 1/16	233229	10 00
Multipole 3 & 4 P.	28	43	11½	1 1/16	200874*	17 00

*Used also on manually-operated breakers.

Order by Style Number

LARGE OIL CIRCUIT-BREAKERS

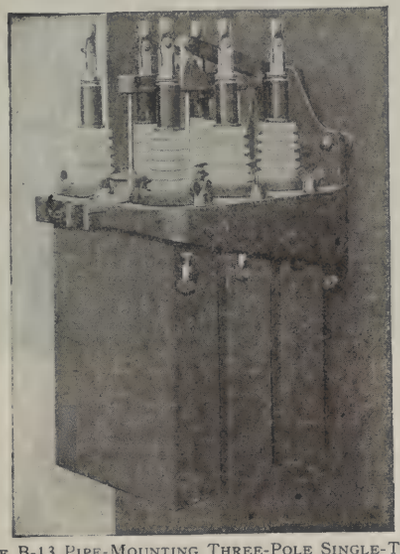
As a result of years of experience in the design and manufacture of switchgear for plants of the largest capacity and for transmission lines of high voltage, the Westinghouse Company has in addition to the moderate capacity circuit-breakers listed in detail, a complete line of larger capacity and higher voltage oil circuit-breakers.

A brief summary of the different types with their range of rated voltages, current capacities and rupturing capacities is given in the following pages. For complete information, prices, etc., apply to the nearest district office.

TYPE B OIL CIRCUIT-BREAKERS

The type B oil circuit-breakers comprise a line of medium capacity breakers.

They are built of three different forms, namely, type Ba, B-2, and B-13, each with a different interrupting capacity, maximum voltage, and details of construction.



TYPE B-13 PIPE-MOUNTING THREE-POLE SINGLE-THROW 300-AMPERE 25000-VOLT CIRCUIT-BREAKER

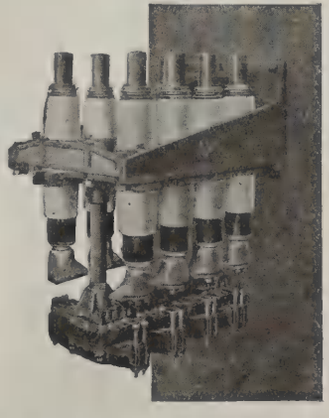
These breakers have a highly effective wiping and self-cleaning form of laminated brush contact, protected by liberally proportioned butt arcing contacts. The opening of all contacts occurs under oil, with a positive direct gravity break assisted by spring acceleration, and with open position maintained by gravity.

The tanks are of heavy sheet iron with all seams lap-welded. They are removable without disturbing the operating mechanism, making inspection of the contacts easy, and they are provided with a high grade insulating lining. The tanks are rectangular in shape except on the 1200-ampere and 2000-ampere type B-13 breakers, which have elliptical tanks similar to those on the type E breakers. The tank supports are very strong.

The type B circuit-breaker is in general a common-frame circuit-breaker. The type Ba has a tank per pole in all sizes. The type B-2 has a tank per pole in the 300-ampere and 600-ampere sizes, but a single tank construction in the other sizes. The type B-13 has a tank per pole in all sizes.

TYPE B-2 PIPE-MOUNTING THREE-POLE SINGLE-THROW 600-AMPERE 15000-VOLT BREAKER COMPLETE WITH TERMINALS

Manually operated circuit-breakers are actuated by a handle mounted in the switchboard cover-plate. When the breakers are supplied with automatic overload trip with remote control, an accelerating spring device is used to quicken the opening of the contacts, and this device, assisted by the arcing contact springs, gives to the moving parts an acceleration greater than that caused by gravity.



TYPE B-2 PIPE-MOUNTING FOUR-POLE SINGLE-THROW 2000-AMPERE 7500-VOLT BREAKER, TANK REMOVED

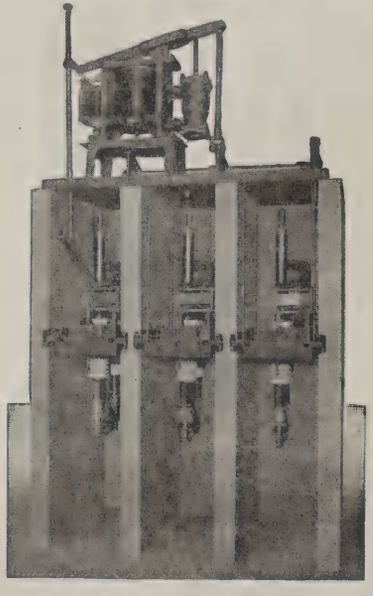
LARGE OIL CIRCUIT-BREAKERS—Continued

All of the following sizes of circuit-breakers can be supplied either manually or electrically operated and either automatic with transformer-trip coils or non-automatic. The manually operated breakers can be panel or panel-frame mounting, or remote-control, while the remote-control breakers, both hand and electrically operated, can be furnished for wall mounting or pipe-frame mounting. All can be furnished in two and three pole, and all except the type B-13 in four-pole types.

Type	Maximum Amperes 60 Cycle	25 Cycle	Maximum Volts	Interrupting Capacity in Arc Amperes at Rated Voltage
Ba	300	400	15000	1350
Ba	600	750	7500	3500
B-2	300	400	15000	1900
B-2	300	400	25000	960
B-2	600	750	15000	1900
B-2	600	750	25000	960
B-2	1200	1350	15000	1900
B-2	1500	1600	7500	3000
B-2	2000	2250	7500	3000
B-13	300	400	25000	1800
B-13	600	750	25000	1800
B-13	1200	1350	15000	3400
B-13	2000	2250	7500	7300

Installation of Remote Manually Operated Type BA Breakers

TYPE E OIL CIRCUIT-BREAKERS



Type E-6 Oil Circuit-Breaker

The type E oil circuit-breakers are particularly adapted to the control of alternating-current circuits of capacity from 25,000 to 40,000 connected turbo-generator kv-a and voltages not over 25,000. They are designed for indoor mounting apart from the switchboard and for either manual or electrical control.

The following features particularly adapt the type E breakers to their class of service.

Very efficient self-cleaning form of high-pressure laminated brush main contacts protected by extra-heavy arcing contacts; submersion and opening of all contacts under oil; quick opening of contacts, assisted by heavy accelerating springs, open position maintained by gravity, strong elliptical lap-welded steel tanks and steel tank-supports; tanks removable without disturbing the operating mechanisms or contacts, making inspection easy; individual tanks enclose the contacts of each pole of the breaker; ample air space at top of tank to allow for proper gas expansion; insulating linings in tanks, unit-type electrical operating mechanism having closing, tripping, accelerating, and shock-

absorbing features self-contained; manually operated breakers tripped free of the mechanical remote control in the automatic overload-trip forms; inability to hold full-automatic overload-trip forms of breaker in the closed position when an excessive overload or short circuit exists on the line; each pole a complete unit, operated by independently adjustable connecting rods to the common electric or manual-operating mechanism, and, in the cell mounting forms, installed in a separate masonry compartment.

The types E-6 and E-8 breakers are designed for cell mounting, and the types E-7 and E-9 for pipe-frame mounting.

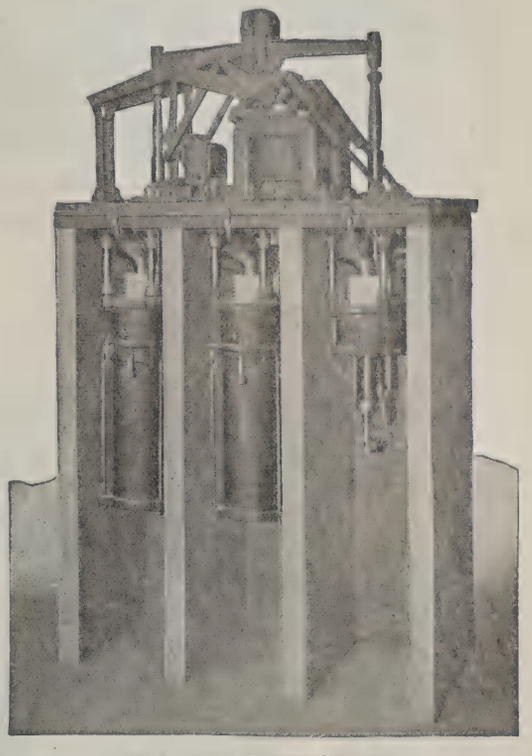
The following sizes are built in either two, three, or four-pole breakers, manually or electrically operated.

Type	Maximum Amperes 60 Cycle	25 Cycle	Maximum Volts	Interrupting Capacity in Arc Amps. at Rated Voltage
E-6 & E-7	300	400	25000	5350
E-6 & E-7	600	750	25000	5350
E-6 & E-7	1200	1350	25000	5350
E-6 & E-7	1600	1800	15000	10000
E-6 & E-7	2000	2250	15000	10000
E-8 & E-9	300	400	25000	2200
E-8 & E-9	600	750	25000	2200
E-8 & E-9	1200	1350	15000	4500
E-8 & E-9	1600	1800	7500	10300
E-8 & E-9	2000	2250	4500	18200

TYPE C OIL CIRCUIT-BREAKERS

The type C oil circuit-breakers are adapted to the control of circuits of large capacity, up to 60,000 connected turbo-generator kv-a and up to 15,000 volts. Two forms of this breaker are built, designated as type CG (superseding previous type C-1) and C-2. They are made for indoor cell mounting and for electrical operation only. They are especially used for lining up with existing installations of similar breakers, and are noted for their great compactness with high rupturing capacity.

The distinctive features of the type C breakers are the self-contained multipole operating mechanism with positive and direct solenoid operation, quick opening hastened by accelerating springs and open position maintained by gravity. The contacts open under oil, and are of a highly efficient form of brush with butt arcing tips. There is an expansion chamber with baffled vent for the arc gases. The poles are isolated in separate tanks and cells, the elliptical tanks being very strong with exceptionally strong fastenings, and removable without disturbing any other part of the breaker.



TYPE C-2 OIL CIRCUIT-BREAKER

LARGE INSTALLATION OF TYPE C-2 CIRCUIT-BREAKERS, DOUBLE-BUS SYSTEM

The following sizes are built in three or four-pole units, electrically operated, with either vertical or horizontal arrangements of leads.

Type	Maximum Amperes 60 Cycle	25 Cycle	Maximum Volts	Interrupting Capacity in Arc Amps. at Rated Voltage
CG	600	800	15000	14000
CG	1200	1500	15000	14000
C-2	600	800	25000	8000
C-2	1200	1500	25000	8000
C-2	2000	2400	15000	15000
C-2*	3000	4000	2500	86300

*Only supplied with horizontal arrangement of leads.

LARGE OIL CIRCUIT-BREAKERS—Continued

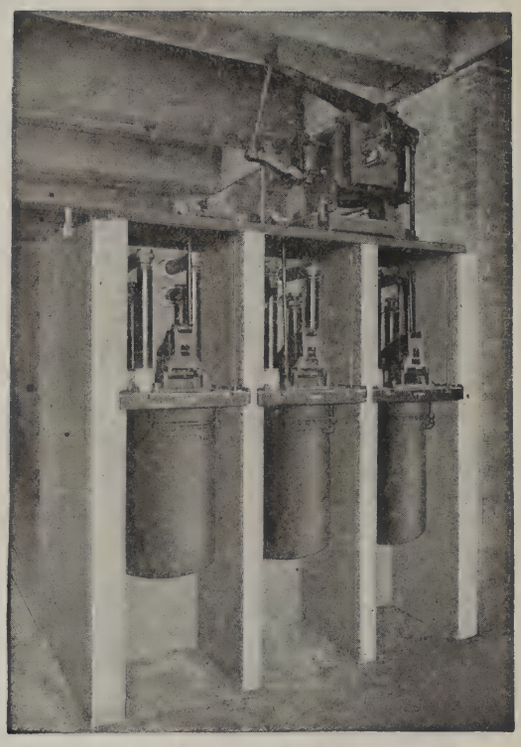
TYPE O OIL CIRCUIT-BREAKERS

The type O oil circuit-breakers are particularly adapted to the control of systems of large capacity from in excess of 40000 up to 100,000 turbo-generator kva. where voltages do not exceed 25000 volts.

This line supplements the type E line of cell mounting breakers, providing higher current and interrupting capacities. These breakers are supplied in single-pole unit form for cell mounting only, each pole being mounted in a separate masonry compartment. The operating mechanism is mounted on the top of the cell structure on a channel and plate base, and operates the several poles as a single unit.

The tanks are cylindrical in form, seamless, and with rounded base, being die-pressed from heavy sheet steel. They represent the strongest form of tank construction possible. Type O-1 tanks are 16 inches in diameter, and type O-2 tanks 20 inches in diameter. These breakers are built in the following sizes, all cell mounting, electrically operated only, in two, three, or four-pole forms.

Type	Maximum Amperes 60 Cycle	Maximum Amperes 25 Cycle	Maximum Voltage	Interrupting Capacity in Arc Amperes at Rated Voltage
O-1	600	800	25000	9600
O-1	1200	1500	25000	9600
O-1	1600	2000	15000	18000
O-2	2000	2400	25000	12300
O-2	3000	4000	15000	23000
O-2	4000	5000	15000	23000

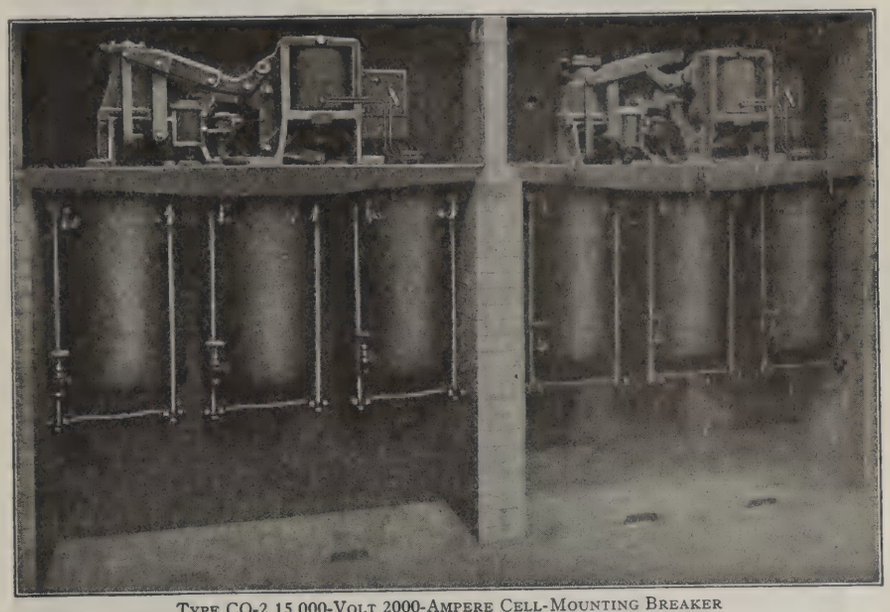


TYPE O-2 3000-AMPERE BREAKER, DOORS REMOVED

LARGE INSTALLATION OF TYPES E AND O BREAKERS

LARGE OIL CIRCUIT-BREAKERS—Continued

TYPE CO OIL CIRCUIT-BREAKERS



TYPE CO-2 15,000-VOLT 2000-AMPERE CELL-MOUNTING BREAKER

The type CO oil circuit-breakers in general perform on circuits of not over 15,000 volts the same service as the type O line, but in more compact space. They have a unit-type electric operating mechanism, forming part of an entirely self-contained breaker which requires no intermediate walls in the cell structure for supporting individual poles. The complete breaker is shipped as one piece, except for the doors and barriers, with all adjustments of contacts and mechanism parts locked, thus reducing the installation work.

The following sizes are built only in three-pole, electrically operated, cell mounting form.

Type	Maximum Amperes 60 Cycle	Maximum Amperes 25 Cycle	Maximum Volts	Interrupting Capacity in Arc Amp. at Rated Voltage
CO-1	600	800	15000	18000
CO-1	1200	1500	15000	18000
CO-1	1600	2000	15000	18000
CO-1	2000	2400	15000	18000
CO-2	600	800	15000	23000
CO-2	1200	1500	15000	23000
CO-2	1600	2000	15000	23000
CO-2	2000	2400	15000	23000
CO-2	2400	3000	15000	23000
CO-2	3000	4000	15000	23000
CO-2	4000	5000	15000	23000

TYPE G OIL CIRCUIT-BREAKERS

The type G oil circuit-breakers comprise a complete line of high-voltage breakers for indoor or outdoor use. Four forms of these breakers are built, known as types G-1, G-11, GA and G-2. Each form has a different interrupting capacity with corresponding differences in construction.

The type G breakers all have the well-known and highly satisfactory condenser type of terminal bushings, steel tanks with welded seams, and large expansion chamber with baffled vents for the arc gases.

All type G breakers can be had in automatic or non-automatic forms. Automatic overload tripping can be obtained either from separate current transformers or from bushing-type current transformers which are slipped over the breaker terminal bushings.

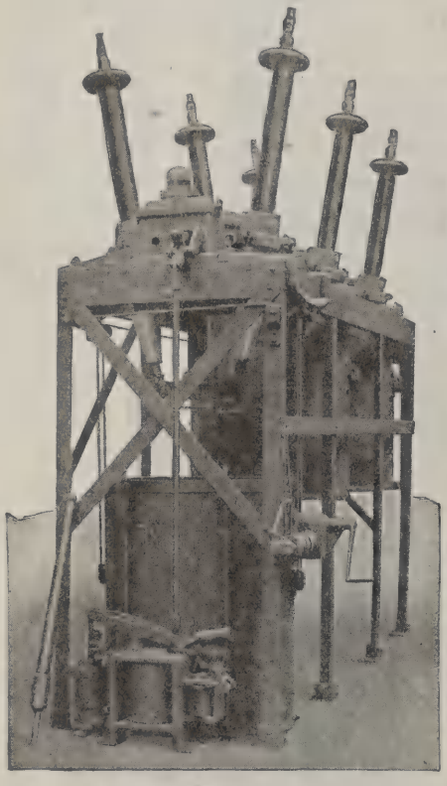
These breakers are available for all voltages from 25,000 to 155,000, indoor or outdoor, manually or electrically operated. They are available for frame mounting up to and including 73,000 volts. With interrupting capacities of from 1440 to 5350 arc amperes per phase at rated voltage available with different types, the requirements of present high voltage systems are well met with this line of G-1 G-11, GA and G-2 breakers.

TYPE GA 135,000-VOLT OUTDOOR BREAKER

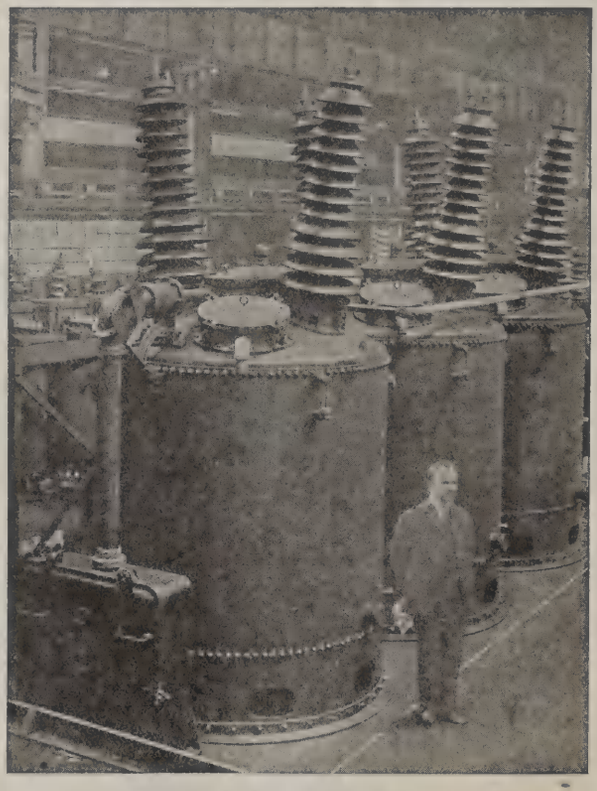
299-7A

LARGE OIL CIRCUIT-BREAKERS—Continued

TYPE G-1 25000-VOLT OUTDOOR BREAKER IN OUTDOOR SUBSTATION



TYPE G-11 73000-VOLT INDOOR FRAME-MOUNTED BREAKER. SHOWING WINDLASS TANK-LIFTING DEVICE



TYPE G-2 135000-VOLT OUTDOOR BREAKER

BURKE HORN GAP SWITCHES

THE Burke Horn Gap Switch is built for outdoor service and so designed that it can be mounted readily on pole or steel frame work. The operating handle may be carried down within reach from the ground. It is at once economical, durable and impervious to freezing, its continued operation being guaranteed under the most severe weather conditions.

The Burke Horn Gap Switch will break extremely heavy loads without deterioration. It is difficult to give any definite figures as to limitations of its breaking capacity, but its rupturing ability may be judged by the fact that after repeatedly opening a dead short circuit on 6000 K. W. bank of transformers at 44,000 V. connected to a generating capacity of 74,000 K. W. the switch was not burnt and its action indicated that the limit of its rupturing capacity had not been reached.

33,000 V. TYPE B

Single pole unit. Duplicate poles are mechanically inter-connected by means of an adjustable bar and operated from the single operating handle.

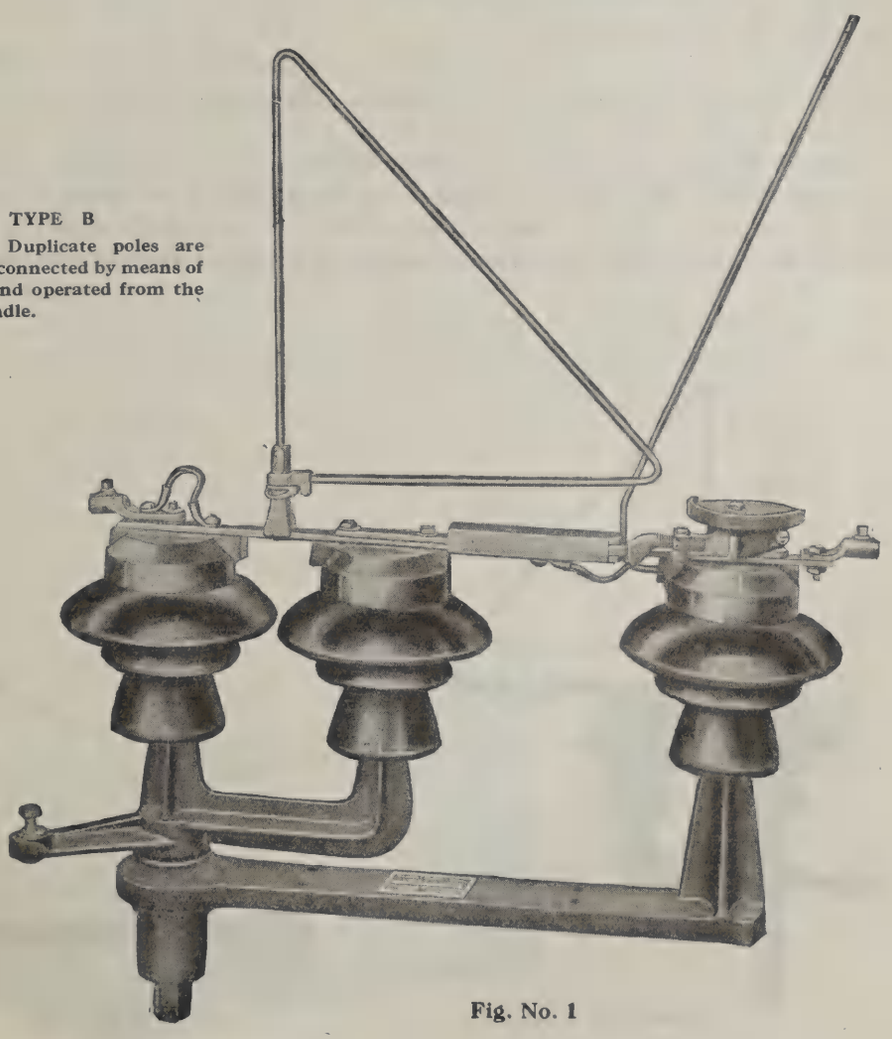


Fig. No. 1

TYPE B

CONSTRUCTION—In Fig. 1 is shown a single-pole unit of the type "B" Burke Horn Gap Switch. Two or more switch units are mechanically interconnected by means of an adjustable bar and operated from a single handle.

The rotating part of the switch, Fig. 2, carries two insulators on which the switch arm and movable horn are attached. The bearing shank is accurately machined. The crank which serves in interconnecting the switches is cast a part of the rotor, thus eliminating any possibility of lost motion.

The stationary part, Fig. 3, is the base of the switch and carries the stationary contact, horns and brass bushed bearing. All parts of the Burke Horn Gap Switch are machined in jigs and templates and are interchangeable. These switches are built for voltages up to and including 36,000 V. The main base and rotating members are of heavy iron castings. This makes the simplest, strongest and most successful construction up to the point where the dimensions of the switch necessitate a change in structure.

Two insulators are used on the rotating member of the switch to avoid subjecting the insulators to torsional strains as such will loosen them between sections or on the pin.

A greater factor of safety is used on the insulators than is usually employed on the line on which the switches are used.

The main contact is completely covered by a sleet hood and protected from all burning by auxiliary arcing horns, as shown in Fig. 4. Fig. 5 is a close-up view of the main contact switch fully closed.

The switch arm is jointed. The short end section against which contact is made is normally held at an angle by a spring which is enclosed in the square brass housing. In closing the switch this arm meets the stationary block which supports the laminated copper leaf brush. This prevents further lateral motion. Further rotation of the switch

Fig. No. 2

Fig. No. 3

TYPE B BURKE HORN GAP SWITCHES—Continued

straightens out the arm and brings the contact block in firm compression with the leaf brush. The hook on the end of the arm insures the arm being brought to the angular position when the switch is opened without depending upon the spring.

The toggle action thus obtained in connection with the flexible leaf brush contact gives increased leverage and insures free, smooth operation. The contacts are completely covered with a sleet hood, which makes operation positive under all weather conditions. This we guarantee.

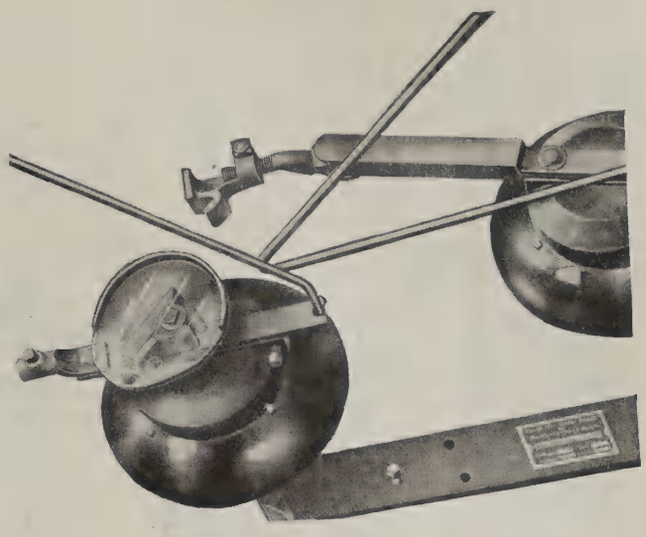


Fig. No. 4

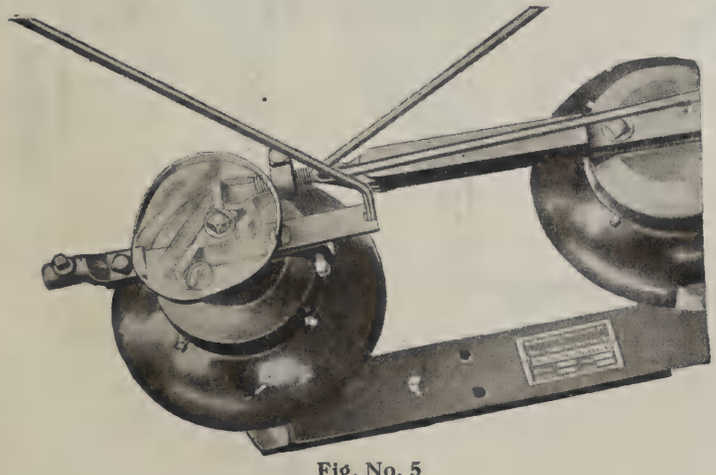
Our aim is to make the Burke Horn Gap Switch the most reliable piece of apparatus it is possible to install.

Switches from 2,200 to 7,000 V. have a blade and jaw type of contact.

The terminals are of heavy cast brass, so arranged that the wire can be clinched over for support and also soldered in addition to the set screws which hold it.

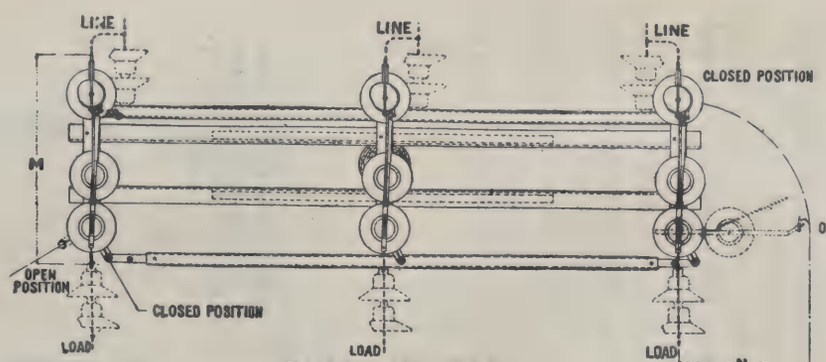
The interconnecting rods between poles of the switch are steel channel with drop forging fittings, having corrugated surfaces which engage each other. The loosening of a single bolt allows adjustments to be made.

A flexible steel coupling is used to make the mechanical connection between the switch and the operating handle. The operating handle and locking device are drop forgings and are designed so that the switch may be locked in either the open or closed position. Each point has been considered to simplify the installation of the switch in the field. Complete assembly instructions are sent out with every switch. The entire frame work and handle of the switch should be well grounded to accord with the accepted practice for high voltage construction.



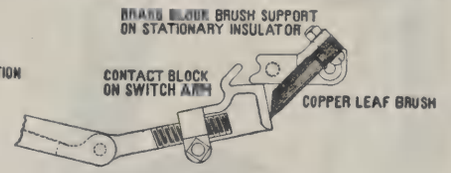
Main Contact of Burke Horn Gap Switch, phantom view, showing laminated leaf brush contact covered by sleet hood.

Fig. No. 5



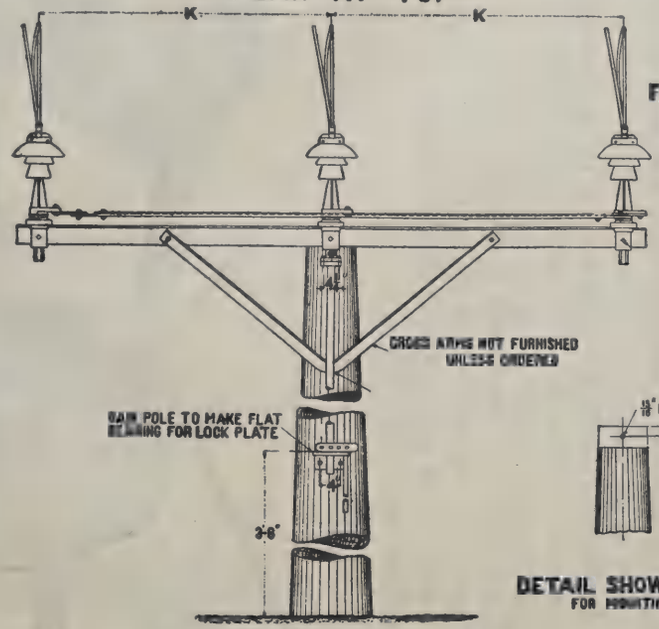
PLAN AT TOP

DIMENSION IN INCHES CORRESPONDING TO LETTERS IN OUTLINE VIEW																	
VOLTAGE	A	B	C	D	E	F	G	H	L	M	N	O	P	Q	R	K	
16500	18	26	5 7/8	8	9 5/8	18	3 3/4	12	3 3/8	30	19 1/4	12 1/2	3 7/8			36	
25000	26	35	6 1/2	9 3/4	14 3/4	18	6	12	4 7/16	39	27	15 1/4	3 7/8			42	
36000	26	37	6 1/2	9 3/4	14 3/4	24	6	12	4 7/16	39	27	17 1/8	3 7/8			54	

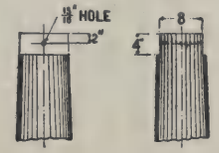


DETAIL OF MAIN CONTACT

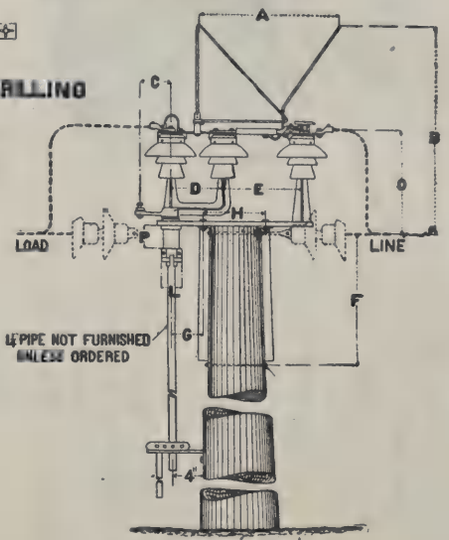
FOUNDATION BOLT DRILLING



SECTION ACROSS LINE



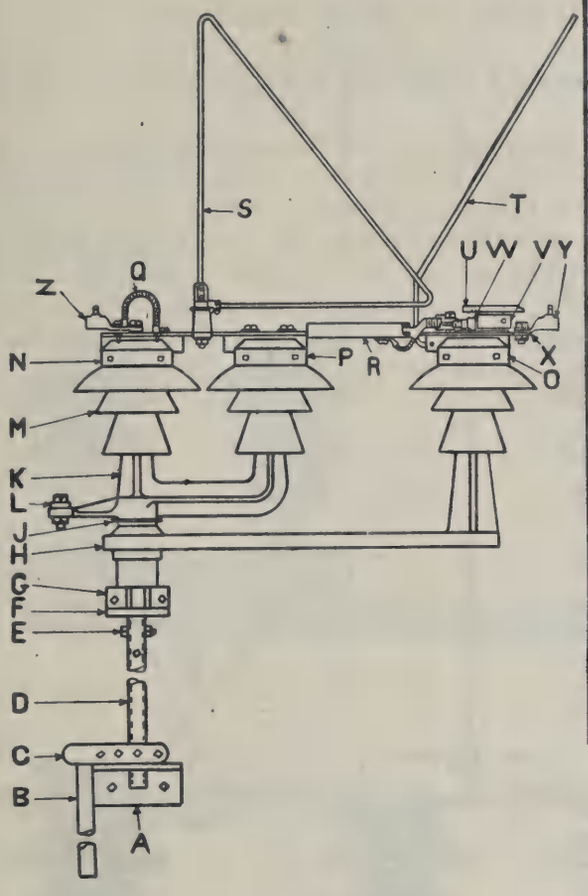
DETAIL SHOWING GAIN ON POLE
FOR MOUNTING CROSS ARMS.



END VIEW

BURKE HIGH VOLTAGE HORN GAP SWITCH 16500 TO 36000-V. TYPE B.

TYPE B BURKE HORN GAP SWITCHES—Continued



LIST OF PARTS				
	PART	STYLE NO. 16000 V.	25000 V.	36000 V.
A	LOCK PLATE	587	587	587
B	" HANDLE	838	838	838
C	CLAMP	1031	1031	1031
D	$1\frac{1}{4}$" PIPE			
E	$\frac{3}{8}$"X2" BOLT & NUT			
F	FORK	702	702	702
G	COUPLING	703	701	701
H	BASE	510	1773	1774
J	CURVED WASHER	500	501	501
K	ROTOR	511	566	654
L	INTER CONNECTING ROD	582	615	617
M	INSULATOR	512	537	3344
N	CAP	760	842	785
O	"	760	841	783
P	"	955	842	785
Q	SHUNT LEADS	528	528	528
R	BLADE COMPLETE	3531	3521	3521
S	FIG 4 HORN	1420	1475	1475
T	SINGLE HORN	1421	543	543
U	SLEET HOOD	992	992	992
V	BRUSH	958	958	958
W	" HOLDER	989	989	989
X	BRASS LINER	1412	1053	1053
Y	TERMINAL LUG	1407	555	555
Z	" "	554	554	554

Price List Burke Horn Gap Switches Type B

Voltage	2-Pole Switches Style No.	2-Pole Switches List Price	3-Pole Switches Style No.	3-Pole Switches List Price	Shipping Weight 3-Pole Switches	List Price Steel Cross Arm Mounting
7000 V.	2002	$ 75 00	2003	$100 00	195 lbs.	$12 00
16500 V.	2023	108 00	2024	145 00	350 lbs.	18 00
25000 V.	2026	150 00	2027	200 00	490 lbs.	20 00
36000 V.	2029	172 00	2030	230 00	550 lbs.	24 00

BURKE HORN GAP SWITCHES—Continued

TYPE IB

The type "IB" switch is in general design and operation similar to the type "B" switch, except that a channel iron base is used and the pins and insulators are interchangeable, so that a single pin and insulator can be held as a spare for any position on the switch. See Figs. 6 and 7 and 8.

Duplicate sets of interconnecting rods are used, so that the operation of the switch is accomplished by the tension on the rods rather than a thrust. This is desirable because of the increased spacing between poles of the switch on higher voltages. Switches above 50,000 V. are of the double break type, as illustrated in Fig. 8. The laminated leaf brush contacts are protected with sleet hoods and are protected against burning by auxiliary arcing horns, the same as the single break switches. The double break is made necessary above 50,000 V. in order to obtain the proper gap in the line. The Burke design allows simple single break construction for the lower voltages.

25,000 V. TYPE IB

Single pole unit. Duplicate poles are mechanically inter-connected by means of an adjustable bar and operated from the single operating handle.

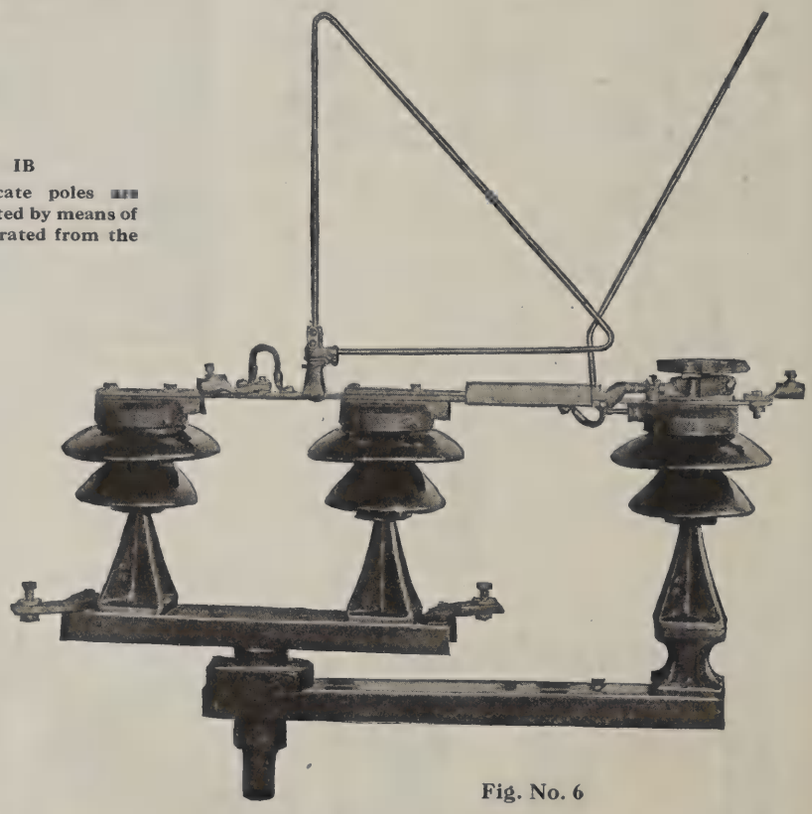


Fig. No. 6

Price List Burke Horn Gap Switches, Type IB

Voltage	2 Pole Switches Style No.	2 Pole Switches List Price	3 Pole Switches Style No.	3 Pole Switches List Price	Shipping Weight 3 Pole Switches	List Price Steel Cross Arm Mounting
16500 V.	2038	$146.00	2039	$195.00	500 lbs.	$18.00
25000 V.	2041	163.00	2439	220.00	600 lbs.	20.00
36000 V.	2043	185.00	2044	250.00	625 lbs.	24.00
50000 V.	2032	290.00	2033	390.00	900 lbs.	Special
70000 V.	2035	500.00	2036	675.00	1670 lbs.	Special

TYPE IB BURKE HORN GAP SWITCHES—Continued

50,000 V. TYPE IB
BURKE HORN GAP SWITCH

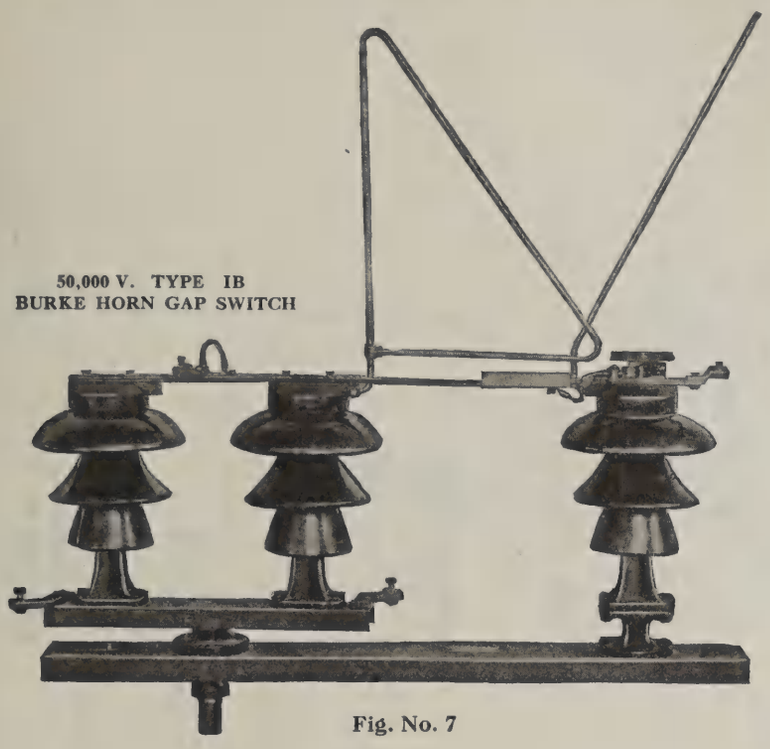


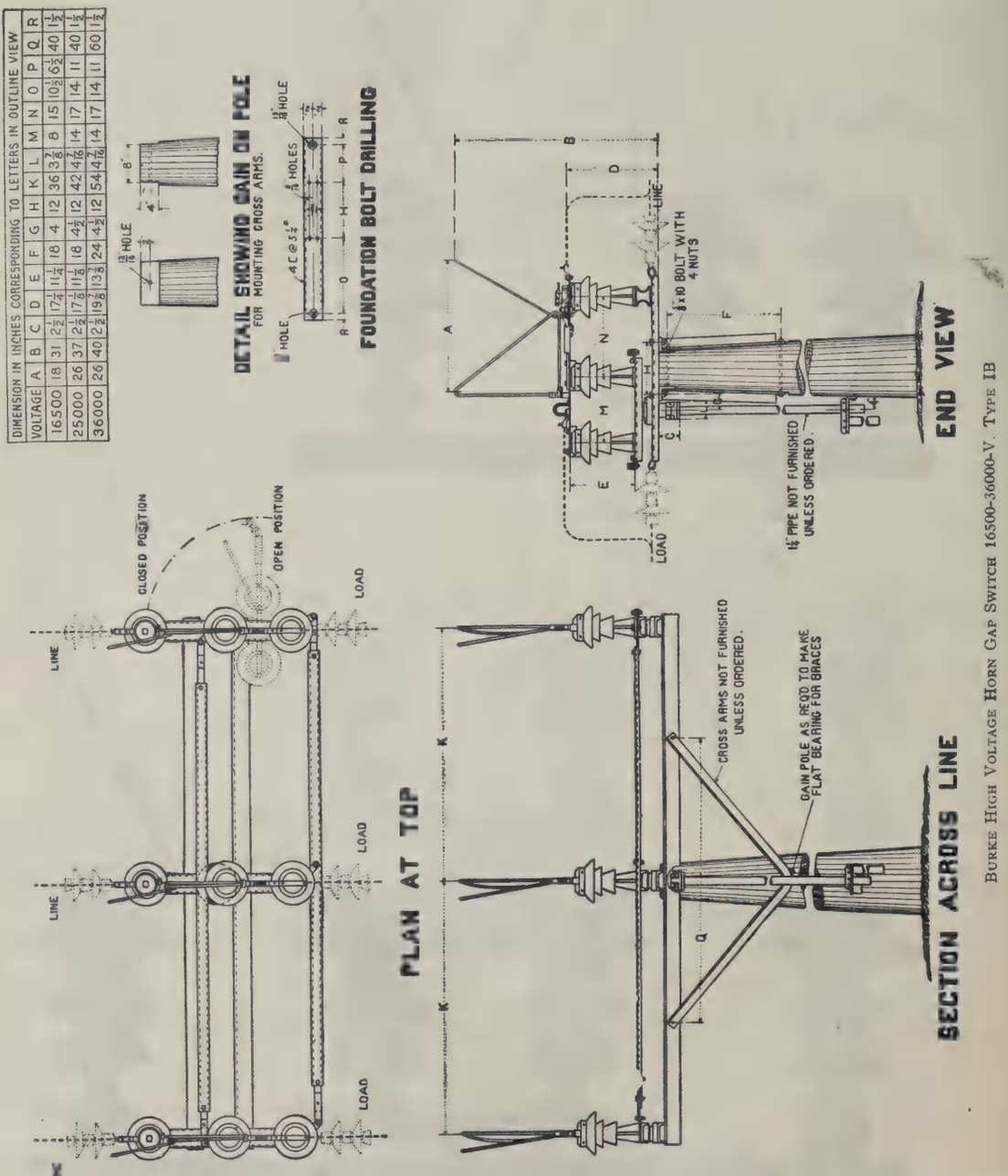
Fig. No. 7

Fig. No. 8

70,000 V. TYPE IB
BURKE HORN GAP SWITCH

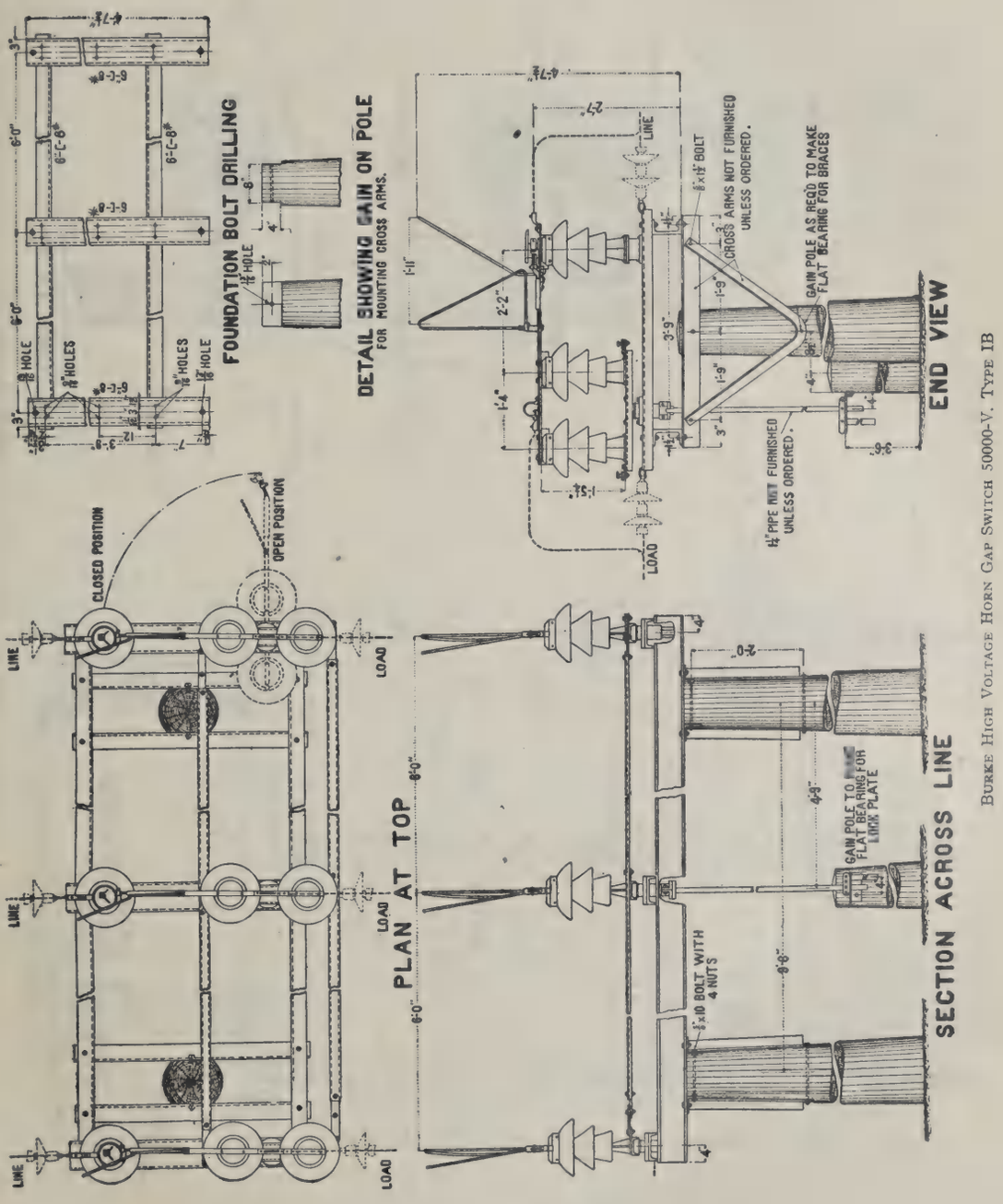
TYPE IB BURKE HORN GAP SWITCHES—Continued

DIMENSION IN INCHES CORRESPONDING TO LETTERS IN OUTLINE VIEW																
VOLTAGE	A	B	C	D	E	F	G	H	K	L	M	N	O	P	Q	R
16500	18	31	2½	17½	11¼	18	4	12	36	3⅜	8	15	10½	6½	40	1½
25000	26	37	2½	17⅞	11⅞	18	4½	12	42	4⅛	14	17	14	11	40	1½
36000	26	40	2½	19⅞	13⅜	24	4½	12	54	4⅛	14	17	14	11	60	1½



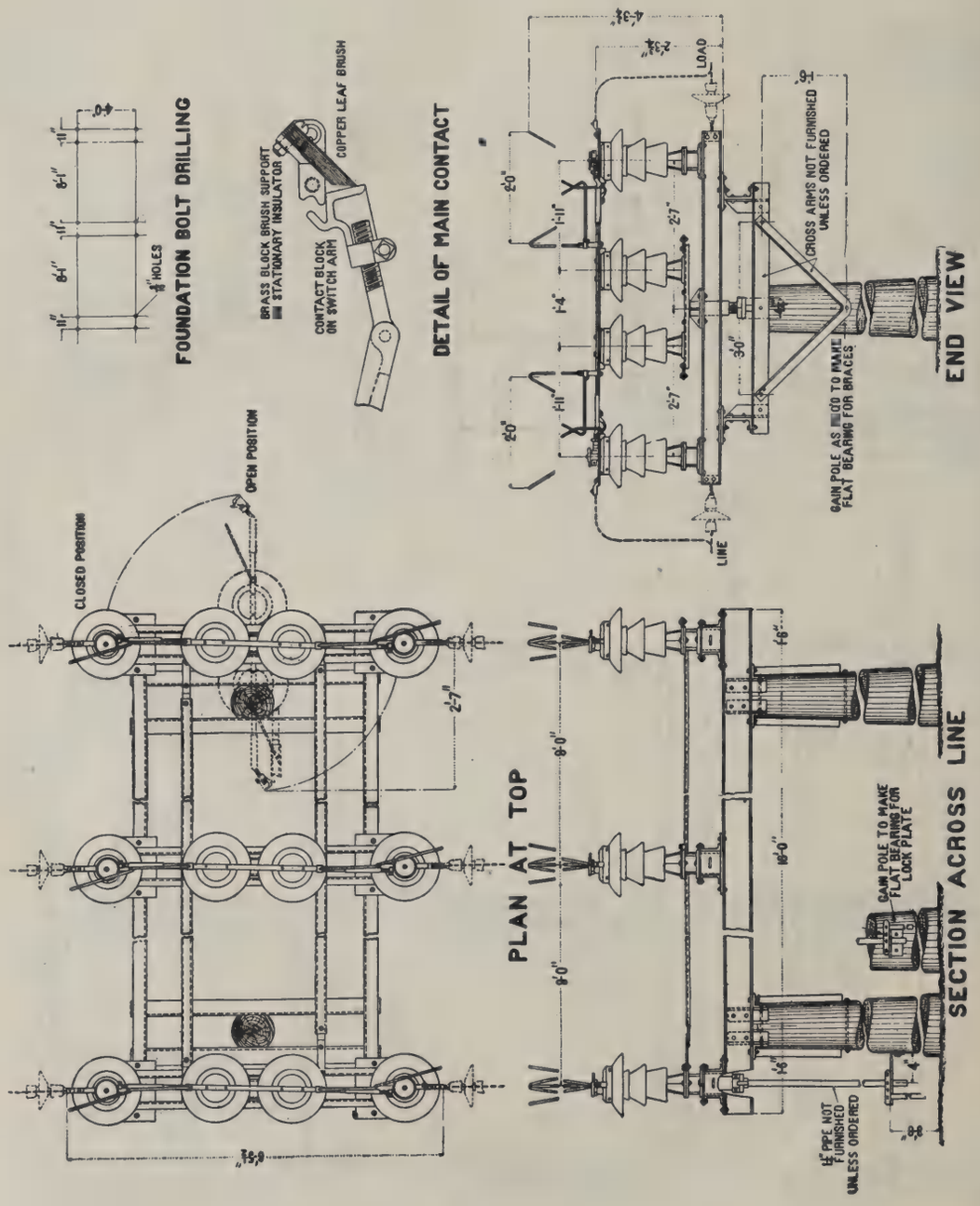
BURKE HIGH VOLTAGE HORN GAP SWITCH 16500-36000-V. TYPE IB

TYPE IB BURKE HORN CAP SWITCHES—Continued


FOUNDATION BOLT DRILLING
DETAIL SHOWING GAIN ON POLE FOR MOUNTING CROSS ARMS.
END VIEW
CLOSED POSITION
OPEN POSITION
LINE
LOAD
PLAN AT TOP
SECTION ACROSS LINE
CROSS ARMS NOT FURNISHED UNLESS ORDERED.
GAIN POLE AS REQD TO MAKE FLAT BEARING FOR BRACES
¼" PIPE NOT FURNISHED UNLESS ORDERED.
GAIN POLE TO FLAT BEARING FOR LOCK PLATE
⅝x10 BOLT WITH 4 NUTS

BURKE HIGH VOLTAGE HORN GAP SWITCH 50000-V. TYPE IB

TYPE IB BURKE HORN GAP SWITCHES—Continued



BURKE HIGH VOLTAGE HORN GAP SWITCH 70000-V. TYPE IB

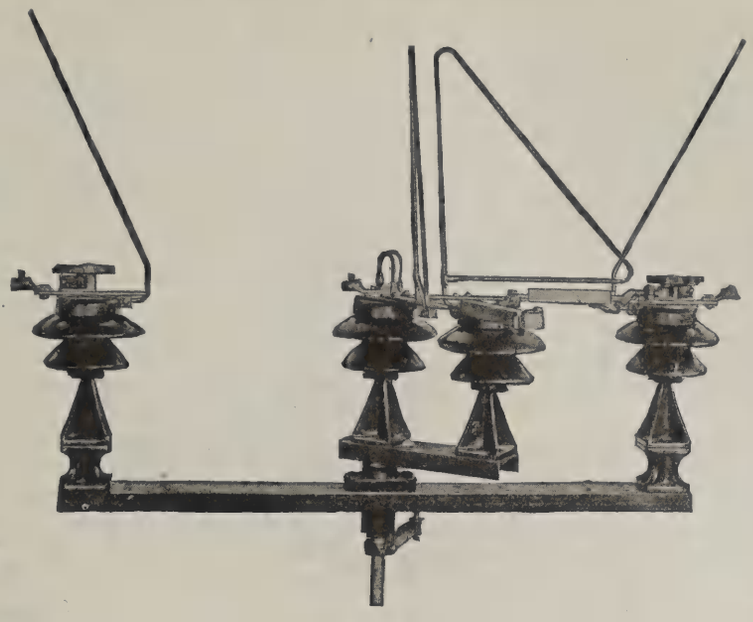


Fig. No. 9

TYPE C

The double-throw Burke Horn Gap Switches in principles of operation are similar to the single-throw switches previously described. A single pole unit of a double-throw switch is pictured in Fig. 9. Two or more such units are mechanically interconnected for operation from a single operating handle. The main contacts are of the laminated leaf brush type completely covered with a sleet hood. The same toggle action is obtained as in the switches previously described which makes operation positive under all weather conditions.

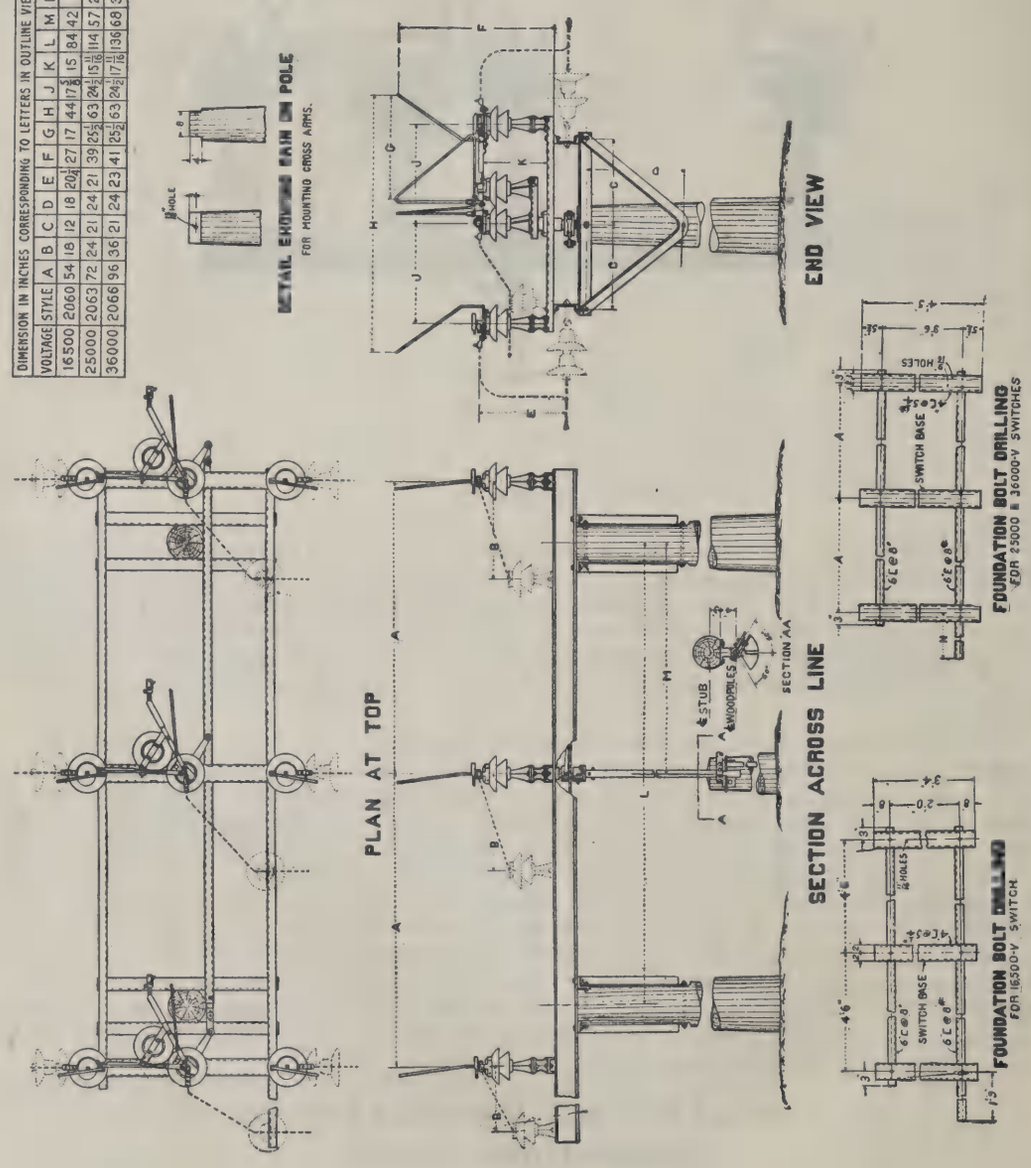
It will be noticed from the illustration that two blades spaced at an angle of 60° are carried on the rotating member of the switch. This allows the reliable crank and bar type of interconnecting mechanism to be used as the switch operates through an arc of less than 120°. The construction of the switch is very substantial in every respect. Two insulators are used on the rotor to avoid torsional strains on the insulators which might otherwise loosen them between sections or on the pin. The type "C" switch is built for voltages up to and including 36,000 V. Above this voltage we recommend the use of two single-throw switches as better clearance is obtained between wiring, which is important on the higher voltages. The double-throw switch has many applications, among which is its use for connecting a sub-station or branch line to either of two parallel transmission lines and where a loop system is used and sectionalized at each sub-station the double-throw switch provides a means for connecting the sub-station to the transmission line on either side of the sectionalizing switch.

Price List Burke Horn Gap Switches
Double-Throw Type C

Voltage	2-Pole Switches Style No.	List Price	3-Pole Switches Style No.	List Price	Shipping Weight 3-Pole Switch
16500 V.	2059	$220.00	2060	$295.00	600 lbs
25000 V.	2062	275.00	2063	365.00	700 lbs.
36000 V.	2065	300.00	2066	400.00	750 lbs.

TYPE C BURKE HORN GAP SWITCHES—Continued

DIMENSION IN INCHES CORRESPONDING TO LETTERS IN OUTLINE VIEW														
VOLTAGE	STYLE	A	B	C	D	E	F	G	H	J	K	L	M	N
16500	2060	54	18	12	18	20½	27	17	44	17⅝	15	84	42	
25000	2063	72	24	21	24	21	39	25½	63	26¼	15 11/16	114	57	27
36000	2066	96	36	21	24	23	41	25½	63	24½	17 11/16	136	68	39



BURKE HIGH VOLTAGE HORN GAP SWITCH 16500 TO 36000-V. TYPE C

BURKE HORN GAP SWITCHES—Continued

TYPE V

This switch is of the vertical break type as illustrated in Fig. 10. Two or more switch units are interconnected for simultaneous operation by a single operating handle. The connections from the operating handle are attached to the center insulator on one pole of the switch. The switches are built for all voltages up to 150,000 volts.

The most rugged type of insulators are used in this switch to insure mechanical reliability. They are the sectional unit type. Insulators of this type are very heavy and to reduce friction to a minimum the rotating column is supported by bronze ball bearings.

The motion between the rotating insulator column and the blade is transmitted by means of bevel gears, a circular rack gear being attached to the top of the insulator. The switch arm is attached to a segment gear which meshes with this circular rack gear. These gears are completely protected from the weather by cast iron housings, likewise all parts of the switch are so designed as to eliminate any danger of locking by over-hanging sleet between moving and stationary parts.

The main contact is of the laminated leaf brush type, completely covered by a sleet hood. It is protected from all burning by auxiliary arcing horns. In closing the switch a toggle action is obtained by straightening out the short end section of the switch arm which is normally held at an angle. Good contact and free, smooth operation are obtained under all weather conditions. There is no danger of the switch freezing up in sleet or winter storms. Every point where such freezing might occur is guarded.

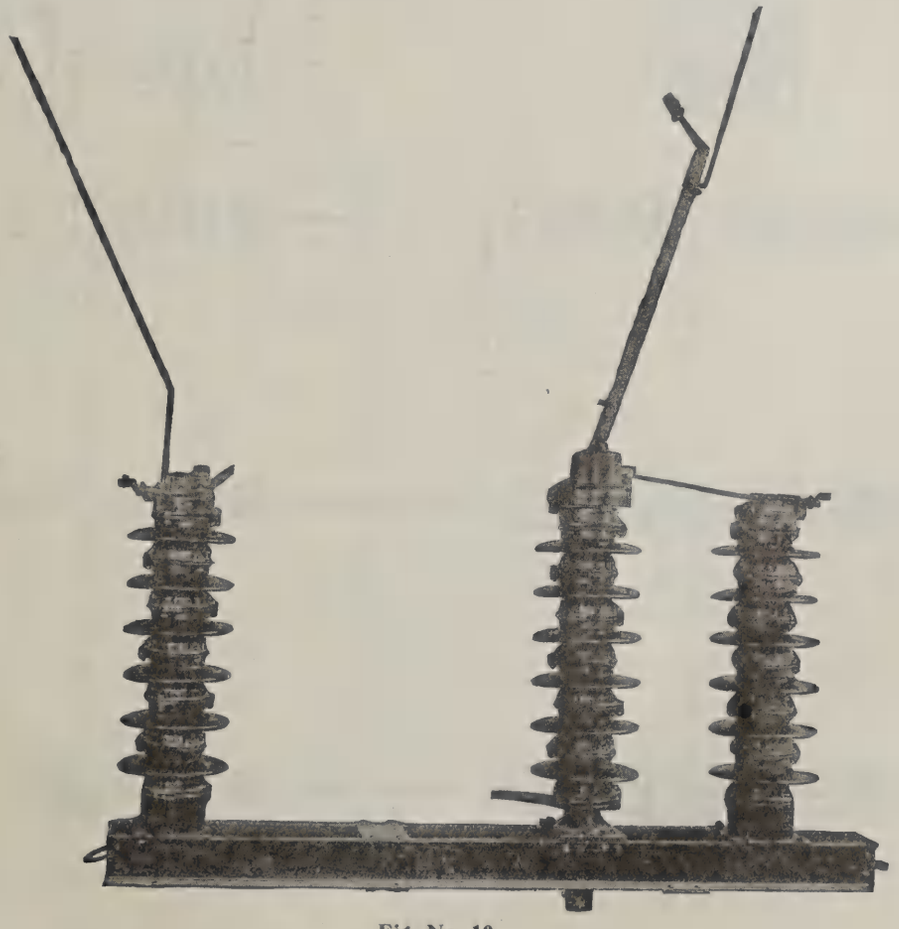
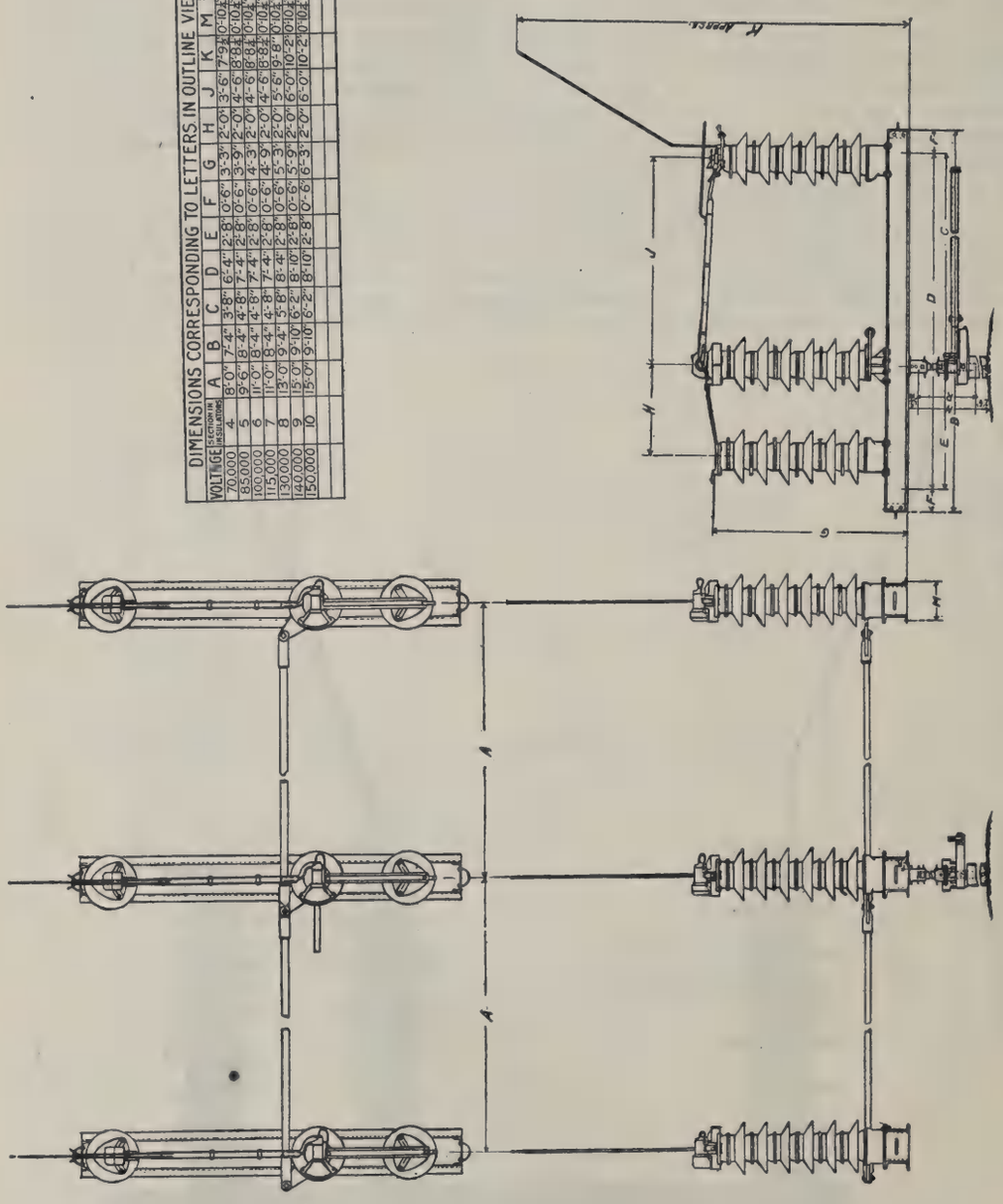


Fig. No. 10

TYPE V BURKE HORN GAP SWITCHES—Continued

DIMENSIONS CORRESPONDING TO LETTERS IN OUTLINE VIEWS

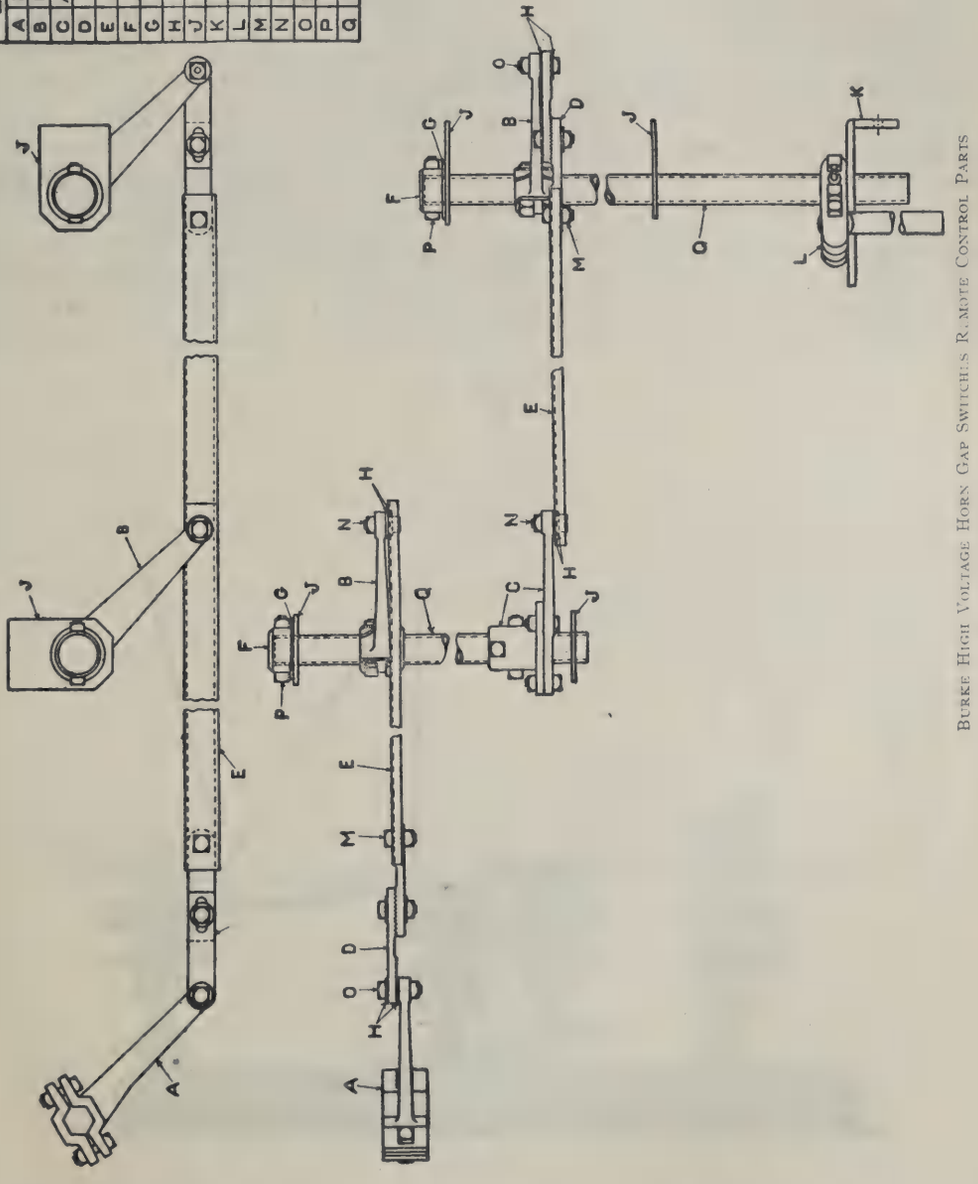
VOLTAGE	NO. OF INSULATORS PER COLUMN	A	B	C	D	E	F	G	H	J	K	M	STYLE
70,000	4	18'-0"	7'-4"	3'-8"	6'-4"	2'-8"	0'-6"	3'-3"	2'-0"	3'-6"	7'-9½"	0'-10½"	2456
85,000	5	19'-6"	8'-4"	4'-8"	7'-4"	2'-8"	0'-6"	3'-9"	2'-0"	4'-6"	8'-8½"	0'-10½"	2459
100,000	6	11'-0"	8'-4"	4'-8"	7'-4"	2'-8"	0'-6"	4'-3"	2'-0"	4'-6"	8'-8½"	0'-10½"	2462
115,000	7	11'-0"	8'-4"	4'-8"	7'-4"	2'-8"	0'-6"	4'-9"	2'-0"	4'-6"	9'-8½"	0'-10½"	2465
130,000	8	13'-0"	9'-4"	5'-8"	8'-4"	2'-8"	0'-6"	5'-3"	2'-0"	5'-0"	10'-2½"	0'-10½"	2468
140,000	9	15'-0"	9'-10"	6'-2"	8'-10"	2'-8"	0'-6"	5'-9"	2'-0"	5'-0"	10'-2½"	0'-10½"	2471
150,000	10	15'-0"	9'-10"	6'-2"	8'-10"	2'-8"	0'-6"	6'-3"	2'-0"	6'-0"	10'-2½"	0'-10½"	2474



VERTICAL BREAK NON-AUTOMATIC SWITCH TYPE VI

BURKE HORN GAP SWITCHES—Continued

LIST OF PARTS		STYLE №
A	HEX. CRANK	8106
B	1¼ PIPE CRANK	807
C	ADJUSTABLE CRANK	3583
D	" COUPLING	583
E	2" CHANNEL	
F	1¼ PIPE CAP	
G	BRASS WASHER	1550
H	¼" BRASS WASHER	
J	GUIDE PLATE	
K	LOCK PLATE	587
L	HANDLE & CLAMP	822
M	½" x 1¼" SH.M. BOLT & NUT	
N	½" x 1½" " " "	
O	½" x 1¾" " " "	
P	½" x 3" " " "	
Q	1¼" PIPE	



BURKE HIGH VOLTAGE HORN GAP SWITCHES REMOTE CONTROL PARTS

Indirect-remote-control parts —Addition price for indirect remote control parts will be furnished on request.

TYPE AA

AUTOMATIC OVERLOAD BURKE HORN GAP SWITCHES—In order to obtain proper protection to a sub-station or sectionalizing line at a moderate cost, the automatic overload Burke Horn Gap Switch described below has been developed.

A degree of protection can of course be obtained by means of a horn gap fuse, but the renewal of fuses in a minimum of time often presents a problem. The type "AA" Automatic Horn Gap Switch meets this objection and makes possible the proper protection of installations of moderate or considerable capacity at a relatively low cost. Fig. 11 pictures a single pole unit of a 50,000 V. automatic switch. (Cover over trip mechanism removed.)

OPERATION—The insulator which carries the solenoid trip magnet is mounted in a bearing and is capable of rotation through a small angle under torsion of a spring. The trip coil is energized by the main line current. On overload the plunger in the trip coil magnet releases the catch, allowing the insulator to swing by force of the spring. This motion moves a trip rod which releases a main latch allowing the three poles of the switch to open simultaneously. The trips are automatically reset by bringing the operating handle to the open position. The switch can not be held closed on an overload or short circuit. The general construction of the switch proper is the same as the manually operated single-throw Burke Horn Gap Switches.

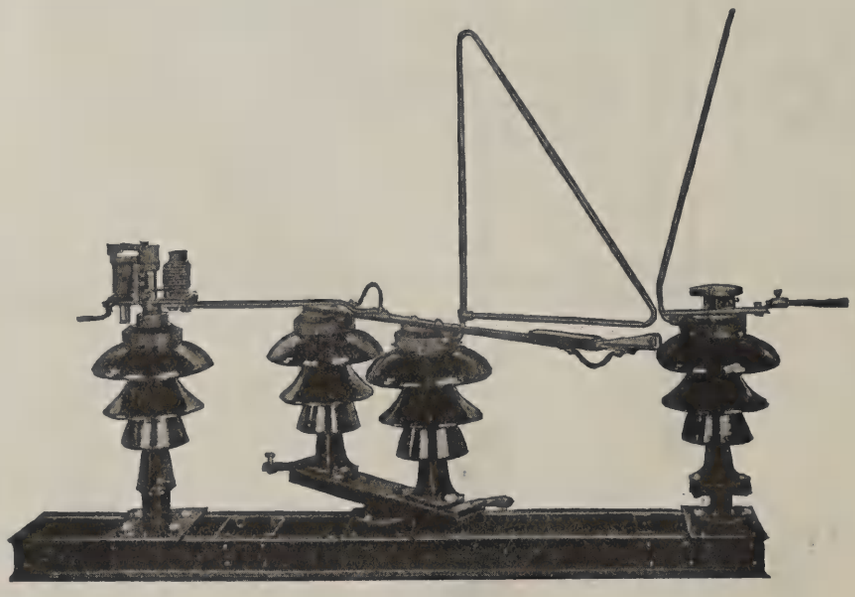


Fig. No. 11

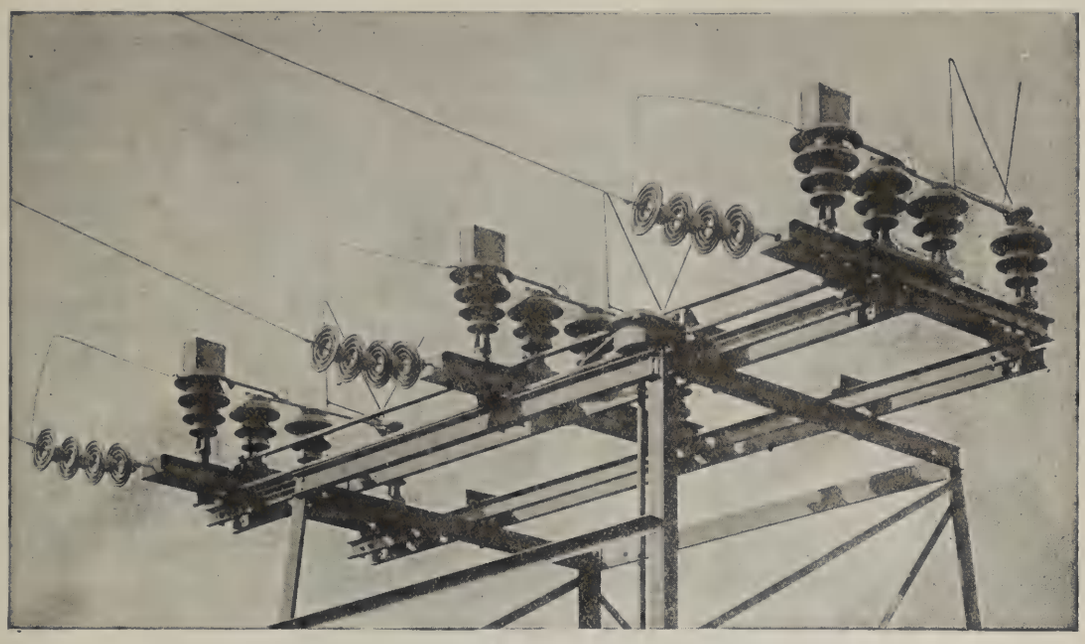


Fig. No. 12

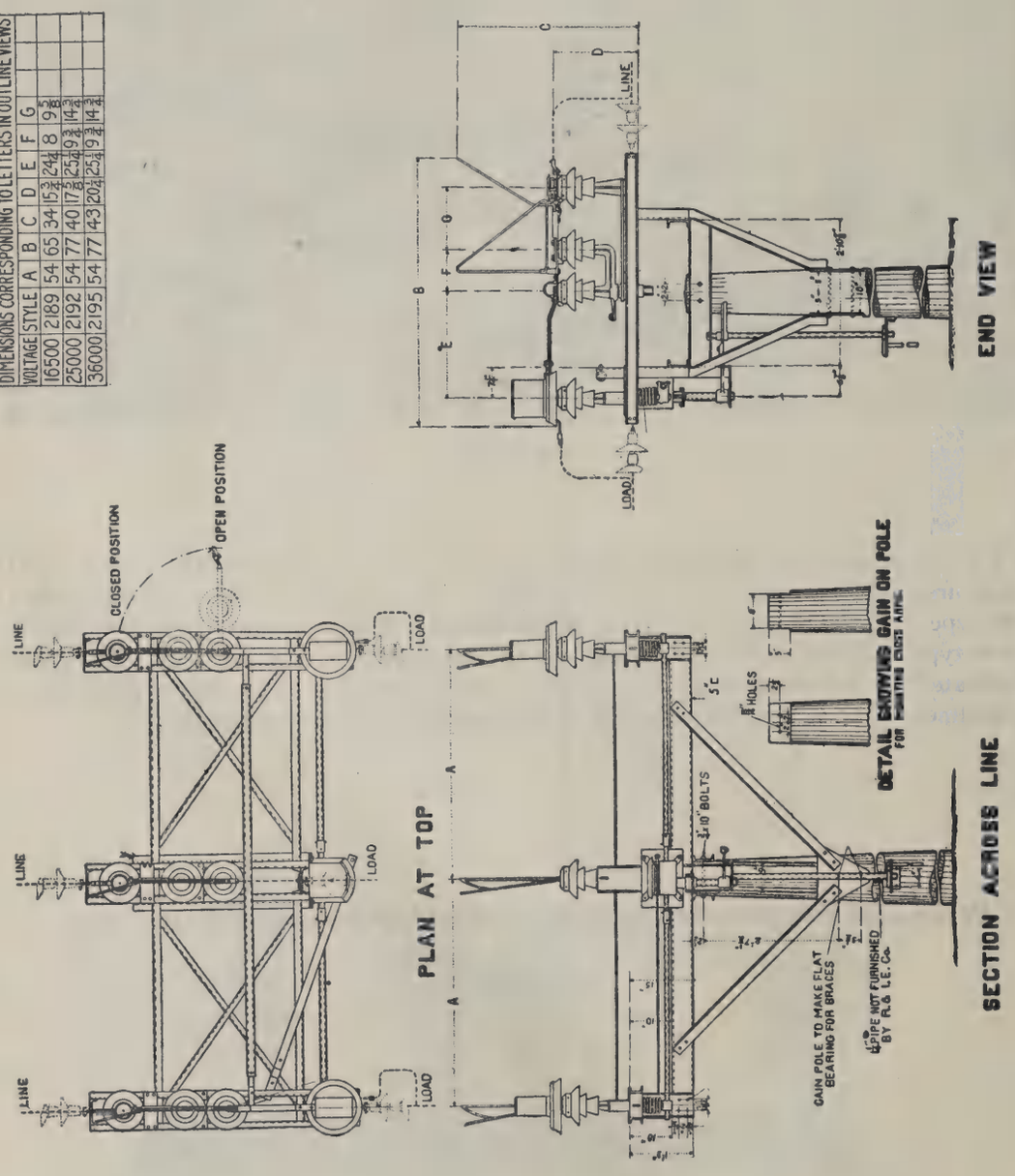
Fig. 12 shows the three-pole 50,000 V. type "AA" switch mounted on a steel structure. These switches are built for voltages up to 70,000 V. For higher voltages the type "AC" automatic switch is recommended. The trip coils are of the double ratio type and wound for any current up to 200 ampere normal capacity. They are calibrated for adjustments of 80 to 150% of normal load. This makes possible an adjustment of from 80 to 300 amperes, or the same ratio in lower currents.

Price List Automatic Overload Horn Gap Switches Type AA

Voltage	Style No.	List Price Including Steel Mounting 3-Pole Switch	Shipping Weight 3-Pole Switch
16500 V.	2189	$700.00	980 lbs.
25000 V.	2192	760.00	1150 lbs.
36000 V.	2195	780.00	1200 lbs.
50000 V.	2198	1050.00	2200 lbs.
70000 V.	———	———	———

TYPE AA BURKE HORN GAP SWITCHES—Continued

DIMENSIONS CORRESPONDING TO LETTERS IN OUTLINE VIEWS									
VOLTAGE	STYLE	A	B	C	D	E	F	G	
16500	2189	54	65	34	15¾	24¼	8	9⅝	
25000	2192	54	77	40	17⅝	25½	9¾	14¾	
36000	2195	54	77	43	20¼	25½	9¾	14¾	



Burke Horn Gap Automatic Switch 16500, 25000 and 36000-V. Type AA

TYPE AC

AUTOMATIC OVERLOAD BURKE HORN GAP SWITCH—The general principle of operation of the type "AC" automatic switch is the same as the type "AA" automatic in that the third insulator is capable of rotation under tension of a torsional spring when released by the action of a series trip coil in opening a latch mounted on top of the insulating column. The switch blade operates in a vertical plane, the switch itself being similar to the type "V" but modified to take care of the automatic features.

When overload permits the trip insulator to rotate, this action releases a latch allowing all poles to open simultaneously. The trip insulators are reset by swinging the operating handle to the left or open position and the switch subsequently closed by bringing the handle to the right and locking it in this position by the notch provided on the operating handle.

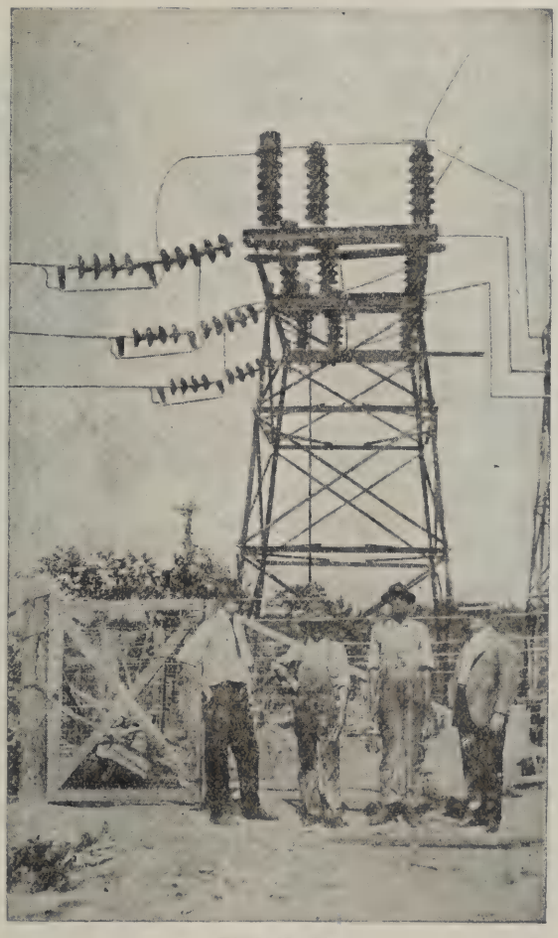


Fig. No. 13

Installation of 3-pole 110,000 volt, Type AC Automatic Horn Gap Switch protecting a bank of 3000 KA transformers

ELECTRICAL OPERATING MECHANISMS

The solenoid operating mechanism pictured in Fig. 13 is intended primarily for the operating of Air Break Switches having vertical operating shafts requiring a 90° rotation. The operating mechanism is housed in a cast iron case. It consists of a vertical shaft supported by ball thrust collars. The upper end of the shaft which extends beyond the case is provided with a flexible coupling for connection to the switch shaft. The shaft is given its rotation by the vertical travel of the heavy nut provided with six grooves or threads of twelve-inch pitch engaging similar grooves or threads on the shaft. The nut is pulled down by the solenoid in the bottom of the iron case. The closing of the switch is effected by energizing the solenoid. As this pulls the nut down it also compresses the heavy spring. The switch is held in a closed position by a latch engaging an arm on the shaft.

The switch is opened electrically by energizing a small shunt trip coil which releases the latch and permits the spring which was compressed in the closing operation to act. Arrangements are made to permit tripping the latch manually, also a lever is provided with which to close the switch manually.

It is often desired to operate Air Break Switch from the power house or sub-station switchboard and this may be handled in the usual manner standard with oil switch equipment including operating switch and signal lights to indicate the position of the switch. The signal lights are controlled by contacts mounted within the case of the solenoid operating mechanism.

The operating mechanism may be energized by either "DC" or "AC"-25 or 60 cycles.

Air Break Switches equipped with such electrical operating mechanism may be made automatic by controlling the shunt trip coil through relays of the usual type or through our Post type relay for outdoor mounting which is described in the following pages.

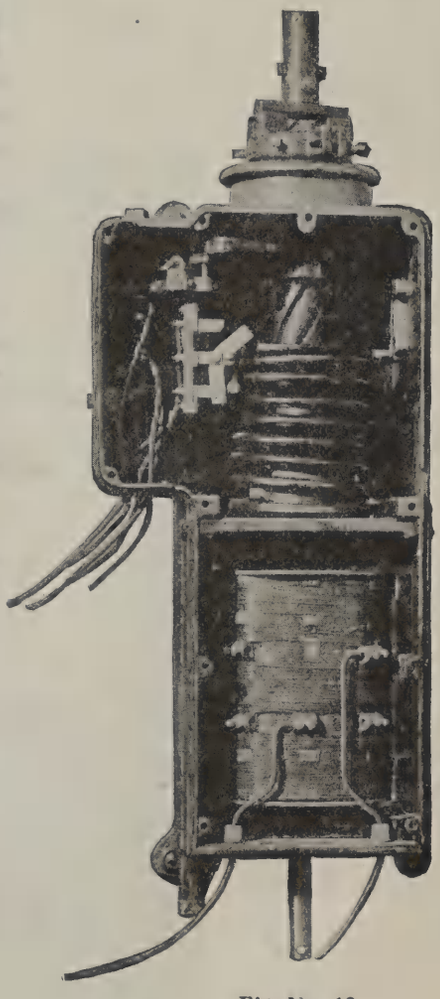


Fig. No. 13

POST TYPE RELAYS

The Post type relays shown in figures 14 and 15 form a convenient means of making a Burke Horn Gap Switch controlled by our Electrical Operating Mechanism, automatic as to overload tripping. The tripping may be instantaneous or controlled by an air dash pot to secure inverse time characteristics as the case may require.

The device consists of a series trip coil in the load circuit of the high tension line This coil is mounted on top of the tubular insulating column.

The pull of the plunger of the trip coil is transmitted to the dash-pot and the contactors by means of a small insulating Micarta Tube.

The dash-pot and contactors are mounted on the cast iron grounded base. They are effectively housed in and so arranged that adjustments of the time of tripping and desired tripping current may be made while in service without removing the case.

Usually two relays are used on three-phase circuits on voltages up to and including 36,000 volts and one on each phase for 44,000 volts and over. These Post type relays may be mounted in a convenient position, either indoors or outdoors but usually it is most convenient to mount them on the same steel bases which support the switch they are intended to control.

Installation of these Post type relays and Electrical Operating Mechanism are illustrated in cuts 16 and 17.

Fig. No. 14

Fig. No. 15

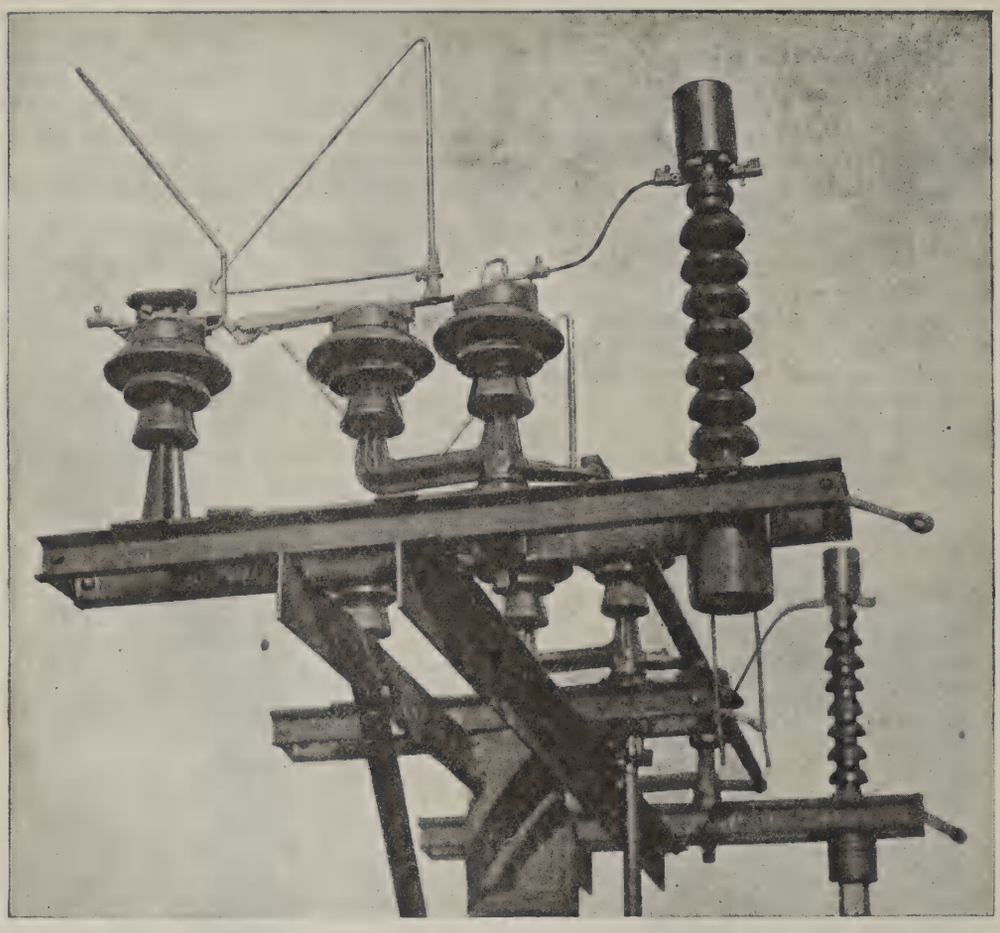


Fig. No. 16

Burke Horn Gap Switch, 33,000 V., equipped with Post type relays.

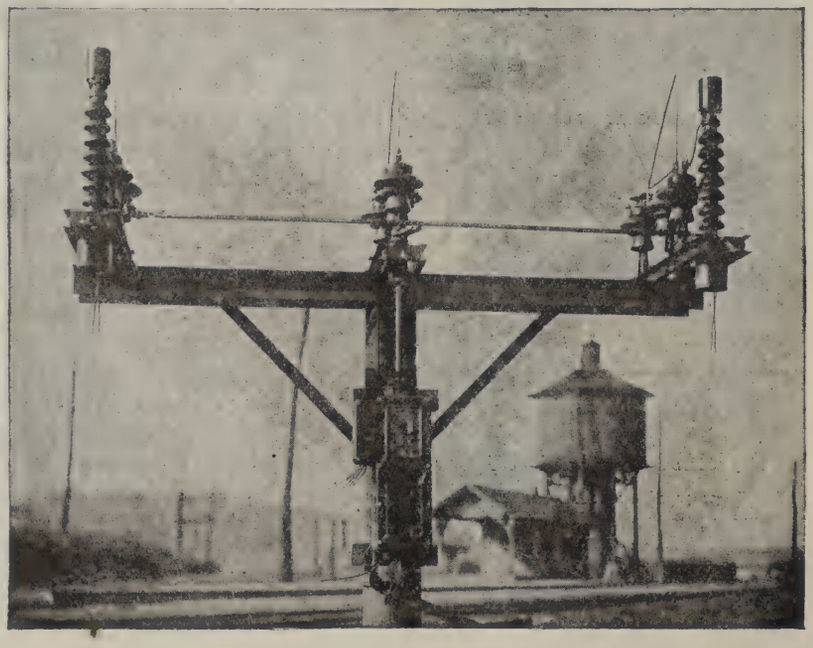


Fig. No. 17

3-Pole Burke Horn Gap Switch equipped with Post type relays and electrical operating mechanism.

BURKE HORN GAP LIGHTNING ARRESTERS AND CHOKE COILS

The Burke horn gap lightning arrester and choke coil is built for all voltages from 2,200 to 120,000 volts. It is more sensitive than the ordinary horn gap arrester and due to the magnetic blowout effect obtained by the choke coil, the power arc which follows a discharge rises very rapidly in the horn gap. A Koppat resistance in the ground circuit limits the rush of dynamic current to ground or between phases in case two or more arresters discharge at the same time. An auxiliary horn gap shunting the resistance allows a very heavy surge to discharge direct to ground.

The Burke horn gap lightning arrester combines a triangular choke coil with a horn gap using one side of the choke coil as one of the horns. The coil is used in this way, first as a magnetic blowout to hasten the travel of the arc up the horns and second to increase the sensitiveness of the arrester. The incoming line is connected to the outside turn. The path of the power circuit is around the coil and out through the center so that the surge entering the coil meets its first obstruction at the first sharp upward turn of the coil opposite which is mounted the ground horn. The voltage will build up at this point and is reflected back by the other turns toward ground. Due to this construction the gap to ground may be set approximately 50 per cent greater than the ordinary shunted horn gap and the same protection obtained.

A surge acts as though it had momentum. It continues to travel straight ahead if possible, and a sudden change in direction, especially upward, results in a "piling up" of voltage at the turning point. A surge will arc to ground where the resistance to ground is weakest or where it meets an obstruction. In the Burke lightning arrester, a most efficient obstruction to surges and a point of weak resistance to ground are concentrated at the same point. Back of this point the load is connected to the line.

The Burke choke coil carries the main conductor in a straight line direct to the arrester horn gap. Any voltage surge to pass the first turn of the coil is forced to make a sharp turn upward and backward at a place where the straight line path would carry it direct to ground.

The choke coil is one continuous piece of strap copper well braced and insulated. A brass flash strap attached to the choke coil forms one side of the horn gap.

Koppat resistance is permanently connected in the ground circuit of each phase and must be so connected to accomplish the purpose for which it is installed. An auxiliary horn gap shunts the resistance, affording a direct path to ground for very heavy surges or a direct stroke of lightning. The use of resistance permanently connected in the ground circuit does not effect the sensitiveness of the arrester. There is obviously no voltage loss across the resistance until current actually flows through it. Therefore, the potential to ground previous to a discharge is the same as though no resistance were connected in circuit. Current can not flow through the resistance until the surge has jumped the gap and is on its way to ground.

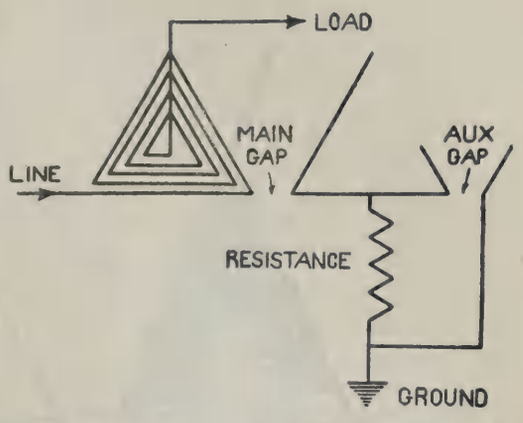
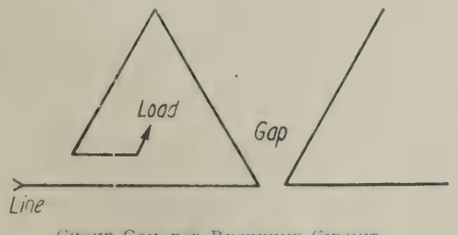


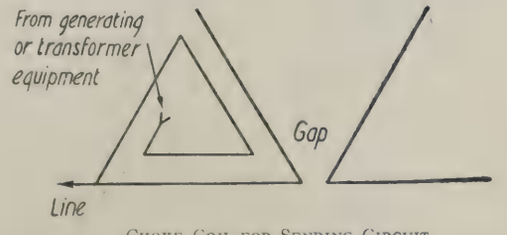
FIG. 1—DIAGRAM OF ARRESTERS USING CHOKE COIL, MAIN AND AUXILIARY GAPS, AND RESISTANCE

Direction of Power

The arresters are listed in the price table **for receiving circuits** and **for sending circuits.** (See Figure 2.) This is necessary, due to the direction of winding of the choke and reactance coils. If an arrester for a receiving circuit is used on a sending circuit, the blowout effects of the coils would be to force the arc downward into the horn, instead of upward out of the horn. Arresters for **receiving circuits** are to be used where the **power is fed into** a substation. Arresters for **sending circuits** are to be used on circuits where **power is sent out** from the station or substation.



CHOKE COIL FOR RECEIVING CIRCUIT



CHOKE COIL FOR SENDING CIRCUIT

FIG. 2

TYPES WB AND WC LIGHTNING ARRESTERS

With High-Capacity Resistance

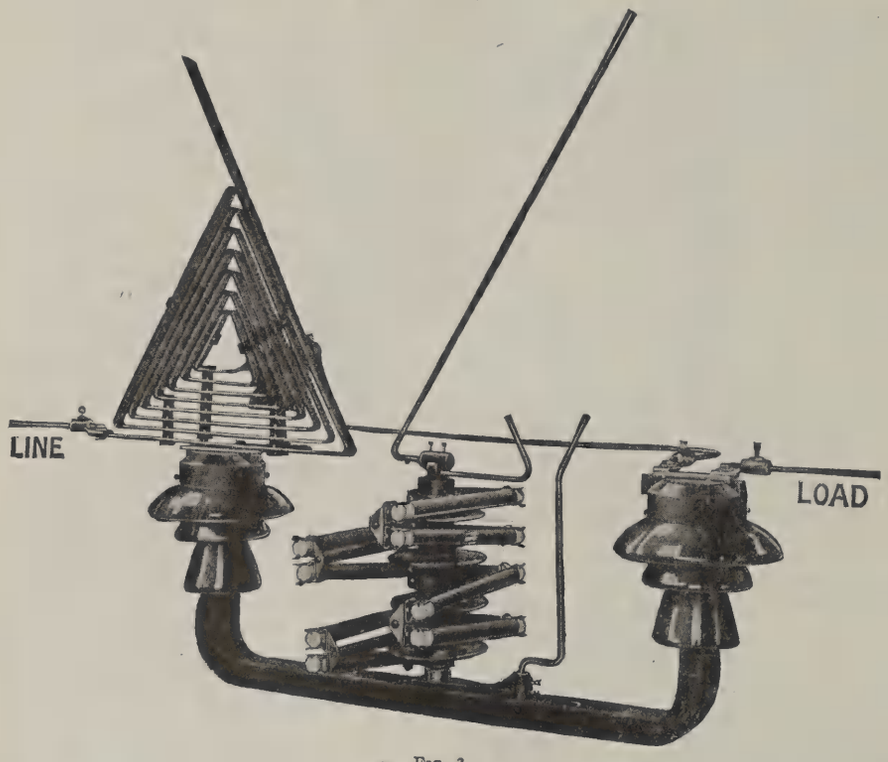


FIG. 3

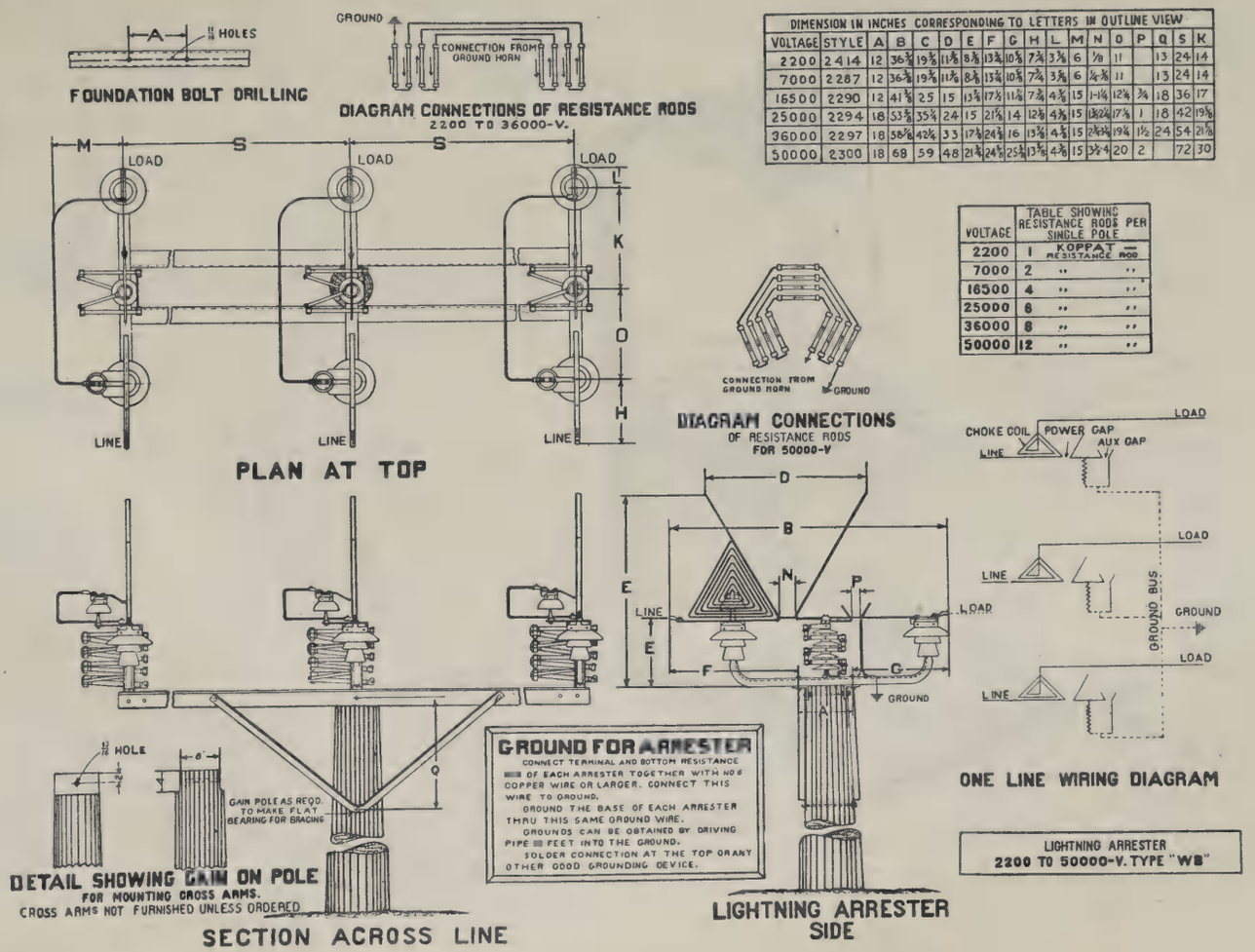
The type WB Burke series horn gap lightning arrester and choke coil is pictured in Fig. 3. This type is in successful operation on all voltages up to and including 110,000 and on systems of heavy capacity.

The type WC arrester is of the same construction as the type WB except designed for sending circuits.

For Receiving Circuits				For Sending Circuits			
Volts	Style Number	Approx. Shipping Weight. Lb.	List Price Single Pole	Volts	Style Number	Approx. Shipping Weight, Lbs.	List Price Single Pole
	Type WB Arresters				**Type WC Arresters**		
2200	2414	43	$ 36 00	.....	.....	...	.....
7000	2287	43	36 00	7000	2321	43	$ 36 00
16500	2290	95	52 00	16500	2324	95	52 00
25000	2294	142	70 00	25000	2327	142	70 00
36000	2297	240	85 00	36000	2330	240	85 00
50000	2300	325	125 00	50000	2333	325	125 00
70000*	2517	...	210 00	70000	2518	...	210 00

For dimensions see Fig. 4.

*Prices of higher voltage arresters than those listed on request.


FOUNDATION BOLT DRILLING
HOLES
DIAGRAM CONNECTIONS OF RESISTANCE RODS
2200 TO 36000-V.
GROUND
CONNECTION FROM GROUND HORN
PLAN AT TOP
LOAD
LINE
SECTION ACROSS LINE
DETAIL SHOWING GAIN ON POLE
FOR MOUNTING CROSS ARMS.
CROSS ARMS NOT FURNISHED UNLESS ORDERED
GAIN POLE AS REQD. TO MAKE FLAT BEARING FOR BRACING
DIAGRAM CONNECTIONS
OF RESISTANCE RODS
FOR 50000-V
LIGHTNING ARRESTER SIDE
GROUND FOR ARRESTER
CONNECT TERMINAL AND BOTTOM RESISTANCE OF EACH ARRESTER TOGETHER WITH NO 6 COPPER WIRE OR LARGER. CONNECT THIS WIRE TO GROUND.
GROUND THE BASE OF EACH ARRESTER THRU THIS SAME GROUND WIRE.
GROUNDS CAN BE OBTAINED BY DRIVING PIPE FEET INTO THE GROUND.
SOLDER CONNECTION AT THE TOP OR ANY OTHER GOOD GROUNDING DEVICE.
CHOKE COIL
POWER GAP
AUX GAP
GROUND BUS
ONE LINE WIRING DIAGRAM
LIGHTNING ARRESTER
2200 TO 50000-V. TYPE "WB"

DIMENSION IN INCHES CORRESPONDING TO LETTERS IN OUTLINE VIEW																		
VOLTAGE	STYLE	A	B	C	D	E	F	G	H	L	M	N	O	P	Q	S	K
2200	2414	12	36⅜	19⅜	11⅝	8⅜	13¾	10⅜	7¾	3⅜	6	⅛	11		13	24	14
7000	2287	12	36⅜	19⅜	11⅝	8⅜	13¾	10⅜	7¾	3⅜	6	¼-⅜	11		13	24	14
16500	2290	12	41⅜	25	15	13⅜	17½	11⅛	7⅞	4⅜	15	1-1¼	12⅛	¾	18	36	17
25000	2294	18	53⅜	35¾	24	15	21½	14	12⅝	4⅜	15	1⅜-2¼	17⅛	1	18	42	19⅜
36000	2297	18	58⅜	42¼	33	17⅜	24½	16	13⅝	4⅜	15	2⅜-3¼	19¼	1½	24	54	21⅜
50000	2300	18	68	59	48	21¾	24½	25½	13⅝	4⅜	15	3½-4	20	2		72	30

VOLTAGE	TABLE SHOWING RESISTANCE RODS PER SINGLE POLE
2200	1 KOPPAT RESISTANCE ROD
7000	2 " "
16500	4 " "
25000	6 " "
36000	8 " "
50000	12 " "

Fig. 4—Approximate Dimensions of Types WB and WC Lightning Arresters

TYPES WBR AND WCR LIGHTNING ARRESTERS

With High Capacity Resistance and with Reactance Coil in Ground Circuit

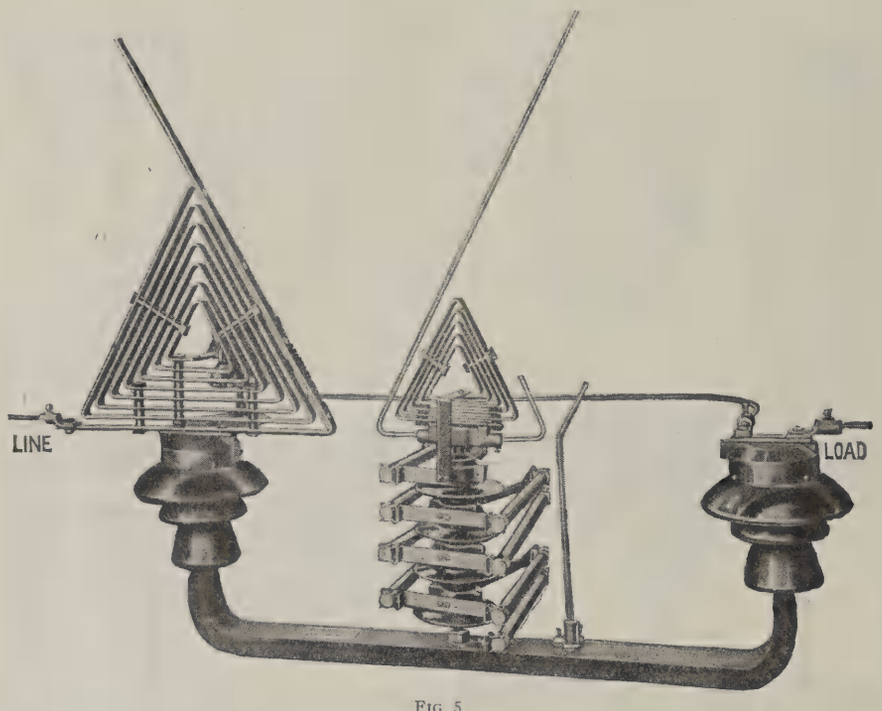


FIG. 5

The type WBR arrester is pictured in Fig. 5. This arrester is recommended for use on the larger transmission systems of heavy capacity where high capacity surges are experienced or where lightning disturbances are often severe.

The arrester is similar to the type WB, except that a reactance coil is connected in series with the high capacity Koppat resistance in the ground circuit. An auxiliary horn gap shunts both the reactance coil and the resistance, thus giving a direct path to ground for a surge of such capacity that it can not be discharged quickly enough through the reactance and resistance.

This reactance is used principally to relieve the resistance of the heavy strains by smoothing out the surge before it reaches the resistance.

The use of the reactance coil in no way interferes with the sensitiveness of the arrester.

The type WCR arrester is of the same construction as the type WBR except designed for sending circuits.

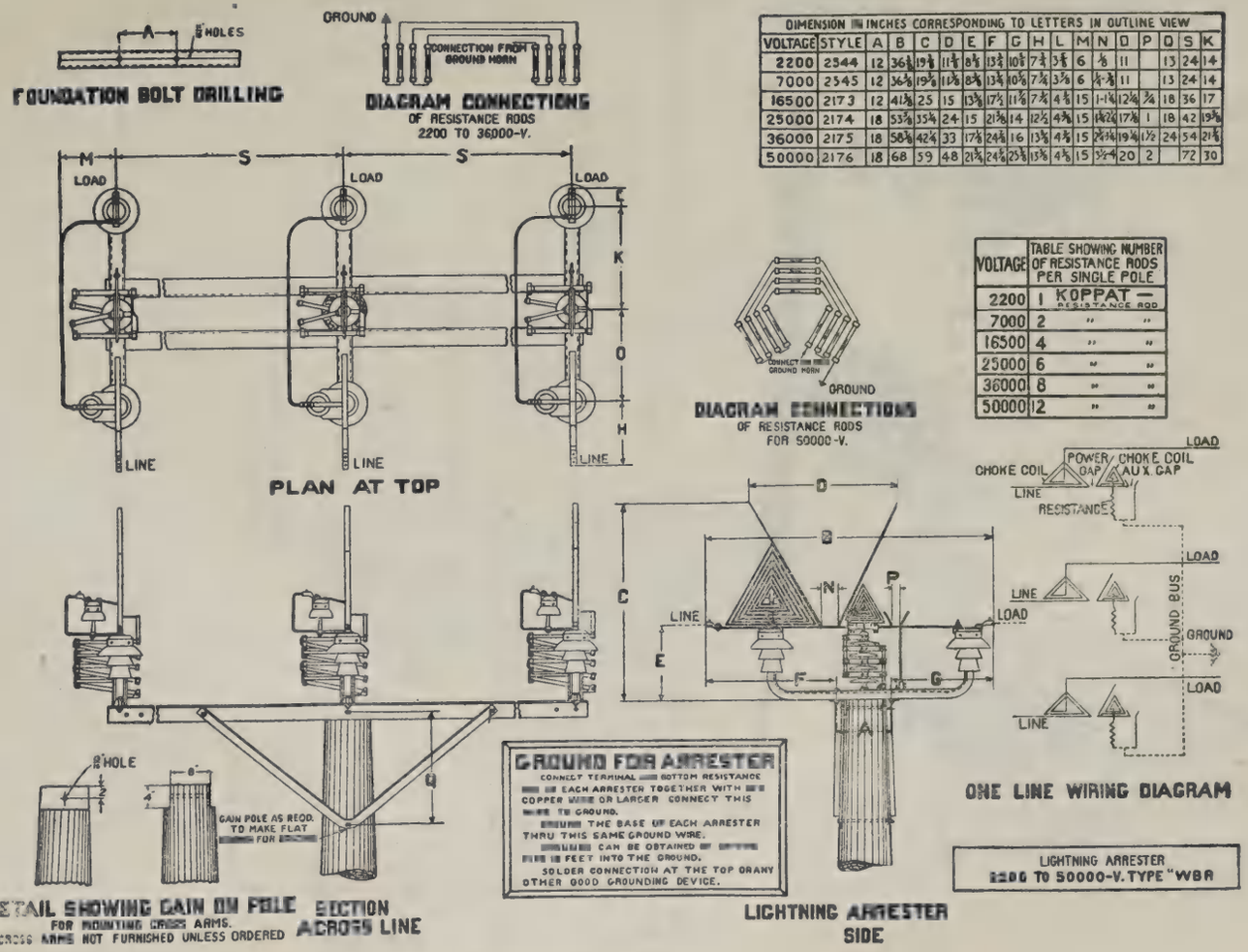
For Receiving Circuits

Volts	Style Number	Approx. Shipping Weight, Lb.	List Price Single Pole
	Type WBR Arresters		
16500	2173	100	$ 60 00
25000	2174	140	85 00
36000	2175	150	95 00
50000	2176	250	140 00
70000	2177	340	220 00

For Sending Circuits

Volts	Style Number	Approx. Shipping Weight, Lb.	List Price Single Pole
	Type WCR Arresters		
16500	2178	100	$ 60 00
25000	2179	140	85 00
36000	2180	150	95 00
50000	2181	250	140 00
70000	2182	340	220 00

For dimensions see Fig. 6.



DIMENSION IN INCHES CORRESPONDING TO LETTERS IN OUTLINE VIEW																	
VOLTAGE	STYLE	A	B	C	D	E	F	G	H	L	M	N	O	P	Q	S	K
2200	2344	12	36⅛	19⅛	11⅛	8⅜	13⅜	10⅛	7⅛	5⅜	6	⅞	11		13	24	14
7000	2345	12	36⅜	19⅜	11⅜	8⅜	13¾	10⅜	7⅞	3⅜	6	⅞-⅜	11		13	24	14
16500	2173	12	41⅜	25	15	13⅜	17½	11⅜	7⅞	4⅜	15	1-1¼	12¼	¾	18	36	17
25000	2174	18	53⅜	35¼	24	15	21⅜	14	12½	4⅜	15	1¼-2	17⅜	1	18	42	19⅜
36000	2175	18	58⅜	42¼	33	17⅜	24⅜	16	13⅜	4⅜	15	2-2¼	19¼	1½	24	54	21⅜
50000	2176	18	68	59	48	21⅜	24⅜	25⅜	13⅜	4⅜	15	3½-4	20	2		72	30

VOLTAGE	TABLE SHOWING NUMBER OF RESISTANCE RODS PER SINGLE POLE
2200	1 KOPPAT — RESISTANCE ROD
7000	2 " "
16500	4 " "
25000	6 " "
36000	8 " "
50000	12 " "

Fig. 6—Approximate Dimensions of Types WBR and WCR Lightning Arresters

TYPES DL AND DLR LIGHTNING ARRESTERS

Double-Line

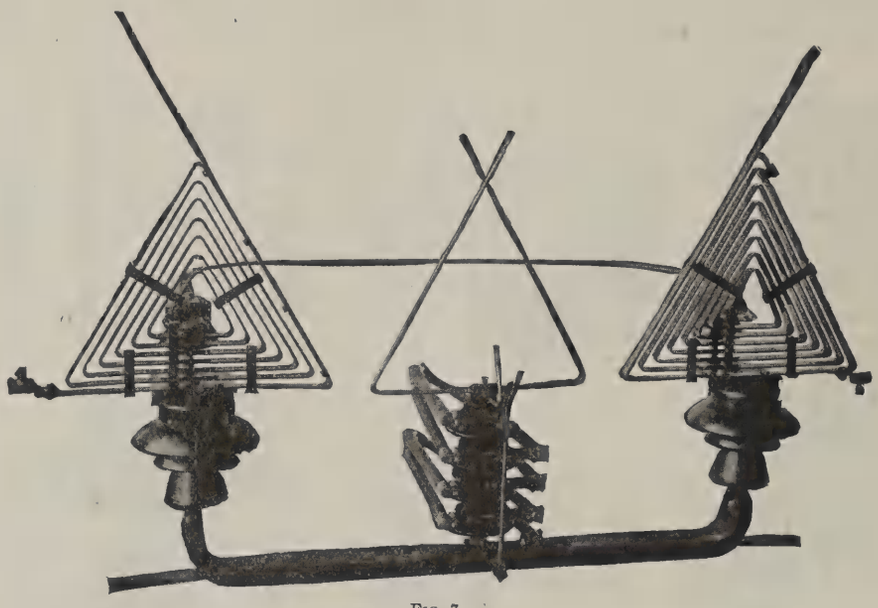


FIG. 7

The type DL lightning arrester pictured in Fig. 7 is designed for the protection of transmission lines. The arrester is similar to the type WB, except it is built with two choke coils so as to arrest surges coming in either direction. The arrester is tapped in series with the transmission line.

By installing the type DL arrester at equal distances along the line or at points where trouble is often experienced, loss of insulators due to lightning will be greatly reduced.

The type DLR arrester is the same as the type DL, except a reactance coil is connected in series with the resistance in the ground circuit giving a line-type arrester with characteristics similar to the type WBR arresters.

Type DL (Double-Line) Arresters

Volts	Approx. Shipping Weight, Lbs.	Style Number	List Price Single Pole
7000	63	2531	$ 45 00
16500	105	2532	66 00
25000	125	2533	100 00
36000	145	2534	110 00
50000	305	2535	150 00

Type DLR Arresters

Prices on request.

For dimensions see Fig. 8.

BURKE HORN GAP LIGHTNING ARRESTERS AND CHOKE COILS—Continued

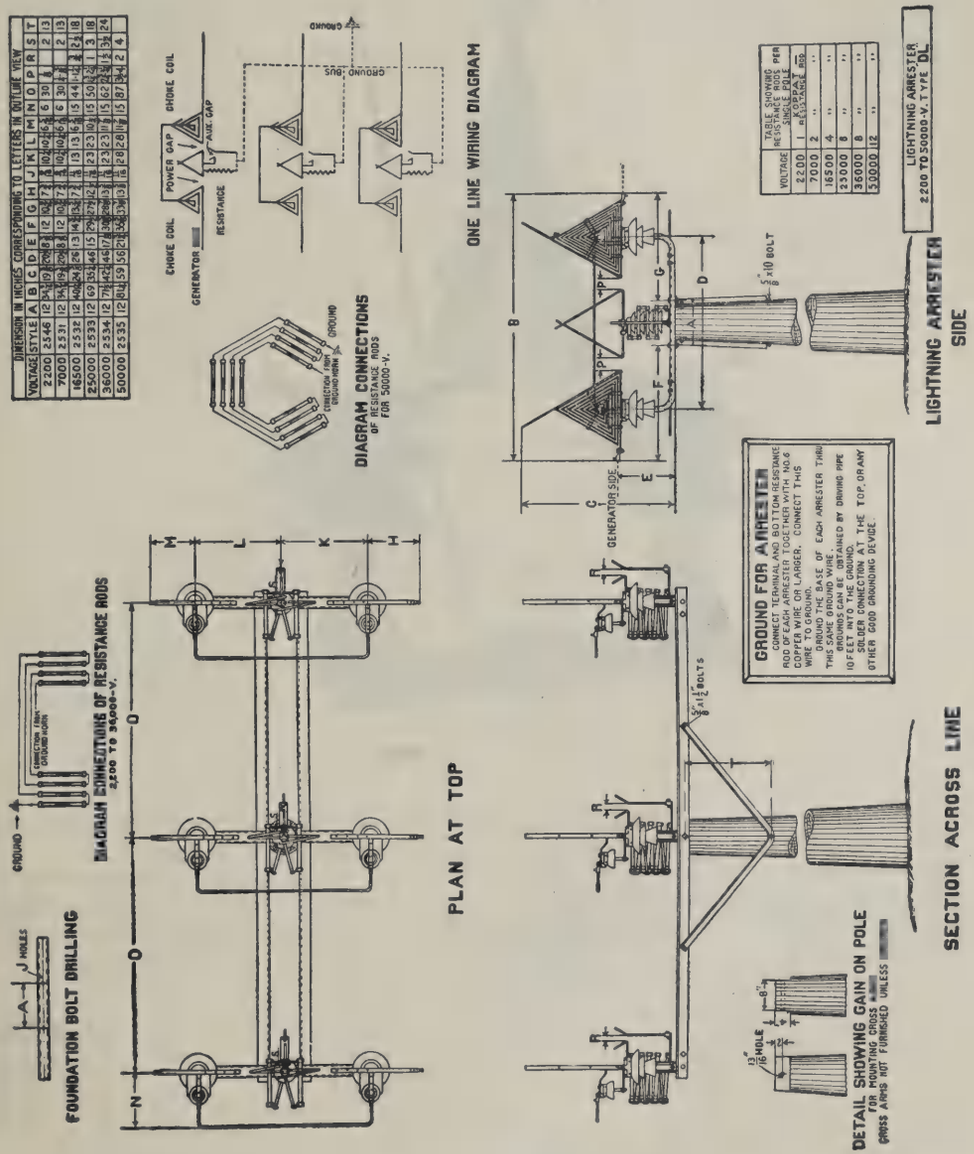

DIMENSION IN INCHES CORRESPONDING TO LETTERS IN OUTLINE VIEW
VOLTAGE STYLE A B C D E F G H J K L M N O P R S T
2200 2346 (2) 3½ 19 20⅜ 8 12 10¾ 7 8 10¾ 6 30 6 2 13
7000 2331 (2) 3½ 19 20⅜ 8 12 10¾ 7 8 10¾ 6 30 6 2 13
16500 2332 (2) 4½ 24 26¾ 12 14 13¾ 7 8 13¾ 6 30 6 2 13
25000 2333 (2) 6½ 35¼ 40⅛ 15 19 17¾ 7 8 17¾ 6 44½ 6 2 18
36000 2334 (2) 7½ 42⅝ 46⅞ 15 23 23¾ 15 8 23¾ 6 50½ 6 2 18
50000 2335 (2) 8½ 59 58⅜ 15 30 29⅜ 15 8 29⅜ 6 87¾ 6 2 24
DIAGRAM CONNECTIONS OF RESISTANCE RODS 2200 TO 36000-V.
DIAGRAM CONNECTIONS OF RESISTANCE RODS FOR 50000-V.
ONE LINE WIRING DIAGRAM
PLAN AT TOP
SECTION ACROSS LINE
LIGHTNING ARRESTER SIDE
GENERATOR SIDE
FOUNDATION BOLT DRILLING
DETAIL SHOWING GAIN ON POLE FOR MOUNTING CROSS ARMS NOT FURNISHED UNLESS
GROUND FOR ARRESTER
TABLE SHOWING RESISTANCE RODS PER SINGLE POLE
LIGHTNING ARRESTER 2200 TO 50000-V. TYPE DL

FIG. 8—APPROXIMATE DIMENSIONS OF TYPE DL LIGHTNING ARRESTERS

TYPE N LIGHTNING ARRESTERS

Without Resistance

FIG. 9

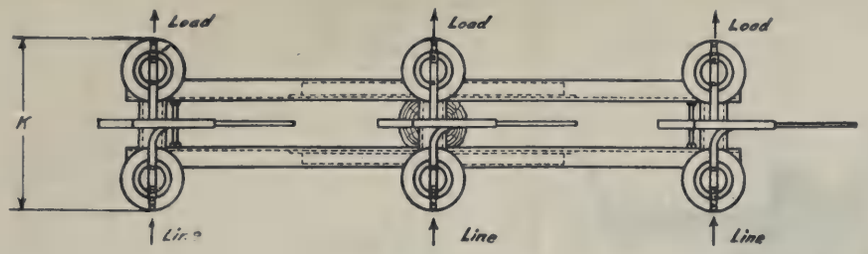
The type N arrester, Fig. 9, uses the same triangular choke coil as the type WB or WBR arresters, but the ground horn is connected direct to ground **with no discharge resistance** in circuit. This arrester is not generally recommended because of the rush of current between phases when two arresters discharge at the same time.

Where this arrester is used, each phase should be grounded separately if possible (a single or common ground is used for any of the other arresters).

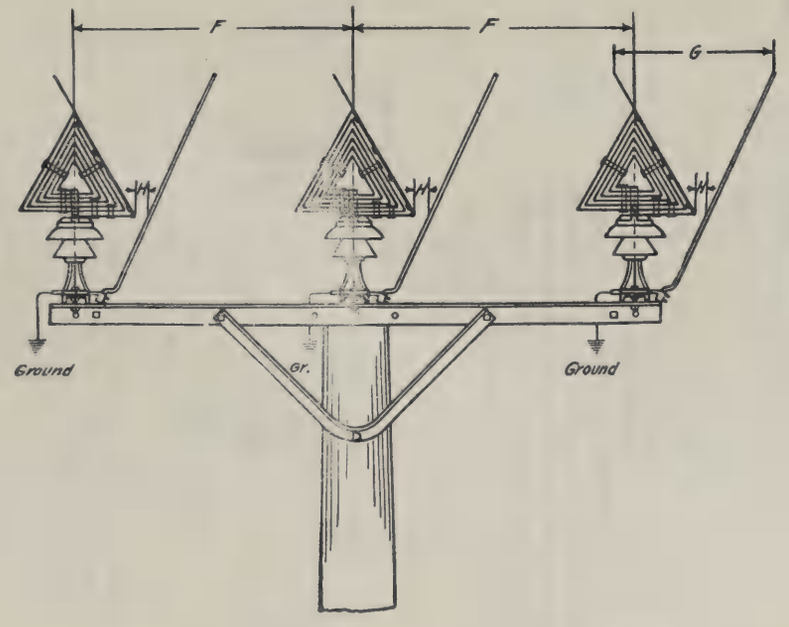
Type N Arresters

Volts	Approx. Shipping Weight, Lbs.	Style Number	List Price Single Pole
7000	35	2091	$24 00
16500	65	2094	30 00
25000	80	2097	50 00
36000	90	2100	55 00
50000	200	2103	70 00

For **dimensions** see Fig. 10.



Dimensions In Inches Corresponding To Letters In Outline Views												
Voltage	A Fig. 1.	B Fig. 1.	A Fig. 2.	B Fig. 2.	C	D	E	F	G	H	K
16,500	2	6			10	13 1/2	25	36	15	11 to 11 1/4	18 3/4
25,000			10	5	16	13 3/8	36	42	24	3/4 to 2 1/4	24 3/4
36,000			10	5	16	16	43	54	33	2 3/4 to 3 1/4	24 3/4
50,000			20	5	20	19 5/8	61	72	48	3 1/2 to 4	28 3/4



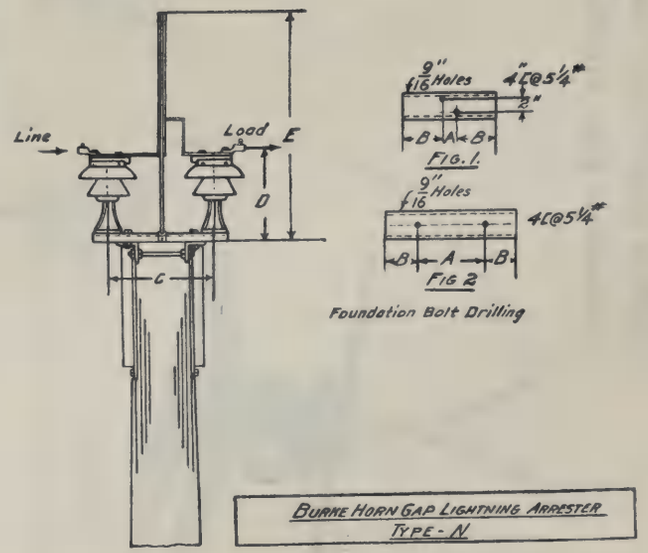


FIG. 10—APPROXIMATE DIMENSIONS OF TYPE N LIGHTNING ARRESTERS

TYPE S LIGHTNING ARRESTERS

Suspension Type with Resistance

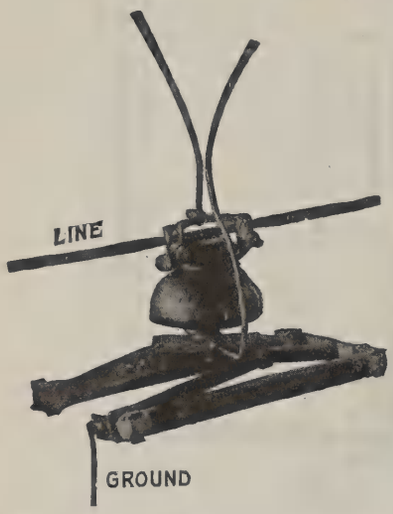


FIG. 11—6600-VOLT TYPE S LIGHTNING ARRESTER

FIG. 12—13200-VOLT TYPE S LIGHTNING ARRESTER

The type S (suspension type) horn gap arrester, Figs. 11-A, 11 and 12, consists of an adjustable horn gap for the resistance in series with the ground circuit. These arresters are built for service voltages up to and including 13,200 volts.

The arrester is clamped and suspended direct from the transmission line without the necessity of cutting the line. This construction eliminates the necessity or requirement of a mounting. As arresters are suspended from the line, they may be placed far enough from the pole to eliminate any danger of accidental contact with them. An arrester may be installed on each phase of a circuit and a common ground wire used.

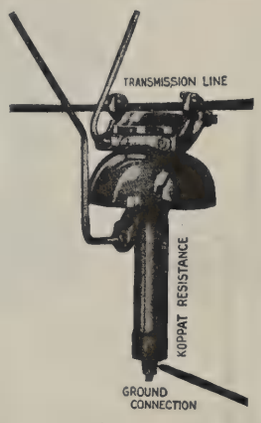


FIG. 11-A—2300-VOLT AND 4000-VOLT TYPE S LIGHTNING ARRESTERS

Type S Arresters

Volts	Approx. Shipping Weight, Lb.	QUANTITY PRICES ON ONE ORDER — NET PRICES EACH — 1 to 25	26 to 50	51 or More
2300	7½	$ 3 90	$ 3 50	$3 15
4000	7½	4 55	4 10	3 70
6600	10	7 80	7 00	6 30
13200	25	11 70	10 55	9 50

BURKE HORN GAP FUSES

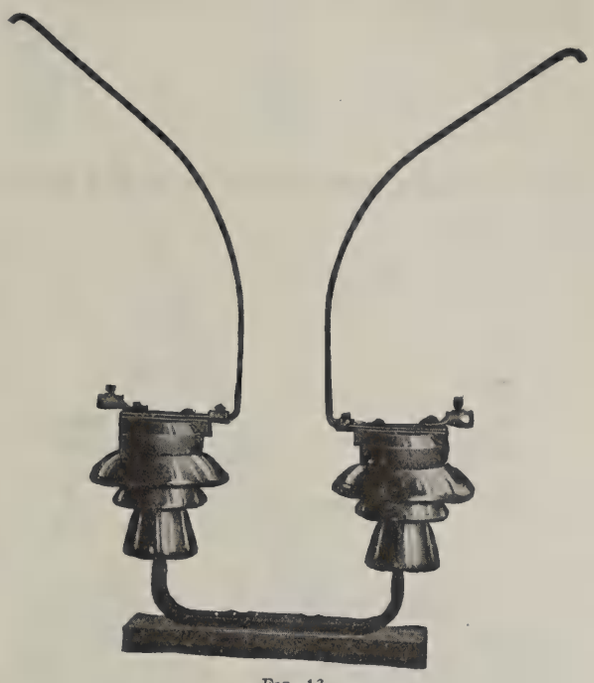


FIG. 13

The type F Burke horn-gap fuses have been designed to meet the demand for apparatus and branch transmission lines where initial cost is of prime consideration. The fuses are built for voltages of 2200 to 70,000 inclusive.

Application—(1) To protect small lighting transformer installations.

(2) To protect outdoor substations.

(3) To protect the trunk line from trouble on branch transmission lines.

(4) To protect high-voltage instrument transformers.

Operation—An arc formed across a pair of diverging horns will climb up and be dissipated. The fuse is mounted between two brass horns so that when it blows the arc will be caught and extinguished. This gives a gradual rupture of the circuit and no harmful surges are produced.

Construction—The fuses are built in single-pole units and on a channel-iron base to which the insulator pins are bolted. The insulators are cemented to these pins with a mixture of litharge and glycerine. Caps are fastened to the insulators by a special means which allows quick and easy removal in case it is necessary to replace an insulator. Brass liners are bolted to the caps in which the horns are fastened. These liners are provided either with set-screws to hold link fuses or a clip to hold cartridge fuses.

Link fuses may be either alloy or aluminum standard fuse wire or copper wire of proper size. When using a very light fuse wire it may be desirable for mechanical reasons to first tie a string between the horns and then to wind the fuse wire spirally about the string before fastening to the horns.

Distinctive Features—The following are some of the features of these fuses, which should be given careful consideration:

Ruggedness characterizes all parts of the fuse. It may be depended on for emergencies.

Insulation is ample. A wide margin of safety is allowed on all insulators.

Clearances and spacings are ample for safety of linemen and for extinguishing arcs.

Sherardized bolts and nuts are used, preventing corrosion.

Terminals are large and arranged so that the line is easily fastened in.

Broken insulators can be quickly and easily replaced. The removable cap and litharge and glycerine cement make a quick job.

Standard fuse wire can be used for re-fusing.

Workmanship is thorough. All parts are carefully machined and completely assembled before leaving the factory.

Erection is simple. Any lineman is capable of doing the work.

Good grounds should be provided for the metal bases in all cases.

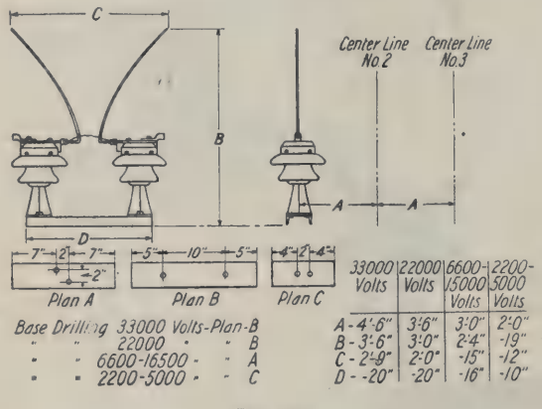
BURKE HORN GAP LIGHTNING ARRESTERS AND CHOKE COILS—Continued

Type F Burke Horn Gap Fuses

Up to 50 Amperes Capacity

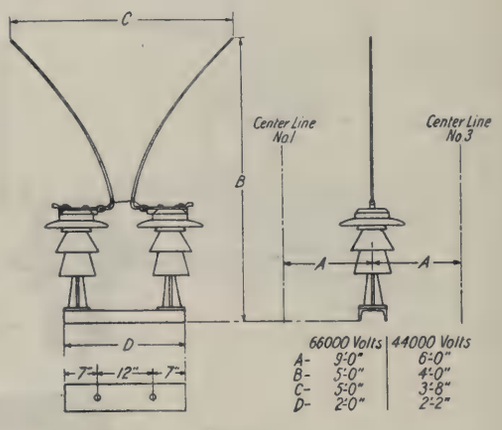
Volts	Approx. Shipping Weight, Lb.	Poles	Style No.	List Price
2200 5000	30	Single	2073	$12 00
16500	55	Single	2076	27 00
25000	73	Single	2079	35 00
36000	78	Single	2082	40 00
50000	175	Single	2085	60 00
70000	245	Single	2088	70 00

APPROXIMATE OUTLINE DIMENSIONS OF BURKE HORN GAP FUSES



	33000 Volts	22000 Volts	6600-15000 Volts	2200-5000 Volts
A	4'-6"	3'-6"	3'-0"	2'-0"
B	3'-6"	3'-0"	2'-4"	-19"
C	2'-9"	2'-0"	-15"	-12"
D	-20"	-20"	-16"	-10"

Fig. 14



	66000 Volts	44000 Volts
A	9'-0"	6'-0"
B	5'-0"	4'-0"
C	5'-0"	3'-8"
D	2'-0"	2'-2"

Fig. 15

COMBINED LIGHTNING ARRESTERS AND FUSES

For the protection of high voltage transmission substations and similar installations, protective apparatus is required. For this service, the horn gap fuse is recommended, both for its dependable operation and low cost of maintenance or fuse renewals. This item should be seriously considered in connection with the low capacity substations where the revenue is not large and where any unnecessary expense might take the profit from the substations.

When used in connection with outdoor substations, we do not recommend that the high-voltage fuse be depended upon to protect the transformers against normal overload but rather to disconnect the transformers from the high-voltage line, in case of internal trouble or a short circuit. The normal overload protection, therefore, should be obtained on the low-voltage side.

For convenience in mounting and to reduce the cost, we combined the Burke series horn gap lightning arrester, choke coil and horn gap fuse on a common base.

The lightning arrester is connected ahead of the fuse, so that there is no danger of the fuse blowing and interrupting service due to a discharge across the arrester.

TYPES R AND RC LIGHTNING ARRESTERS

With High-Capacity Resistance

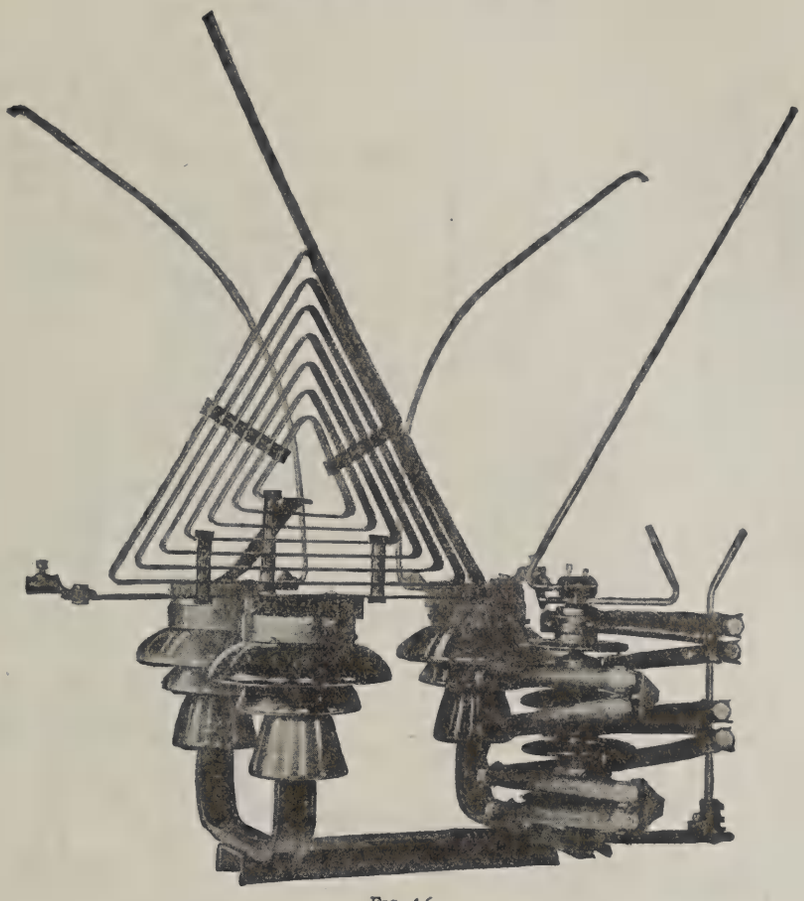


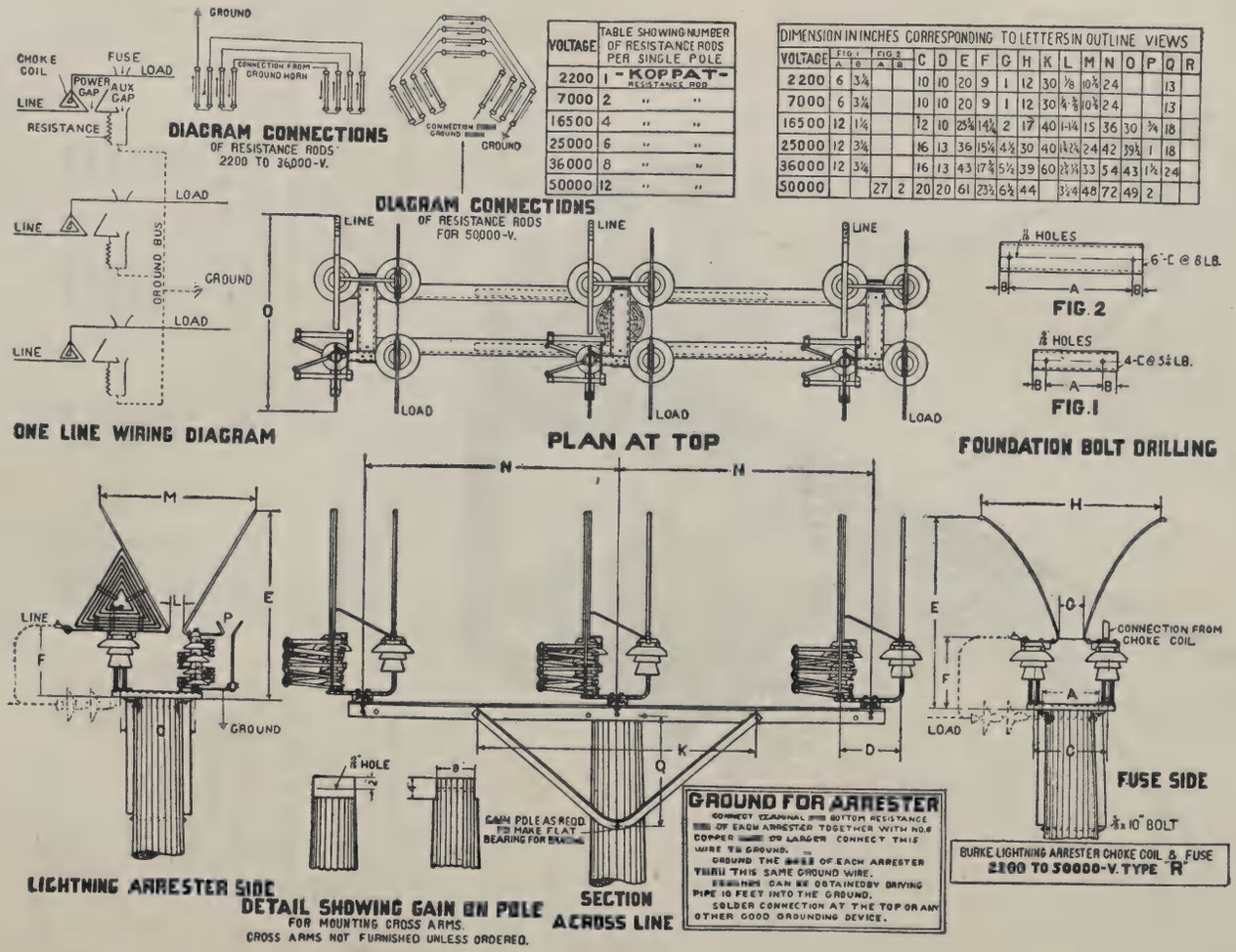
FIG. 16

The type R Burke horn gap combined lightning arrester, choke coil and fuse consists of a type WB lightning arrester and a horn gap fuse. This is pictured in Fig. 16.

The type RC arrester is of the same construction as the type R except designed for sending circuits.

For Receiving Circuits				For Sending Circuits			
Volts	Style Number	Approx. Shipping Weight, Lb.	List Price Single Pole	Volts	Style Number	Approx. Shipping Weight, Lb.	List Price Single Pole
	Type R Arresters				**Type RC Arresters**		
2200	**2412**	65	$ 35 00	.....	.....	....	.....
7000	**2145**	65	35 00	7000	**2322**	65	35 00
16500	**2148**	105	65 00	16500	**2445**	105	65 00
25000	**2151**	135	85 00	25000	**2323**	135	85 00
36000	**2154**	142	95 00	36000	**2324**	142	95 00
50000	**2157**	305	170 00	50000	**2325**	305	170 00
70000	**2160**	490	240 00	70000	**2326**	490	240 00

For dimensions see Fig. 17.



VOLTAGE	TABLE SHOWING NUMBER OF RESISTANCE RODS PER SINGLE POLE
	1 - KOPPAT - RESISTANCE ROD
2200	1
7000	2
16500	4
25000	6
36000	8
50000	12

DIMENSION IN INCHES CORRESPONDING TO LETTERS IN OUTLINE VIEWS																		
VOLTAGE	FIG 1 A	FIG 1 B	FIG 2 A	FIG 2 B	C	D	E	F	G	H	K	L	M	N	O	P	Q	R
2200	6	3¼			10	10	20	9	1	12	30	⅛	10¾	24			13	
7000	6	3¼			10	10	20	9	1	12	30	¼-⅜	10¾	24			13	
16500	12	1¼			12	10	25¾	14½	2	17	40	1-1¼	15	36	30	¾	18	
25000	12	3¼			16	13	36	15¼	4⅜	30	40	1½-2¼	24	42	39½	1	18	
36000	12	3¼			16	13	43	17¾	5½	39	60	2⅜-3½	33	54	43	1½	24	
50000			27	2	20	20	61	23½	6½	44		3¼	48	72	49	2		

FIG. 17—APPROXIMATE DIMENSIONS OF TYPES R AND RC LIGHTNING ARRESTERS

TYPE RR AND RCR LIGHTNING ARRESTERS

With High-Capacity Resistance and with Reactance Coil in Ground Circuit, Choke Coil and Fuse

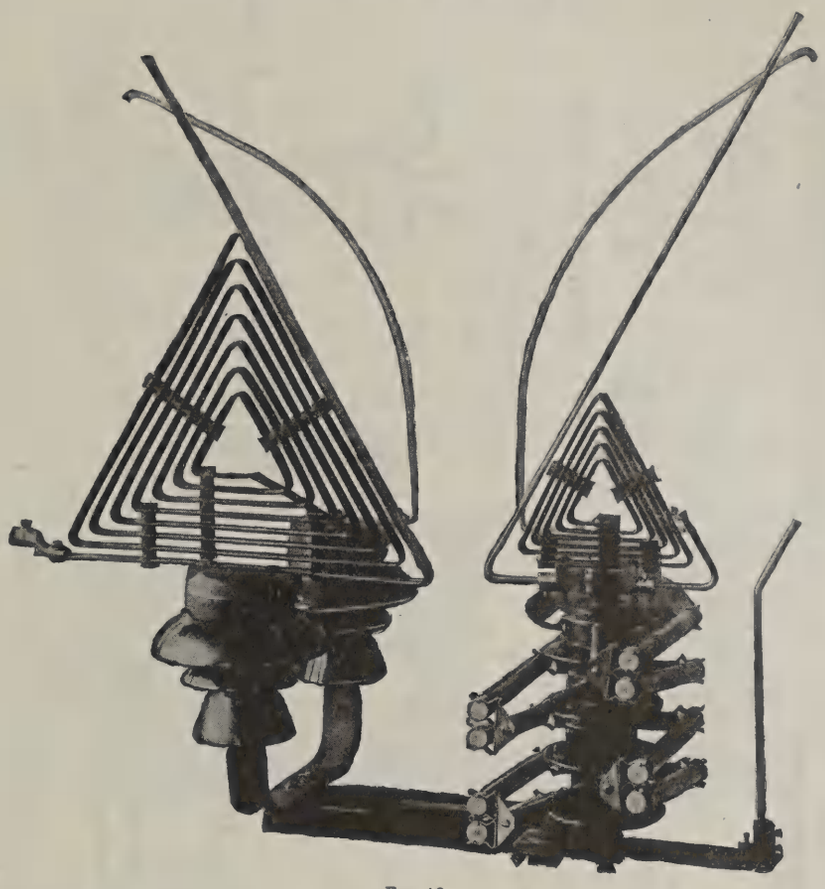


FIG. 18

The type RR arrester combination, Fig. 18, consists of the type WBR lightning arrester and a horn gap fuse.

The type RCR arrester is of the same construction as the type RR except designed for sending circuits.

Volts	For Receiving Circuits: Style Number	Approx. Shipping Weight, Lb.	List Price Single-Pole	Volts	For Sending Circuits: Style Number	Approx. Shipping Weight, Lb.	List Price Single-Pole
	Type RR Arresters				**Type RCR Arresters**		
16500	2163	107	$ 70 00	16500	2168	107	$ 70 00
25000	2164	137	95 00	25000	2169	137	95 00
36000	2165	145	105 00	36000	2170	145	105 00
50000	2166	310	185 00	50000	2171	310	185 00
70000	2167	495	250 00	70000	2172	495	250 00

For dimensions see Fig. 19.

BURKE HORN GAP LIGHTNING ARRESTERS AND CHOKE COILS—Continued

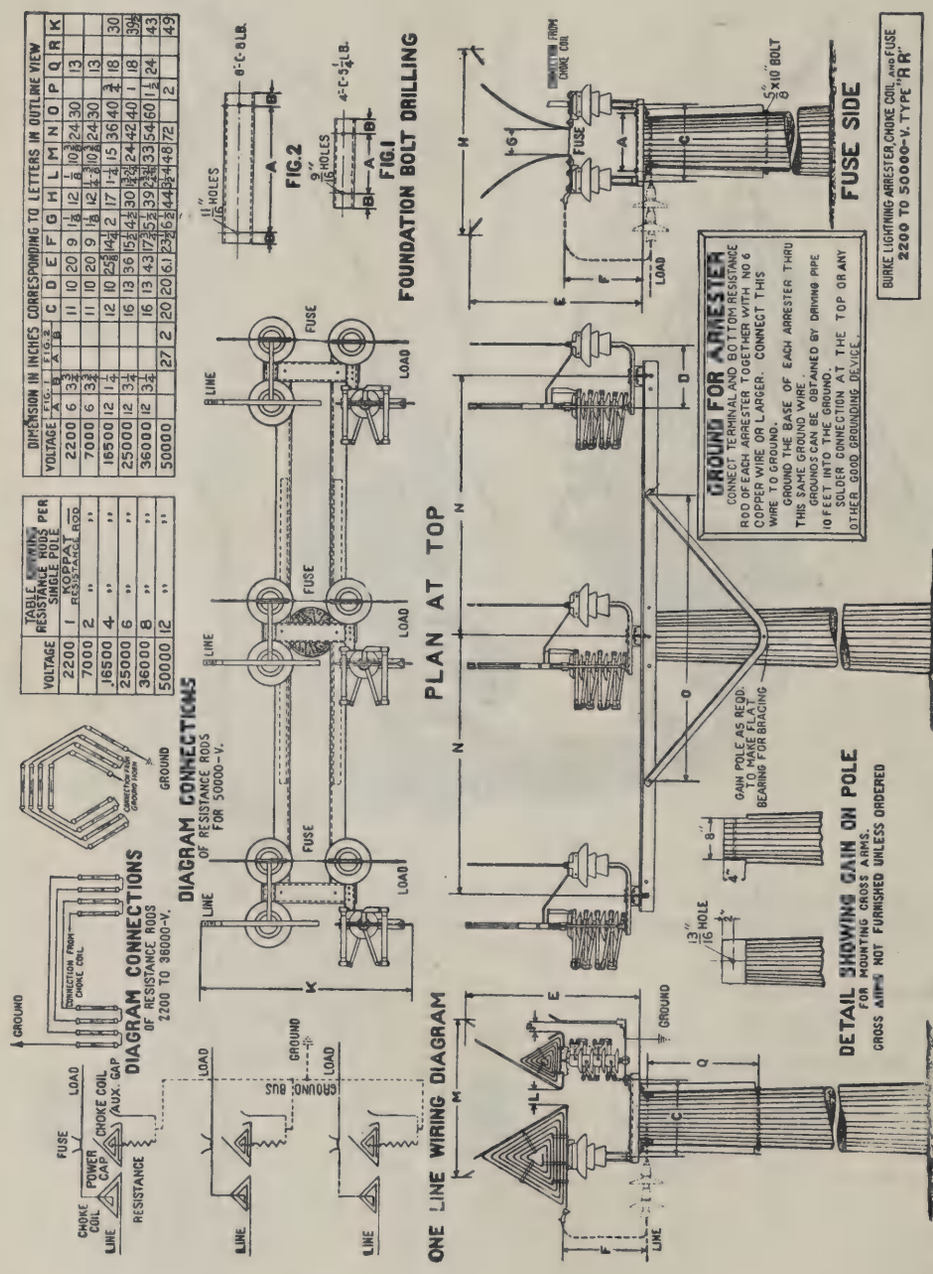

DIMENSION IN INCHES CORRESPONDING TO LETTERS IN OUTLINE VIEW
VOLTAGE FIG. 1 A B FIG. 2 A B C D E F G H L M N O P Q R K
2200 6 3 3 11 10 20 9 1 1 12 1 10 3 24 30 13
7000 6 3 3 11 10 20 9 1 1 12 1 10 3 24 30 13
16500 12 1 1 12 10 25 14 2 17 1 1 15 36 40 2 1 18 30
25000 12 3 1 16 13 36 15 1 4 30 2 2 24 42 40 1 18 39
36000 12 3 1 16 13 43 17 2 5 39 2 3 33 54 60 1 2 24 43
50000 27 2 20 20 61 23 2 6 3 48 3 48 72 2 49
TABLE SHOWING RESISTANCE RODS PER SINGLE POLE
VOLTAGE
2200 1 KOPPAT RESISTANCE ROD
7000 2 " "
16500 4 " "
25000 6 " "
36000 8 " "
50000 12 " "
DIAGRAM CONNECTIONS OF RESISTANCE RODS 2200 TO 36000-V.
DIAGRAM CONNECTIONS OF RESISTANCE RODS FOR 50000-V.
ONE LINE WIRING DIAGRAM
FIG. 2
FIG. 1
FOUNDATION BOLT DRILLING
PLAN AT TOP
GROUND FOR ARRESTER
CONNECT TERMINAL AND BOTTOM RESISTANCE ROD OF EACH ARRESTER TOGETHER WITH NO 6 COPPER WIRE OR LARGER. CONNECT THIS WIRE TO GROUND.
GROUND THE BASE OF EACH ARRESTER THRU THIS SAME GROUND WIRE.
GROUNDS CAN BE OBTAINED BY DRIVING PIPE 10 FEET INTO THE GROUND.
SOLDER CONNECTION AT THE TOP OR ANY OTHER GOOD GROUNDING DEVICE.
BURKE LIGHTNING ARRESTER, CHOKE COIL AND FUSE 2200 TO 50000-V. TYPE "R R"
FUSE SIDE
SECTION ACROSS LINE
DETAIL SHOWING GAIN ON POLE
FOR MOUNTING CROSS ARMS.
GROSS ARMS NOT FURNISHED UNLESS ORDERED
LIGHTNING ARRESTER SIDE

FIG. 19—APPROXIMATE DIMENSIONS OF TYPES RR AND RCR LIGHTNING ARRESTERS

TYPE M LIGHTNING ARRESTERS

Without Resistance

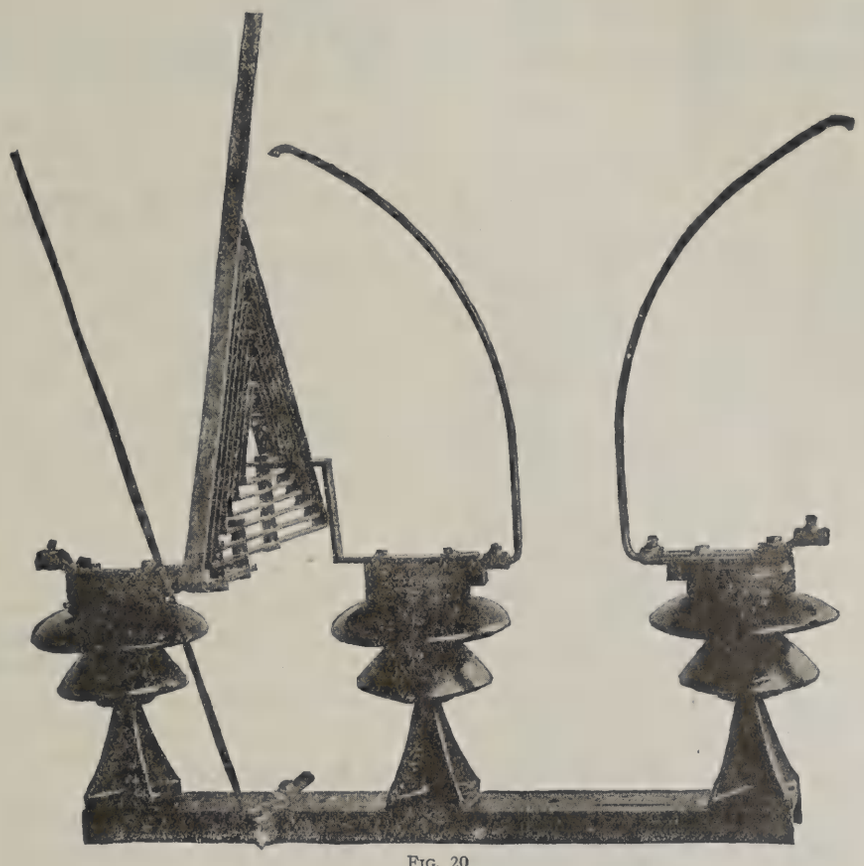


FIG. 20

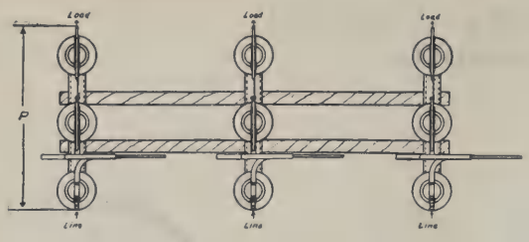
The type M arrester combination shown in Figure 20 consists of the type N lightning arrester and the horn gap fuse.

Type M Arresters

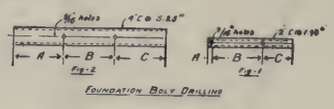
Volts	Approx. Shipping Weight, Lb.	Style Number	List Price Single Pole
7000	42	2127	$ 30 00
16500	95	2130	40 00
25000	150	2133	60 00
36000	165	2136	75 00
50000	245	2139	110 00

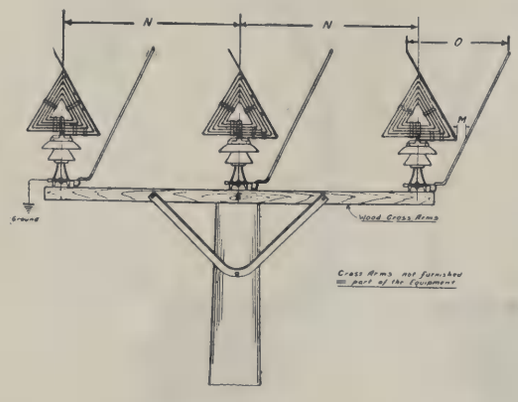
For dimensions see Figure 21.

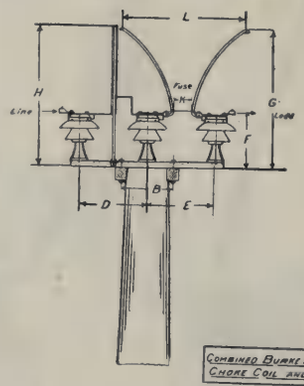
BURKE HORN GAP LIGHTNING ARRESTERS AND CHOKE COILS—Continued



Dimensions in Inches corresponding to Letters in Outline Views															
Voltage	Fig. 1 A	Fig. 1 B	Fig. 1 C	Fig. 2 A	Fig. 2 B	Fig. 2 C	D	E	F	G	H	K	L	M	N	O	P
2200-5000	1	12	7				8	8	7½	18¾	19	1	12	½-⅜	24	13	20½
6600-16500				7	12	7	10	12	13⅝	29⅝	26⅝	2	16½	1½-1⅜	36	18	29
25000				12	12	12	16	16	13⅝	34	34¼	4½	30	2-2⅝	42	24	43
36000				12	12	12	16	16	18½	41⅝	44⅜	5½	39	2¾-3¾	54	33	48







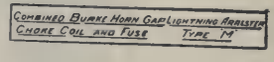


FIG. 21—APPROXIMATE DIMENSIONS OF TYPE M LIGHTNING ARRESTERS

STEEL CROSS ARM MOUNTINGS

Complete steel mounting for mounting types WB, WC, WBR, WCR, R, RC, RR, or RCR lightning arresters, on wooden poles. The mounting consists of one pair of cross arms with braces and necessary bolts to accommodate three single-pole units.

Voltage	Center of Switches	Approx. Shipping Weight, Lb.	Net Price Black Painted	Net Price Galvanized
7000	2′-0″	...	$13 00	on request
16500	3′-0″	114	18 20	on request
25000	3′-6″	144	20 80	on request
36000	4′-6″	171	26 00	on request

APPROXIMATE SETTINGS FOR HORN GAPS

All Types of Burke Lightning Arresters

Volts	Connection	Length of Main Gap Inches	Length of Auxiliary Gap Inches
220–750	A.C. or D.C.	1/16	...
3200	A.C.	1/8	...
4000	Delta	3/16	...
4000	A.C. 4-Wire Star	3/16 Power, 1/8 Neutral	...
6600	A.C.	1/4 — 3/8	...
11000	A.C.	3/4 — 1	5/8
16500	A.C.	1 — 1 1/4	3/4
25000	A.C.	1 3/4 — 2 1/4	1
36000	A.C.	2 3/4 — 3 1/4	1 1/2
50000	A.C.	3 1/2 — 4	2
70000	A.C.	6 — 7*	3

*This covers total if two gaps are in series.

The foregoing settings for the horn gaps are given as approximate, due to the effect local transmission system characteristics, altitude above sea level or other conditions may have on the horn-gap settings. The settings given are the limits of those usually found to give the more satisfactory service, but ultimate purchaser may desire to vary the settings to suit his particular condition.

BURKE STEEL TOWERS AND OUTDOOR SUBSTATIONS

General—The information given herein was compiled during July and August, 1918, and covers general data on steel towers and outdoor substations, their application and auxiliaries. Of necessity, the prices given are approximate and vary with market conditions; hence, users of the figures should increase them by such amounts as will place estimates "on the safe side."

The approximate prices given in connection with the descriptions of the steel towers, outdoor substations, etc., cover the equipment with the iron or steel having one shop coat of either black graphite or red lead paint.

When requesting quotations or placing orders for towers or substations, give the following information. This information is necessary before we can intelligently quote or fill the order. The data required is as follows:

(1) Customer's name and location.

*(2) Single-line wiring diagram giving geographical direction of lines and maximum available ground space. It is important that the direction of lines be in geographic synchronism with the ground directions.

(3) Voltage—high and low.

(4) Is station receiving or sending station or both.

(5) Size, make and characteristics of transformers.

(6) Number of phases.

(7) List of apparatus needed as accurately as possible

(8) Height of station.

(9) Special notes.

Ground Connection—Each leg of the tower should be grounded as shown in the figures. Galvanized pipe of 1½-inch diameter is driven if possible, 10 feet into the earth. The top of the pipe is then sawed off and copper wire of No. 2 B & S gauge or larger is soldered into the pipe.

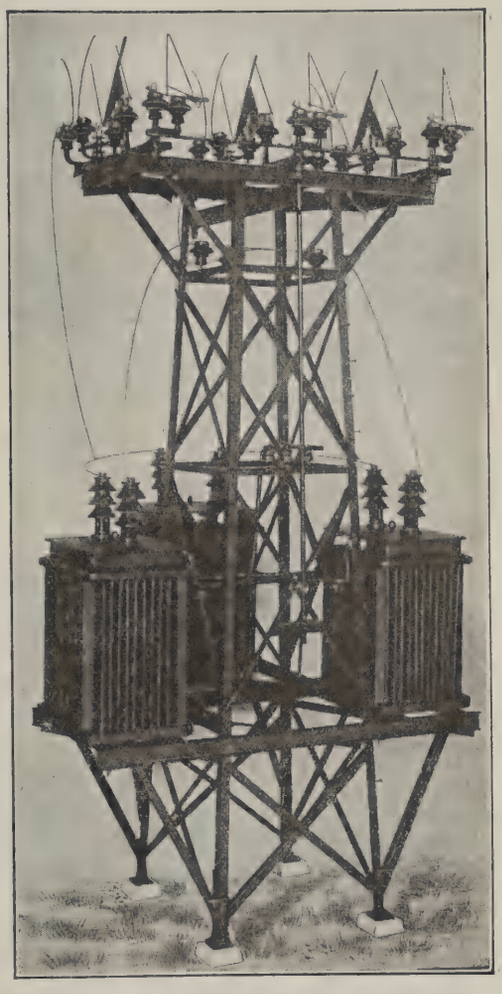


FIG. 1—TYPICAL MODEL P OUTDOOR SUBSTATION

*The single-line diagram should be on a separate sheet of paper marked North at top, East on right and South at bottom.

BURKE STEEL TOWERS AND OUTDOOR SUBSTATIONS—Continued

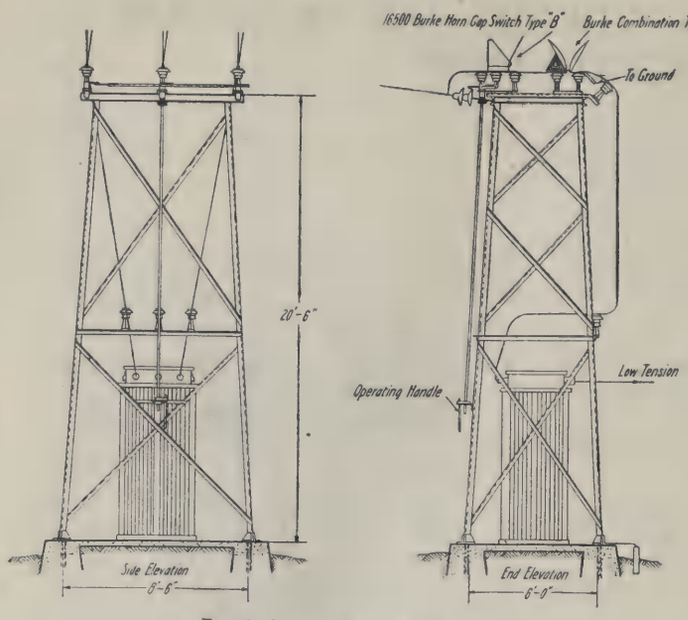


FIG. 2—SPECIAL MODEL B SUBSTATION

Special Model B Substation—This station can be used for any voltage up to and including 36,000.

All steel work, including foundation and erection bolts, for special model B station—

Approximate price.....**$200.00**

To obtain the cost of the complete station, add the price of one (1) three-pole type B Burke horn-gap switch and three (3) single-pole type R combined Burke horn-gap lightning arresters, choke coils and fuses.

Approximately twelve (12) pin-type and strain-type insulators are also required for carrying the high- and low-voltage wiring.

Standard Model C Substation—This station can be used for any voltage up to and including 36,000.

All steel work for a standard model C substation, including foundation and erection bolts—

Approximate price.....**$300.00**

To obtain cost of the complete substation, add the price of one (1) three-pole type B Burke horn-gap switch and three (3) single-pole type R combined Burke horn-gap lightning arresters, choke coils and fuses.

Approximately ten (10) pin-type and strain insulators are also required for carrying the high- and low-tension wiring.

Total maximum weight of transformers, 10800 lbs.

Total transformer space, 7 feet 6 inches by 6 feet 0 inches

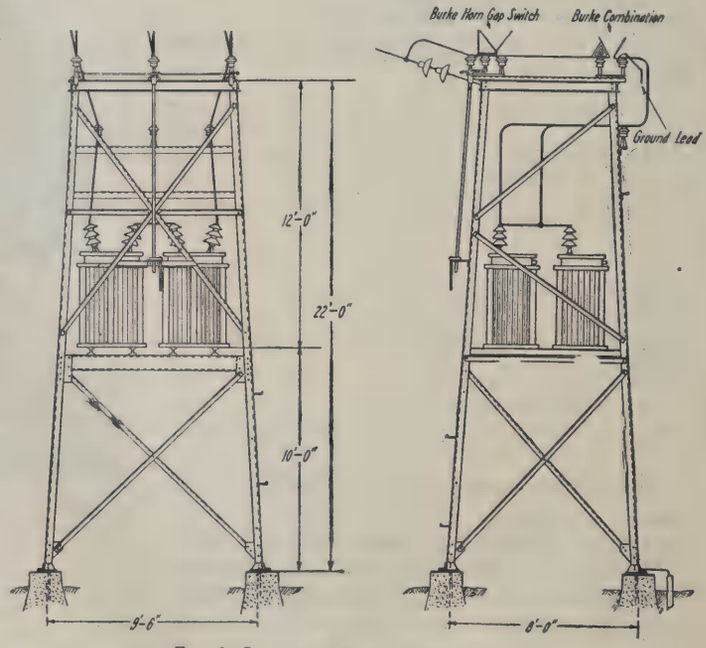


FIG. 3—STANDARD MODEL C SUBSTATION

PRICES ON REQUEST

BURKE STEEL TOWERS AND OUTDOOR SUBSTATIONS—Continued

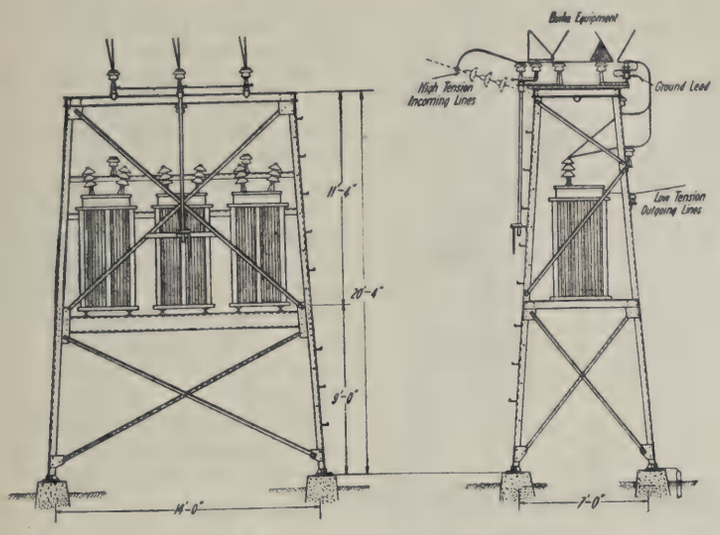


FIG. 4—STANDARD MODEL D SUBSTATION

Standard Model D Substation—This station can be used for any voltage up to and including 36,000.

All steel work for a standard model D substation including foundation and erection bolts—

Approximate price. . . **$385 00**

To obtain the cost of the complete substation, add the price of one (1) three-pole type B Burke horn-gap switch and three (3) single-pole type R combined Burke horn-gap lightning arresters, choke coils and fuses.

Approximately one (1) inverted-type insulator and nine (9) pin-type insulators (strain) are also required for carrying the high- and low-voltage wiring.

Total weight of transformers, 15,000 lbs.

Total transformer space, 12 feet 6 inches by 5 feet 0 inches.

Standard Model E Substation—This station can be used for any voltage up to and including 36,000.

All steel work for a standard model E substation, including erection and foundation bolts—

Approximate price. **$365.00**

To obtain the cost of the complete substation add the price of one (1) three-pole type B Burke horn-gap switch and three (3) single-pole type R combined Burke horn-gap lightning arresters, choke coils and fuses.

Approximately ten (10) pin-type and strain insulators are also required for carrying the high- and low-voltage wiring.

Total maximum weight of transformers, 12,000 lbs.

Total transformer space, 10 feet 6 inches by 8 feet 3 inches.

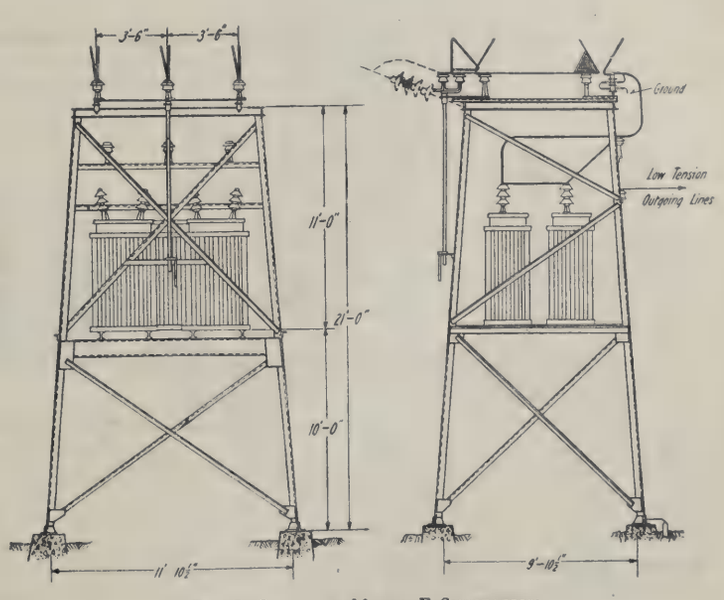


FIG. 5—STANDARD MODEL E SUBSTATION

PRICES ON REQUEST

BURKE STEEL TOWERS AND OUTDOOR SUBSTATIONS—Continued

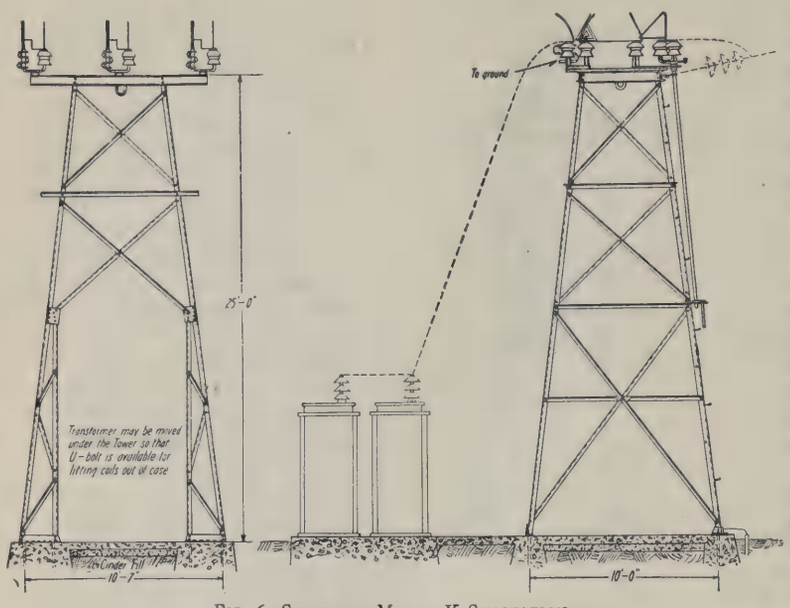

To ground
25'-0"
Transformer may be moved under the Tower so that U-bolt is available for lifting coils out of case
Cinder Fill
10'-7"
10'-0"

FIG. 6—STANDARD MODEL K SUBSTATION

Standard Model K Substation—This station can be used for any voltage up to and including 36,000.

All steel work for a standard model K substation including erection and foundation bolts—

Approximate price. . . **$236**

To obtain the cost of the complete substation add the price of one (1) three-pole type B Burke horn-gap switch and three (3) single-pole type R combined lightning arresters, choke coils and fuses.

Approximately three (3) strain insulators are also required for carrying the high-voltage wiring.

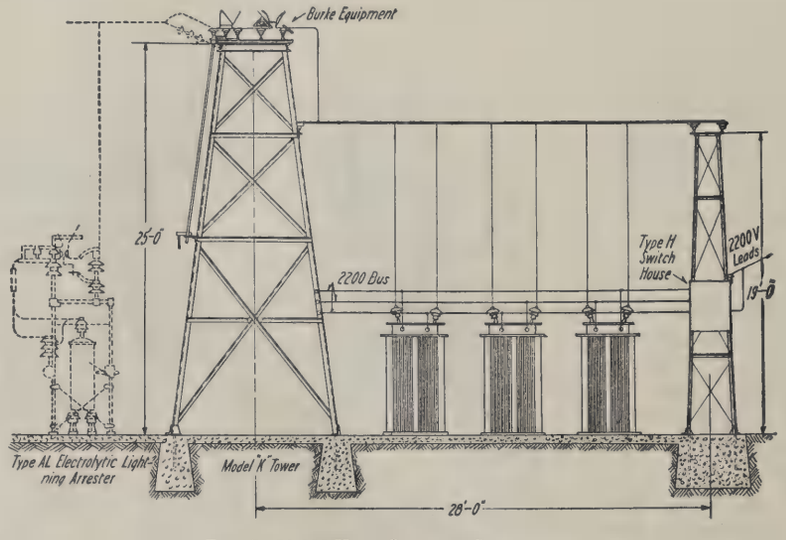


FIG. 7—22,000-VOLT OUTDOOR SUBSTATION

Outdoor Substation—This station can be used for any voltage up to and including 36,000.

Steel work for an outdoor substation, including all erection and foundation bolts—

Approximate price. **$360.00**

To obtain the cost of the complete station add the price of one (1) three-pole type B Burke horn-gap switch and three (3) single-pole type R combined lightning arresters, choke coils and fuses. Approximately nine (9) high-tension strain-type insulators, nine (9) low-tension strain insulators, and six (6 low-tension pin-type insulators are also required for carrying the high- and low-tension wiring.

When desired the type R combined lightning arresters, choke coils and fuses can be omitted and the type AL electrolytic lightning arresters substituted therefor, as indicated.

If desired three (3) horn-gap fuses can be used in place of the fuses removed with the combination type R lightning arrester, choke coils and fuses.

PRICES ON REQUEST

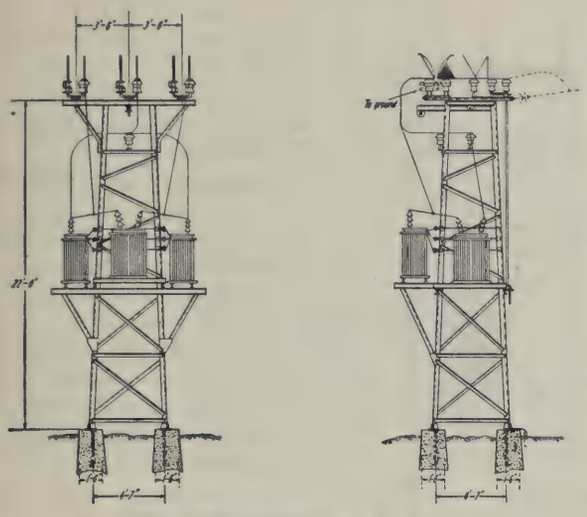


FIG. 8—STANDARD MODEL P-1 SUBSTATION

Standard Model P-1 Substation—This station can be used for any voltage up to and including 36,000. (Standard for 3—25-kva. transformers.)

All steel work for a standard model P-1 substation, including all erection and foundation bolts—

Approximate price.....**$280.00**

To obtain the cost of the complete substation, add the price of one (1) three-pole type B Burke horn-gap switch and three (3) single-pole type R combined Burke horn-gap lightning arresters, choke coils and fuses.

Approximately twenty-four (24) pin-type and strain insulators are also required for carrying the high - and low-voltage wiring.

Maximum weight of transformers, 1800 lbs. each.

Maximum floor space for each transformer, 3 feet 0 inches by 2 feet 6 inches.

Standard Model P-2 Substation—This station can be used for any voltage up to and including 36,000. (Standard for 3—75-kva. transformers.)

All steel work for a model P-2 substation, including erection and foundation bolts—

Approximate price.....**$400.00**

To obtain the cost of the complete station, add the price of one (1) three-pole type B Burke horn-gap switch and three (3) single-pole type R combined lightning arresters, choke coils and fuses.

Approximately seven (7) pin-type insulators and eighteen (18) strain insulators are also required for carrying the high- and low-voltage wiring.

Maximum weight of transformers, 4,000 lbs. each.

Maximum floor space for each transformer, 4 feet 6 inches by 3 feet 6 inches.

Standard Model P-3 Substation—This station can be used for any voltage up to and including 36,000. (Standard for 3—150-kva. transformers.)

All steel work for a standard model P-3 substation. including erection and foundation bolts—

Approximate price.....**$470.00**

To obtain the cost of the complete station, add the price of one (1) three-pole type B Burke horn-gap switch and three (3) single-pole type R combined lightning arresters, choke coils and fuses.

Approximately seven (7) pin-type insulators and eighteen (18) strain insulators are also required for carrying the high- and low-voltage wiring.

Maximum weight of transformers, 6,000 lbs. each.

Maximum floor space for each transformer, 4 feet 6 inches by 3 feet 6 inches.

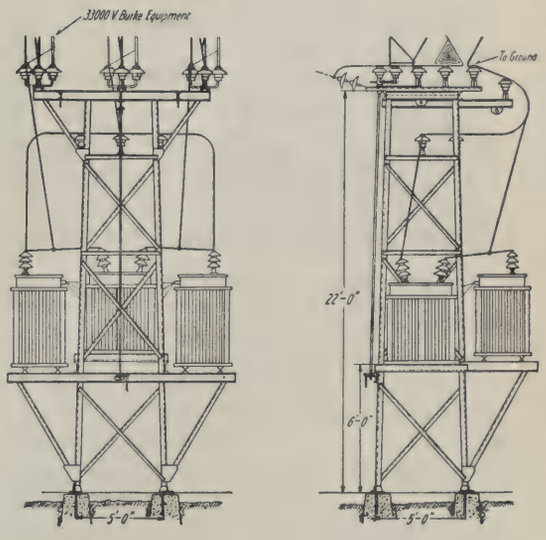


FIG. 9—STANDARD MODEL P-3 SUBSTATION

PRICES ON REQUEST

BURKE STEEL TOWERS AND OUTDOOR SUBSTATIONS—Continued

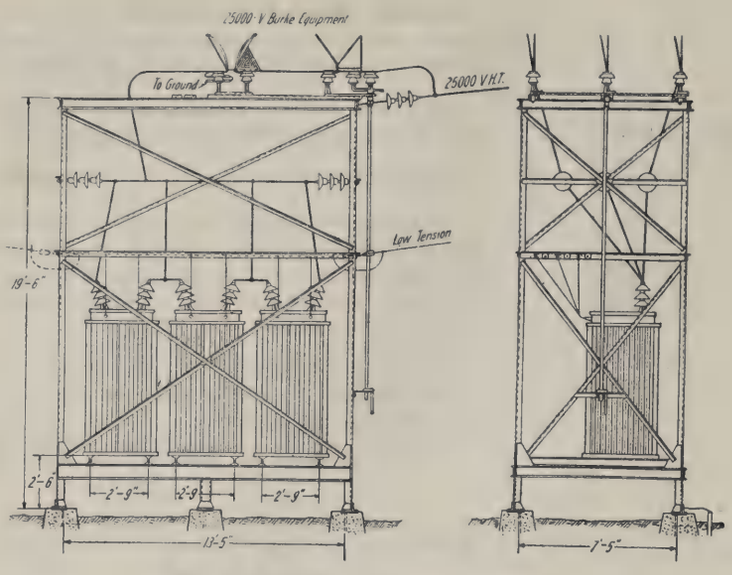


FIG. 10—25,000-VOLT OUTDOOR SUBSTATION

Outdoor Substation — This station can be used for any voltage up to and including 25,000.

All steel work for an outdoor substation, including all erection and foundation bolts—

Approximate price. . . **$395.00**

To obtain the cost of the complete station, add the price of one (1) three-pole type B Burke horn-gap switch and three (3) single-pole type R combined lightning arresters, choke coils and fuses.

Approximately eighteen (18) strain insulators are also required for carrying the high- and low-voltage wiring.

Total maximum weight of transformers, 21,000 lbs.

Total transformer space, 13 feet 6 inches by 7 feet 6 inches.

Outdoor Substation—This station can be used for any voltage up to and including 36,000.

All steel work for an outdoor substation, including all erection and foundations bolts—

Approximate price. **$420.00**

To obtain the cost of the complete station add the price of two (2) three-pole type B Burke horn-gap switches and three (3) single-pole type R combined Burke lightning arresters, choke coils and fuses.

Approximately fifteen (15) inverted-type and strain insulators are also required for carrying the high-voltage wiring.

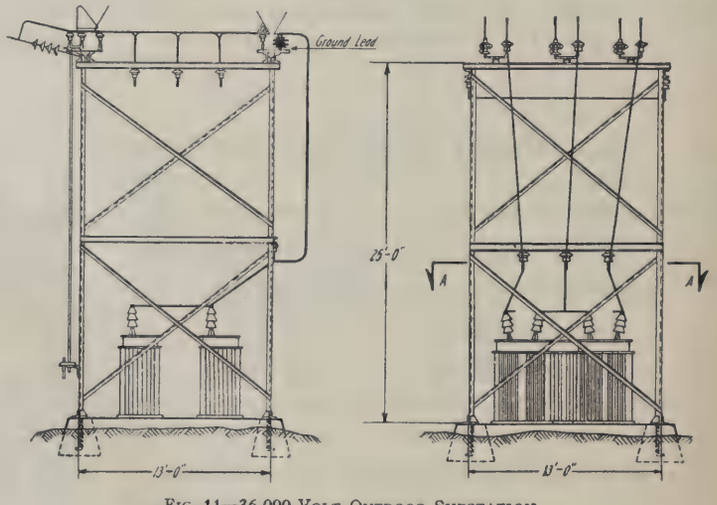


FIG. 11—36,000-VOLT OUTDOOR SUBSTATION

PRICES ON REQUEST

BURKE STEEL TOWERS AND OUTDOOR SUBSTATION—Continued

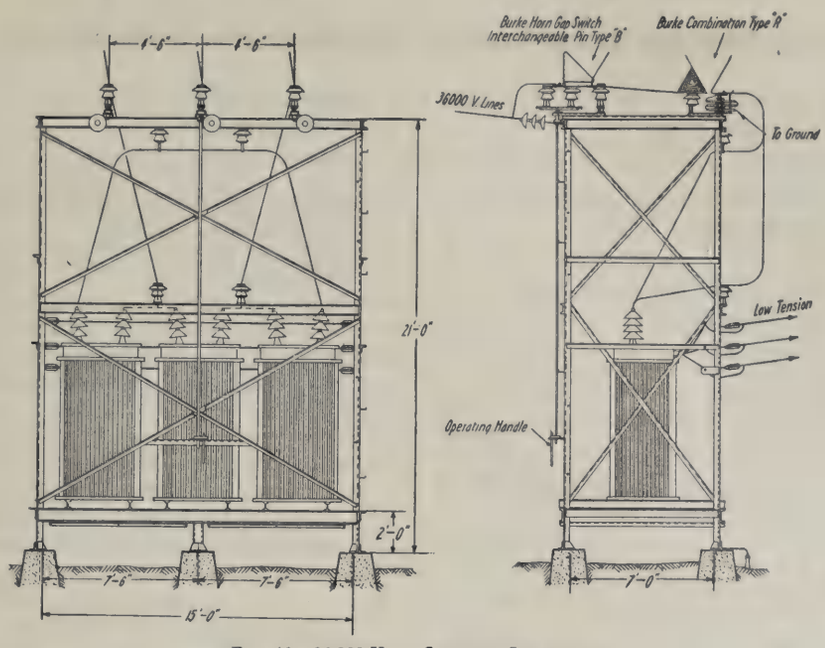


FIG. 12—36,000-VOLT OUTDOOR SUBSTATION

Outdoor Substation—This station can be used for any voltage up to and including 36,000.

All steel work for an outdoor substation, including erection and foundation bolts—

Approximate price.....**$465.00**

To obtain the cost of the complete station add the price of one (1) three-pole type B Burke horn-gap switch and three (3) type R combined lightning arresters, choke coils and fuses.

Approximately four (4) pin-type and inverted-type insulators and twelve (12) strain insulators are required for carrying the high and low-tension wiring.

Total maximum weight of transformers 19,500 lbs.

Total transformer space, 14 feet 0 inch by 6 feet 0 inch.

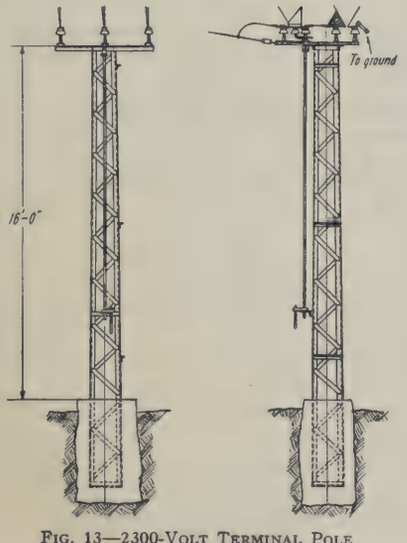


FIG. 13—2300-VOLT TERMINAL POLE

Terminal Pole Equipped with 2300-Volt Type J Switch and Type R Combination—All steel work for a standard 2300-volt terminal pole, arranged for 2300-volt equipment as per Fig. 13, and including all erection bolts—

Approximate price **$115.00**

To obtain the cost of the complete pole, add the price of one (1) three-pole type J Burke horn-gap switch Style No. 2003 and three (3) single-pole type R combination lightning arrester, choke coil and fuses, Style No. 2145.

Approximately three (3) strain insulators are also required.

PRICES ON REQUEST

Auxiliaries for Steel Towers and Outdoor Substations

1—7,000-volt type J single-pole Burke horn-gap switch, Style No. 2001.
Approximate price.....$24.70

1—7,000-volt type J two-pole Burke horn-gap switch, Style No. 2002.
Approximate price.....$48.75

1—7,000-volt type J three-pole Burke horn-gap switch, Style No. 2003.
Approximate price.....$65.00

1—16,500-volt single-pole type B Burke horn-gap switch, Style No. 2022.
Approximate price.....$35.75

1—25,000-volt single-pole type B Burke horn-gap switch, Style No. 2025.
Approximate price.....$50.05

1—36,000-volt single-pole type B Burke horn-gap switch, Style No. 2028.
Approximate price.....$57.20

1—16,500-volt three-pole type B Burke horn-gap switch, Style No. 2024.
Approximate price.....$94.25

1—25,000-volt three-pole type B Burke horn-gap switch, Style No. 2027.
Approximate price.....$130.00

1—36,000-volt three-pole type B Burke horn-gap switch, Style No. 2030.
Approximate price.....$149.50

3—16,500-volt single-pole type R combined Burke horn-gap lightning arresters, choke coils and fuses and Koppat resistor in the ground circuit, Style No. 2148.
Approximate price each.....$42.25

3—25,000-volt single-pole type R combined Burke horn-gap lightning arresters, choke coils and fuses and Koppat resistor in the ground circuit, Style No. 2151.
Approximate price each.....$55.25

3—36,000-volt single-pole type R combined horn-gap lightning arresters, choke coils and fuses and Koppat resistor in the ground circuit, Style No. 2154.
Approximate price each.....$61.75

Bus-Type Insulators

1—16,500-volt Inverted Insulators.
Price.....$4.55

1—25,000-volt Inverted Insulators.
Price.....$4.94

1—36,000-volt Inverted Insulators.
Price.....$5.07

1—16,500-volt (2 disc) Strain Insulators.
Price.....$7.80

1—25,000-volt (3 disc) Strain Insulators.
Price.....$11.70

1—36,000-volt (4 disc) Strain Insulators.
Price.....$15.60

PRICES ON REQUEST

WESTINGHOUSE SWITCHBOARDS

GENERAL INFORMATION

Westinghouse switchboards can be obtained to meet any commercial demand that may arise in the control and application of electric current.

Standard panels using standard apparatus for various classes of service have been designed, and those of the smaller capacities, intended primarily for light and power systems of small industrial plants, public garages, small hotels, and central stations of small capacity are listed in this catalogue. These panels will be found to meet practically all ordinary requirements that may come up in switchboard installations. Drawings are available and a board made up of such panels can be shipped in less time and furnished at less cost than one having special panels.

It is, therefore, of advantage for the Customer to select standard panels whenever possible

However, for special conditions that cannot be met by these standard panels, or where special material is desired, the extensive manufacturing facilities and long engineering experience of the Westinghouse Company insure that such propositions will be taken care of promptly and completely when referred to the Company with complete details of special requirements.

The selection of suitable switchboard apparatus for certain requirements is naturally governed by several conditions. In some cases first cost is the determining feature. In most cases continuity of service is of considerable mportance. In many cases continuity of service must be prov'ded regardless of cost. In all cases the maximum degree of safety to life and property that can be obtained should be the goal. These, and other considerations, such as space available, voltage and capacity of plant, govern the proper selection of a switchboard equipment.

Panel Materials

Black marine-finished slate and black marine-finished blue Vermont marble have been adopted as the standard materials for Westinghouse switchboards. Slate is one of the strongest and most serviceable materials known for this service, and where the voltage of live parts mounted on it does not exceed about 750 volts, its insulating properties are entirely satisfactory. Marble is used only for those panels which require a higher dielectric strength.

In appearance, black marine-finished slate and marble are a dull velvety black which may easily be kept in good condition, and when rubbed with oil this finish will not show oil stains. This feature is of special importance where oil circuit-breakers are mounted directly on the panels.

When desired, other materials and finishes may be obtained on special order, involving an increase in price and a longer delivery.

Finish

The standard black-marine finish is a durable finish of a dull velvety black appearance. It can readily be applied to switchboards in the field when the finish has been marred, or where the customer wishes to refinish an existing polished or black-enameled board. Other finishes than black marine can be obtained on special order, but in general, a longer delivery may be expected where such finishes are specified.

On the standard panels the finish of all metal parts on the front not carrying current is also black marine; current-carrying parts on the front of the panels are of polished copper or the equivalent of dipped finish.

Frames are painted dull black.

Assembly and Connections

All Westinghouse panels for which frames are included and which have apparatus mounted directly on them, are completely assembled, with the exception of the meters and relays, and wired at the Works before shipment.

On remote-control boards all busses and connections are shipped in bulk uncut. On pane'-mounted boards, if bus-bars and connections are of strap, rod, or tubing, they are cut, bent and put in place; if they are of wire they are shipped in reels, uncut, together with the wire for instrument busses and for primary leads of voltage transformers.

The main connections for 600 volts and below are bare for all capacities. For higher voltages up to and including 2500, the main connections are of insulated wire up to 225 amperes. For larger capacities the main connections included in equipment style numbers are furnished bare, and must be insu'ated by the purchaser during installation if conditions so require. This insulation may consist of treated cloth tape or micarta tubing (refer to section on "Westinghouse Insulating Materials and Supplies").

The standard terminals furnished on apparatus are suitable for the required size and number of cables per lead corresponding to the National Electrical Code rating of rubber-insulated cables for the particular ampere capacity. Ordinarily, standard terminals are larger than required due to the apparatus being used on circuits of less than the apparatus rating, or to the use of cable having other

insulation than rubber. Unless the customer advises the size of cables he will use, terminals will be supplied according to our understanding of his circuit requirements, or, if these cannot be judged the terminals will be standard for the capacity of the apparatus.

A wiring diagram showing complete connections is supplied with each switchboard.

Grounding Framework—In general, the framework of switchboards for voltages above 150 volts should be effectively grounded except for D. C. grounded service (railway circuits), and for D. C. series circuits when the latter are provided with suitable rubber mats or wooden insulating platforms so that no person can inadvertently come in contact with such ungrounded parts while standing on any grounded surface (including floors of conducting materials). The grounding of non-current-carrying parts and the guarding of current-carrying parts is more important in those installations where unauthorized and untrained employees are liable to come in contact with the apparatus than in stations where only authorized and experienced employees are permitted. Westinghouse switchboards are designed to conform as nearly as possible with the general provisions of existing safety codes, but where there are special local safety requirements, customers must call attention to them at the time of ordering switchboards, if provision is to be made for taking care of such requirements in the building of the switchboard.

Instrument Equipment

The instruments regularly included in the panel equipment of Westinghouse switchboards are the standard Westinghouse apparatus and are of the highest grade. The meters supplied are the 7-inch round pattern instruments, except in the case of the smaller switchboards, where the 5-inch round type meters are furnished.

Field Rheostats

Field rheostats are operated by means of a hand wheel on the front of the panel, from which a shaft extends through the panel to the rheostat, or to a rotating mechanism for remote control.

Rheostat mountings are not included in the style number and list price of Westinghouse panels, but the generator and exciter panels are drilled for standard mounting.

If other than Westinghouse rheostats are to be provided for they must be remote controlled, as the panels are not adapted for other than Westinghouse rheostats mounted directly on the rear of the panels. Drilling templates and necessary outline should accompany order.

(For detailed data refer to "Rheostat Mountings" in the section on Switchboard Accessories.)

Ground Detector Outfits

Ungrounded systems should be equipped with some form of ground detector for indicating grounded circuits. For systems up to and including 600 volts, the ground detector consists of incandescent lamps capable of withstanding full bus-bar voltage connected in series from each bus-bar to ground so as to form a continuously indicating detector.

For 1100 volts and 2200 volts a continuously indicating static ground detector mounted on brackets above the top of the switchboard is used, but is not supplied as part of the standard generator panel equipment and must be ordered separately. Refer to type JB alternating-current switchboard panels in this section.

Arrangement of Panels

The sequence of panels is important on account of the necessity for designing a switchboard to provide for future extensions, for the most economical distribution of bus-bar copper, and to provide means for measuring the total load.

When a switchboard comprises generator, totalizing, and feeder panels only, the standard arrangement of panels when facing the front of the switchboard is to place the generator panels at the left, the feeder panels on the right, and the load or instrument panels between the two.

In fixing any arrangement of panels it is most practical and economical to locate the heaviest capacity panels next to the totalizing panel, the lightest capacity panels being located at the ends. The bus-bar copper can then be tapered by the use of laminated bus-bars. This construction reduces the amount of bus-bar copper to a minimum and permits making extensions easily.

Capacity of Switchboard Apparatus

The ampere rating of a switchboard panel corresponds to the capacity of the switches or circuit-breakers mounted on the panel or controlled from it. The switches and circuit-breakers listed on Westinghouse panels are rated in accordance with the National Electrical Code and will carry their rated amperage continuously.

Switches and circuit-breakers are given a maximum rating as they reach a final temperature quickly when carrying a steady current. Their capacity must therefore correspond to the one or two-hour overload capacity of the machine or circuit, if such a rating exists, in addition to its continuous capacity.

The usual temperature rise guarantee for switchboard apparatus when carrying its rated current is 28 degrees C. for knife switches, 30 degrees C. for conducting parts of carbon and oil circuit-breakers, and 50 degrees C. for circuit-breaker coils and frames. Bus-bars and connections are proportioned so as not to exceed 28 degrees C. rise and instrument transformers are not allowed to exceed 50 degrees C. Shunts and resistances are exempt from temperature limitations. A room-temperature of 25 degrees C. is used as a basis. Where the room-temperature exceeds this value, larger capacity apparatus should be chosen in order that the ultimate temperatures will not exceed those fixed on this basis.

The maximum possible setting of overload circuit-breakers should not be less than the momentary overload capacity of the machine or circuit.

Ammeters are commonly furnished with full scales corresponding to approximately 125 to 150 per cent of the ampere rating of the panel. This allows for overload swings and yet gives good readability on scale at normal load.

Circuit-Breaker Calibration

The **tripping range** of overload automatic circuit-breakers is from 80 to 160 per cent of their normal current rating.

Fuses

All fuses supplied on Westinghouse switchboards are Westinghouse enclosed fuses. They conform to the requirements of the National Electrical Code where it applies, and are included in the "List of Approved Fittings" issued by the National Board of Fire Underwriters.

Unless otherwise specified, fuses of the same capacity as the switches will be furnished. When desired, fuses of smaller capacity will be furnished according to the following list. The switch capacity must be the same as that of the fuse holder.

Fuse Holder	Ampere Ratings 250-Volt Fuses	600-Volt Fuses
30	6, 10, 15, 20, 25, 30	3, 5, 7, 10, 15, 20, 25, 30
60	40, 50, 60	40, 50, 60
100	70, 80, 100	70, 80, 100
200	125, 150, 175, 200	125, 150, 175, 200
400	225, 250, 275, 300, 350, 400	225, 250, 275, 300, 350, 400
600*	500, 600	500, 600

*These capacities above 250 volts are not included in the National Electrical Code.

Bus-Bars

The amount of bus copper required for a switch board equipment depends on the arrangement of panels and the distribution of circuits; hence, bus-bars are not included in the panel style numbers listed in this catalogue and must be ordered separately.

Safe Carrying Capacity—The amperes allowable per strap in the bus-bar will vary according to the conditions of installation and service.

The table below may be used as a guide in ordinary work. The values are based on ¾-inch spacing between adjacent faces of straps, and on a temperature rise of not more than 28 degrees Centigrade above a room temperature of 25 degrees Centigrade. A reduction in the spacing between straps will materially decrease the amperes allowable per strap.

Maximum Continuous Bus Capacity Amperes	Amperes per Copper Strap 2" x ⅛" Strap	3" x ⅛" Strap
500	400	600
1000	350	550
1500	...	500

For direct-current three-wire systems, include for third or neutral bus to rear of feeder panels, one strap of same size as other two buses. On rear of generator panels, when more than one generator panel is used, include for equalizer buses two buses each of capacity of largest generator.

For calculating the amount of copper needed for direct-current two-wire systems, the **cross-section of the equalizer bus-bar** is in general made about one-half that of the positive or negative bus behind the generator panels.

Bus-Bar Prices

When switchboard panels are for **bus-bar operation** the total list price of the switchboard is the list price of the panels with their equipment, selected from column headed "Bus-Bar Operation" in table of style numbers, plus a list price for bus-bar copper and insulators using the following unit prices:

Size of Strap Inches	List Price Per Foot
2 x ⅛	$1 25
3 x ⅛	1 75

GENERAL INFORMATION—Continued

INSTRUCTIONS FOR ORDERING

Standard Westinghouse switchboard panels are described in the following pages of this section, and are listed by **Style Numbers.**

Standard panels should be ordered by these Style Numbers.

When a panel is ordered by Style Number, the purchaser will receive all of the apparatus included in that Style Number. The apparatus included is given in the following pages for each panel listed.

Prices not given herein will be furnished on application to the nearest district office.

When a panel or section is ordered by Style Number and no changes are to be made, no data sheet will be required. If, however, the panel is to be added to, or must match, an existing switchboard, or any other variations are required, the order must be accompanied by a switchboard **data sheet Form No. 2724**, completely filled out. If the data sheet does not seem to cover all of the purchaser's requirements and conditions, explanatory notes, sketches or drawings should also accompany the order to give complete information. Full information given at the time of entering the order prevents unnecessary correspondence and delay in shipment.

It is urged that, if possible, panels be selected from those listed, without alteration, as manufacturing information has been prepared on such panels and quick deliveries can be made. Panels covering a very wide range of application have, therefore, been listed so that any probable condition can be met by applying a standard panel.

The feeder panels listed may be adapted to control a smaller number of circuits than is included under the style number, in which case a deduction from the list price of the panel will be made for each feeder circuit omitted. The amount of this deduction is given in the following pages in connection with the various types of boards listed.

Panels forming part of a **multi-panel switchboard** requiring bus connections include all necessary bus-bar brackets, connections for operating the switchboard, etc., but **do not include the bus-bars.** Orders and requests for prices, therefore, should state whether the panels are "Panels for Individual Operation" or "Panels for Bus-Bar Operation."

Pipe sockets designed to receive ¾-inch gas pipe, are provided with all panels listed, but the brace pipe and flange for connecting the pipe to the wall or floor are not included in the Style Number and should be ordered separately. For these additional details, see section on "Switchboard Accessories."

Additions to Switchboards—All panels manufactured and assembled at the Works are supplied with a nameplate secured to the rear of the panels for identification and containing the following information:

1. Stock order number.
2. Shade of marble or finish of slate.
3. Number of panel.

These nameplates have been used since 1907 and this information should be furnished with the order when additions are to be made to Westinghouse switchboards. If it is known that changes have been made by the Purchaser since installation, the Company should be advised in regard to such changes if they have any bearing on the design of the new panel on order.

If panels are to be added and matched to switchboards not manufactured by this Company or to Westinghouse switchboards not built at the Works, outline drawings or sketches of the existing board should accompany order.

Black-Dial Meters

Will be Furnished if Desired at No Change in List Price

TYPE JD TWO-WIRE DIRECT-CURRENT SWITCHBOARD PANELS

110-220 VOLTS

Application—Type JD switchboards are particularly adapted to the control of from one to three generators in small industrial plants and central stations operating direct-current two-wire systems of 250 volts or less.

Capacity—The capacity of a single generator panel is limited to 300 amperes with type CD and 600 amperes with type CC circuit-breakers, and that of a complete switchboard composed of these panels to 1500 amperes, with the number of panels limited to six. For greater capacities, a switchboard composed of type GD panels is recommended.

Type Designation—According to the usual method of designating types of panels, the letter J signifies that the panel is mounted on a type J 1¼-inch pipe frame, and the second letter D indicates direct-current application.

Panel Construction—Each panel consists of a single section, 48 inches high by 12, 16, 20, or 24 inches wide, 1½ inches thick, with ⅜-inch bevels on front edges, bolted at the four corners to the switchboard frame. This frame is made of 1¼-inch pipe uprights, resting in floor flanges and supporting the necessary panel and top-iron brackets, to which the panel is bolted. The total height of the panel is 76⅜ inches.

Automatic protection is provided for the generator circuits by (a) single-pole type CC or CD carbon circuit-breakers, or (b) enclosed fuse blocks mounted on the front of the panel; for feeder circuits by (a) single-pole type CD or CC carbon circuit-breakers, (b) enclosed fuse blocks on the front of the panel, or (c) enclosed fuse blocks on slate bases mounted on brackets on rear of panel. Style number includes type CD circuit-breakers up to 300 amperes and type CC for larger capacities.

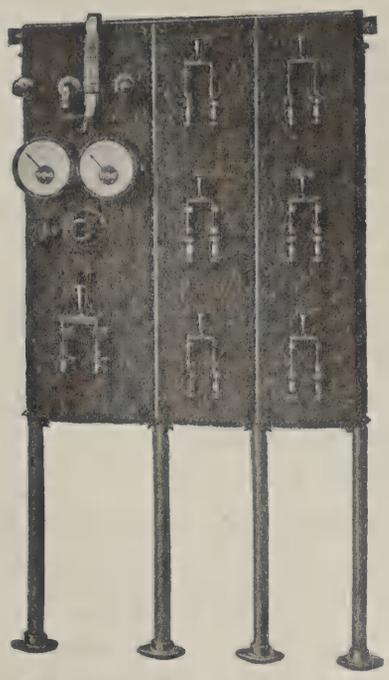


FIG. 1—TYPE JD DIRECT-CURRENT SWITCHBOARD PANELS

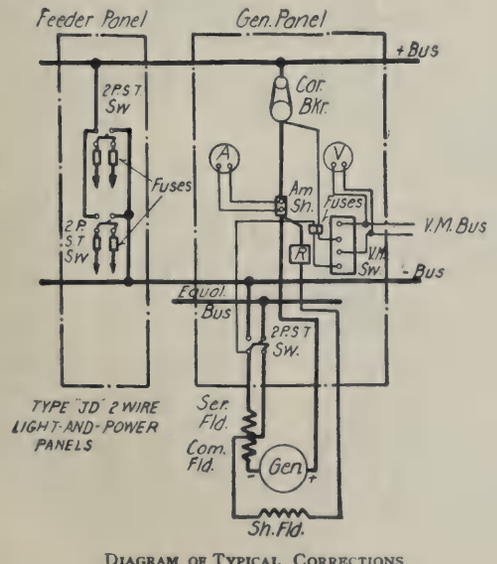


DIAGRAM OF TYPICAL CORRECTIONS

Field Rheostats—Standard generator panels will be drilled for tetrapod rheostat mounting.

The panel style number does not include the rheostat mounting or the operating mechanism, but does include the necessary panel drilling to mount them.

Data Sheet—Each order for a switchboard should be accompanied by a switchboard data sheet, Form No 2724, completely filled out. Full information given at the time of entering order prevents unnecessary correspondence and delay in shipment.

Shipment—Any one of the panels listed in this section can be shipped within 15 days after receipt of order at the factory with full and complete information and data sheet properly filled out. However, **any change or substitution** of apparatus as listed by style number will necessitate obtaining a **new delivery promise from the Works.**

Panel style numbers include the frame, the panel with apparatus mounted thereon according to schedules given, and necessary details and connections for operating a single panel.

Bus-bars, when required, must be ordered separately. See also Instructions for Ordering.*

GENERATOR PANELS

With Circuit-Breaker Protection

110-220 VOLTS

For a single-throw system order panel Fig. 2 for the first machine installed and panel Fig. 3 for each succeeding machine.

For a double-throw system order panel Fig. 4 for the first machine installed and panel Fig. 5 for each succeeding machine.

FIG. 2

FIG. 3

FIG. 4

FIG. 5

Schedule of Apparatus

*One voltmeter, type SL.

One ammeter, type SL.

One drilling only for standard Westinghouse tetrapod rheostat mounting.

*One ground detector outfit.

One double-contact type RS voltmeter switch with a removable handle.*

One single-pole circuit-breaker; type CD for capacities up to and including 300 amps., and type CC above 300 amps.

One knife switch, type A two-pole.

*With panel Fig. 2 and 4 only.

Panel Style No. 110 Volts	Panel Style No. 220 Volts	Fig.	Ampere Capacity—Switch	Ampere Capacity—Circuit-Breaker	Ampere Capacity—Ammeter Full Scale	Panel Width Inches	List Price 110 Volts Individual Operation	List Price 110 Volts Bus-Bar Operation	List Price 220 Volts Individual Operation	List Price 220 Volts Bus-Bar Operation
Single-Throw										
167607	167608	2	30	30	50	16	$240 00	$250 00	$245 00	$255 00
167609	167610	2	60	60	100	16	245 00	255 00	250 00	260 00
167611	167612	2	100	100	200	16	250 00	260 00	255 00	265 00
167613	167614	2	200	150	200	16	260 00	270 00	265 00	275 00
167615	167616	2	200	200	300	16	265 00	275 00	270 00	280 00
167617	167618	2	400	300	500	16	285 00	295 00	290 00	300 00
167619	167620	2	400	400	600	16	335 00	345 00	340 00	350 00
167621	167622	2†	600	600	1000	20	330 00	390 00	400 00	410 00
167988		3	30	30	30	16	190 00	200 00	190 00	200 00
167989		3	60	60	100	16	195 00	205 00	195 00	205 00
167990		3	100	100	200	16	200 00	210 00	200 00	210 00
167991		3	200	150	200	16	210 00	220 00	210 00	220 00
167992		3	200	200	300	16	215 00	225 00	215 00	225 00
167993		3	400	300	500	16	240 00	250 00	240 00	250 00
167994		3	400	400	600	16	285 00	295 00	285 00	295 00
167995		3†	600	600	1000	20	330 00	340 00	330 00	350 00
Double-Throw										
167623	167624	4	30	30	50	16	265 00	275 00	270 00	280 00
167625	167626	4	60	60	100	16	275 00	285 00	280 00	290 00
167627	167628	4	100	100	200	16	280 00	290 00	285 00	295 00
167629	167630	4	200	150	200	16	295 00	310 00	305 00	320 00
167631	167632	4	200	200	300	16	300 00	315 00	325 00	340 00
167633	167634	4	400	300	500	16	330 00	350 00	360 00	375 00
167635	167636	4	400	400	600	16	400 00	425 00	410 00	435 00
167637	167638	4†	600	600	1000	20	480 00	520 00	490 00	525 00
167996		5	30	30	50	16	215 00	225 00	215 00	225 00
167997		5	60	60	100	16	225 00	235 00	225 00	235 00
167998		5	100	100	200	16	235 00	245 00	235 00	245 00
167999		5	200	150	200	16	245 00	260 00	245 00	260 00
168000		5	200	200	300	16	250 00	265 00	250 00	265 00
168001		5	400	300	500	16	295 00	310 00	295 00	310 00
168002		5	400	400	600	16	340 00	355 00	340 00	355 00
168003		5†	600	600	1000	20	415 00	460 00	415 00	460 00

†These panels will not line up with other panels as meters and rheostats will be mounted lower down.

Approximate weight, boxed, 700 pounds.

Bus-bars and bus-connections are not included in the above style numbers.

Order by Style Number

GENERATOR PANELS

With Fuse Protection

110-220 VOLTS

For a single-throw system order panel Fig. 6 for the first machine installed and panel Fig. 7 for each succeeding machine.

For a double-throw system order two panels Fig. 8 for the first two machines installed and panel Fig. 9 for each succeeding machine.

FIG. 6

FIG. 7

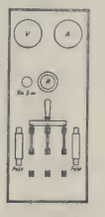


FIG. 8

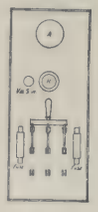


FIG. 9

Schedule of Apparatus

*One voltmeter, type SL
One ammeter, type SL.
One dri ling only for standard Westinghouse tetrapod rheostat mounting.

*With panel Fig. 6 and 8 only.

*One ground detector outfit.
One double-contact type RS voltmeter switch with a removable handle.*
One knife switch type A three-pole
Two fuse blocks and fuses, enclosed type

Panel Style No. 110 Volts	220 Volts	Fig.	—Ampere Capacity— Switch	Fuse	Ammeter Full Scale	Panel Width Inches	List Price 110 Volts Individual Operation	110 Volts Bus-Bar Operation	220 Volts Individual Operation	220 Volts Bus-Bar Operation
Single-Throw										
167639	167640	6	30	30	50	16	$215 00	$225 00	$220 00	$230 00
167641	167642	6	60	60	100	16	220 00	230 00	225 00	235 00
167643	167644	6	100	100	200	16	230 00	240 00	235 00	245 00
167645	167646	6	200	150	200	16	245 00	255 00	250 00	260 00
167647	167648	6	200	200	300	16	250 00	260 00	255 00	265 00
167649	167650	6	400	300	500	16	290 00	300 00	295 00	305 00
167651	167652	6	400	400	600	16	305 00	315 00	325 00	335 00
167653	167654	6	600	600	1000	20	375 00	395 00	385 00	410 00
168004		7	30	30	50	16	165 00	175 00	165 00	175 00
168005		7	60	60	100	16	170 00	180 00	170 00	180 00
168006		7	100	100	200	16	180 00	190 00	180 00	190 00
168007		7	200	150	200	16	195 00	205 00	195 00	205 00
168008		7	200	200	300	16	200 00	210 00	200 00	210 00
168009		7	400	300	500	16	240 00	255 00	240 00	255 00
168010		7	400	400	600	16	245 00	275 00	245 00	275 00
168011		7	600	600	1000	20	325 00	365 00	325 00	365 00
Double-Throw										
167655	167656	8	30	30	50	16	225 00	240 00	230 00	245 00
167657	167658	8	60	60	100	16	230 00	245 00	235 00	250 00
167659	167660	8	100	100	200	16	240 00	255 00	245 00	260 00
167661	167662	8	200	150	200	20	260 00	385 00	265 00	290 00
167663	167664	8	200	200	300	20	265 00	290 00	270 00	295 00
167665	167666	8	400	300	500	20	315 00	345 00	320 00	350 00
167667	167668	8	400	400	600	20	335 00	365 00	340 00	370 00
167669	167670	8	600	600	1000	24	415 00	465 00	420 00	470 00
168012		9	30	30	50	16	170 00	190 00	170 00	190 00
168013		9	60	60	100	16	180 00	195 00	180 00	195 00
168014		9	100	100	200	16	205 00	215 00	205 00	215 00
168015		9	200	150	200	20	210 00	235 00	210 00	235 00
168016		9	200	200	300	20	215 00	240 00	215 00	240 00
168017		9	400	300	500	20	270 00	295 00	270 00	295 00
168018		9	400	400	600	20	290 00	315 00	290 00	315 00
168019		9	600	600	1000	24	365 00	420 00	365 00	420 00

Approximate weight boxed, 650 pounds.

Bus-bars and bus-connections are not included in the above style numbers.

Order by Style Number

ALTERATIONS FROM STANDARD FEEDER PANELS LISTED

The feeder panels listed may be adapted to control a smaller number of circuits than is included under the style number, in which case a deduction from the list price of the panel will be made for each feeder circuit omitted, according to the following table. It should be noted, however, where switches are omitted from standard panels, that the space will remain blank, in order to maintain standard design and to permit of a possible future addition of the omitted circuit.

Ampere Capacity	Deductions From Panel List Price — Single-Throw Fuses on Front	Single-Throw Fuses on Rear	Double-Throw Fuses on Front	Double-Throw Fuses on Rear
30	$ 5 00	$10 50	$ 5 75	$12 00
60	8 00	12 50	10 00	14 00
100	12 50	19 50	14 50	21 50
200	16 50	22 00	22 00	24 00
300*	30 00	36 00	42 00	50 00
400	32 75	38 50	44 00	53 50

*Capacity of switch is 400 amperes, fuses 300 amperes.

FEEDER PANELS

With Two-Pole Knife Switches and Single-Pole Circuit-Breakers

110-220 VOLTS

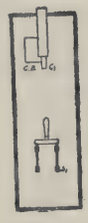


FIG. 10

FIG. 11

Schedule of Apparatus

Per circuit—

One knife switch, type A two-pole, single-throw.

One circuit-breaker; type CD for capacities of 300 amps. and below, and type CC above 300 amps.

Panel Style No.	Number of Circuits Per Panel	Fig.	Throw of Switch	Ampere Capacity and Distribution of Switches and Circuit-Breakers S1	C1	Panel Width Inches	List Price — Individual Operation	Bus-Bar Operation
168020	1	10	Single	1- 60	1- 60	12	$115 00	130 00
168021	1	10	Single	1-100	1-100	12	120 00	135 00
168022	1	10	Single	1-200	1-200	12	130 00	145 00
168023	1	10	Single	1-400	1-300	12	150 00	165 00
168024	1	10	Single	1-400	1-400	12	190 00	205 00
168025	1	11	Double	1- 60	1- 60	12	120 00	140 00
168026	1	11	Double	1-100	1-100	12	125 00	145 00
168027	1	11	Double	1-200	1-200	12	140 00	160 00
168028	1	11	Double	1-400	1-300	12	170 00	195 00
168029	1	11	Double	1-400	1-400	12	210 00	250 00
168030	2	10	Single	2- 60	2- 60	20	170 00	185 00
168031	2	10	Single	2-100	2-100	20	180 00	195 00
168032	2	10	Single	2-200	2-200	20	205 00	220 00
168033	2	10	Single	2-400	2-300	20	245 00	265 00
168034	2	10	Single	2-400	2-400	20	320 00	345 00
168035	2	11	Double	2- 60	2- 60	20	200 00	235 00
168036	2	11	Double	2-100	2-100	20	205 00	245 00
168037	2	11	Double	2-200	2-200	20	235 00	285 00
168038	2	11	Double	2-400	2-300	20	290 00	345 00
168039	2	11	Double	2-400	2-400	20	380 00	460 00

FEEDER PANELS

With Single-Throw Switches Fused on Front of Panel

110-220 VOLTS

FIG. 12

FIG. 13

FIG. 14

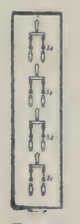


FIG. 15

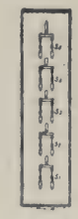


FIG. 16

Schedule of Apparatus

Fused knife switches, type A 2-pole, single-throw.

Panel Style No.	Number of Circuits Per Panel	Fig.	Ampere Capacity of Fuses and Distribution of Switches and Fuses S1	S2	S3	S4	S5	Panel Width, Inches	List Price Individual Operation	List Price Bus-Bar Operation
167671	2	12	1-400	1-400	.....	....	....	12	$210 00	$220 00
167672	2	12	1-400	1-300*	.....	....	....	12	200 00	210 00
167673	2	12	1-400	1-200	.....	....	....	12	180 00	190 00
167674	2	12	1-300*	1-300*	.....	....	....	12	190 00	200 00
167675	2	12	1-300*	1-200	.....	....	....	12	170 00	180 00
167676	2	12	1-200	1-200	.....	....	....	12	140 00	150 00
167677	2	12	1-200	1-100	.....	....	....	12	130 00	135 00
167678	3	12	1-100	1-100	1-100	....	....	12	155 00	165 00
167679	3	14	1-100	1- 60	1- 60	....	....	12	140 00	150 00
167680	4	15	1- 60	1- 60	1- 60	1-60	....	12	145 00	160 00
167681	10	16	2- 30	2- 30	2- 30	2-30	2-30	12	260 00	285 00
167682	3	13	1-400	2-200	.....	....	....	16	230 00	240 00
167683	3	13	1-400	2-100	.....	....	....	16	240 00	250 00
167684	3	13	1-300*	2-200	.....	....	....	16	215 00	225 00
167685	3	13	1-300*	2-100	.....	....	....	16	200 00	210 00
167686	4	12	2-200	2-200	.....	....	....	16	230 00	260 00
167687	4	12	2-200	2-100	.....	....	....	16	215 00	230 00
167688	6	14	2-100	2-100	2-100	....	....	16	270 00	290 00
167689	6	14	2-100	2- 60	2- 60	....	....	16	240 00	260 00
167690	8	15	2- 60	2- 60	2- 60	2-60	....	16	270 00	285 00
167691	15	16	3- 30	3- 30	3- 30	3-30	3-30	16	375 00	400 00
167692	4	12	2-400	2-400	.....	....	....	20	375 00	385 00
167693	4	12	2-400	2-300*	.....	....	....	20	355 00	370 00
167694	4	12	2-400	2-200	.....	....	....	20	310 00	330 00
167695	4	12	2-300*	2-300*	.....	....	....	20	340 00	365 00
167696	4	12	2-300*	2-200	.....	....	....	20	300 00	315 00
167697	4	12	2-300*	2-100	.....	....	....	20	275 00	285 00
167698	4	12	2-200	2-200	.....	....	....	20	235 00	255 00
167699	4	12	2-200	2-100	.....	....	....	20	215 00	235 00
167700	9	14	3-100	3-100	3-100	....	....	24	390 00	400 00
167701	9	14	3-100	3- 60	3- 60	....	....	24	335 00	355 00
167702	12	15	3- 60	3- 60	3- 60	3-60	....	24	385 00	405 00
167703	20	16	4- 30	4- 30	4- 30	4-30	4-30	24	490 00	530 00

*Capacity of switch is 400 amperes, fuses 300 amperes.
Approximate weight, boxed, 400 pounds.
Bus-bars and bus-connections are not included in the above style numbers.

Order by Style Number

FEEDER PANELS

With Single-Throw Switches Fused on Rear of Panel

110-220 VOLTS

FIG. 17

FIG. 18

FIG. 19

FIG. 20

FIG. 21

Schedule of Apparatus

Knife switches, type A, two-pole, single-throw.
Fuse blocks and fuses, enclosed type, mounted on rear.

Panel Style No.	Number of Circuits Per Panel	Fig.	Ampere Capacity of Fuses and Distribution of Switches and Fuses S1	S2	S3	S4	S5	S6	Panel Width, Inches	List Price Individual Operation	List Price Bus-Bar Operation
167704	3	17	1-400	1-400	1-400	.....	....	....	12	$345 00	355 00
167705	3	17	1-400	1-300*	1-200	.....	....	....	12	305 00	315 00
167706	3	17	1-300*	1-300*	1-300*	.....	....	....	12	345 00	355 00
167707	3	17	1-300*	1-200	1-100	.....	....	....	12	260 00	270 00
167708	3	17	1-200	1-200	1-200	.....	....	....	12	225 00	235 00
167709	3	17	1-200	1-100	1- 60	.....	....	....	12	200 00	270 00
167710	4	19	1-100	1-100	1-100	1-100	....	....	12	230 00	240 00
167711	4	19	1-100	1-100	1- 60	1- 60	....	....	12	210 00	220 00
167712	5	20	1- 60	1- 60	1- 60	1- 60	1-60	....	12	230 00	240 00
167713	12	21	2- 30	2- 30	2- 30	2- 30	2-30	2-30	12	400 00	415 00
167714	5	18	1-400	2-200	2-200	.....	....	....	16	410 00	420 00
167715	5	18	1-400	2-200	2-100	.....	....	....	16	380 00	390 00
167716	5	18	1-400	2-100	2-100	.....	....	....	16	355 00	365 00
167717	5	18	1-300*	2-200	2-200	.....	....	....	16	390 00	400 00
167718	5	18	1-300*	2-200	2-100	.....	....	....	16	375 00	385 00
167719	5	18	1-300*	2-100	2-100	.....	....	....	16	355 00	365 00
167720	6	17	2-200	2-200	2-200	.....	....	....	16	390 00	410 00
167721	6	17	2-200	2-100	2- 60	.....	....	....	16	335 00	345 00
167722	8	19	2-100	2-100	2-100	2-100	....	....	16	400 00	410 00
167723	8	19	2-100	2-100	2- 60	2- 60	....	....	16	395 00	405 00
167724	10	20	2- 60	2- 60	2- 60	2- 60	2-60	....	16	410 00	420 00
167725	18	21	3- 30	3- 30	3- 30	3- 30	3-30	3-30	16	535 00	550 00
167726	6	17	2-400	2-400	2-400	.....	....	....	20	655 00	665 00
167727	6	17	2-400	2-300*	2-200	.....	....	....	20	555 00	565 00
167728	6	17	2-300*	2-300*	2-300*	.....	....	....	20	605 00	615 00
167729	6	17	2-300*	2-200	2-100	.....	....	....	20	470 00	480 00
167730	4	17	2-200	2-200	2-200	.....	....	....	20	395 00	410 00
167731	6	17	2-200	2-100	2- 60	.....	....	....	20	335 00	350 00
167732	12	19	3-100	3-100	3-100	3-100	....	....	24	580 00	590 00
167733	12	19	3-100	3-100	3- 60	3- 60	....	....	24	535 00	545 00
167734	15	20	3- 60	3- 60	3- 60	3- 60	3-60	....	24	585 00	595 00
167735	24	21	4- 30	4- 30	4- 30	4- 30	4-30	4-30	24	725 00	750 00

*Capacity of switch is 400 amperes, fuses 300 amperes.
Approximate weight, boxed, 400 pounds.
Bus-bars and bus-connections are not included in the above style numbers.

Order by Style Number

FEEDER PANELS

With Double-Throw Switches

110-220 VOLTS

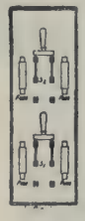


FIG. 22

FIG. 23

Schedule of Apparatus

Knife switches, type A, two-pole, double-throw.

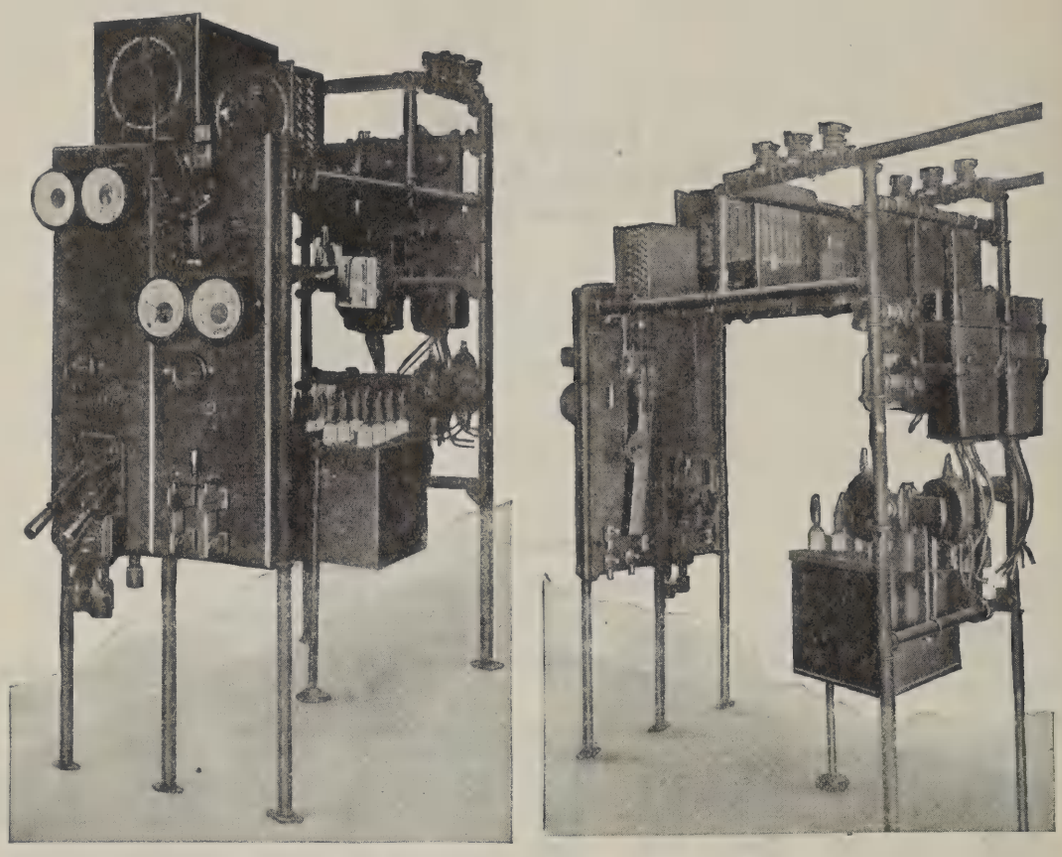
Fuse blocks and fuses, enclosed type, mounted on front of panel, or on rear. Fuses are connected to the hinge jaw of switches by copper strap.

Panel Style No.	Number of Circuits Per Panel	Fig.	Location of Fuses	AMPERE CAPACITY OF FUSES AND DISTRIBUTION OF SWITCHES AND FUSES S1	S2	S3	S4	Panel Width, Inches	LIST PRICE Individual Operation	Bus-Bar Operation
167736	3	22	Front	1–100	1–100	1–100	....	16	$225 00	$235 00
167737	3	22	Front	1– 60	1– 60	1– 60	....	16	180 00	190 00
167738	4	22	Front	1– 30	1– 30	1– 30	1–30	16	205 00	215 00
167739	1	22	Front	1–400	1–400	.....	....	20	340 00	350 00
167740	2	22	Front	1–300*	1–300*	.....	....	20	315 00	325 00
167741	1	22	Front	1–200	1–200	.....	....	20	220 00	230 00
167742	1	23	Rear	1–400	1–400	.....	....	12	360 00	375 00
167743	2	23	Rear	1–300*	1–300*	.....	....	12	335 00	350 00
167744	2	23	Rear	1–200	1–200	.....	....	12	260 00	275 00
167745	3	23	Rear	1–100	1–100	1–100	....	12	240 00	250 00
167746	3	23	Rear	1– 60	1– 60	1– 60	....	12	200 00	215 00
167747	3	23	Rear	2– 30	2– 30	2– 30	2–30	12	335 00	355 00
167748	4	23	Rear	2–200	2–200	.....	....	16	345 00	360 00
167749	6	23	Rear	2–100	2–100	2–100	....	16	360 00	375 00
167750	6	23	Rear	2– 60	2– 60	2– 60	....	16	400 00	420 00
167751	12	23	Rear	3–30	3–30	3– 30	3–30	16	435 00	460 00
167752	4	23	Rear	2–400	2–400	.....	....	20	570 00	590 00
167753	4	23	Rear	2–300*	2–300*	.....	....	20	545 00	560 00
167754	4	23	Rear	2–200	2–200	.....	....	20	350 00	365 00
167755	9	23	Rear	3–100	3–100	3–100	....	24	470 00	505 00
167756	9	23	Rear	3– 60	3– 60	3– 60	....	24	395 00	420 00
167757	16	23	Rear	4– 30	4– 30	4– 30	4–30	24	520 00	550 00

*Capacity of switch is 400 amperes, fuses 300 amperes.
Approximate weight, boxed, 400 pounds.
Bus-bars and bus-connections are not included in the above style numbers.

Order by Style Number

TYPE JD SWITCHBOARDS FOR MINES



FRONT AND REAR VIEWS OF TYPE JD SWITCHBOARD FOR THE CONTROL OF SYNCHRONOUS MOTOR-GENERATOR SET FOR MINING SERVICE.*

Application

Type JD mining panels are particularly adapted for the control of small direct-current generators and A.C.–D.C. motor-generator sets, operating two-wire, grounded-negative, direct-current systems of 275 and 600 volts; and for the control of small 275-volt synchronous converters for mine service, operating two-wire, grounded-negative, direct-current systems.

Panel Description

Type JD panels for mines, as indicated by the type letter J, are mounted on type J 1¼-inch pipe frames.

Panels for the control of 275-volt direct-current engine-driven generators are in general similar to type JD generator panels, Style Nos. 167608-10-12-14-16-18-20-22, and 167988 to 167995, except the connections on the rear are made for a grounded negative; and a two-pole circuit-breaker is furnished for disconnecting the generator from the line or bus as required by the national Electrical Code (Fig. 13).

*Standard panels do not include A.C. or D.C. bus supports or disconnecting switches. These can be furnished on special order. The location and method of mounting the auto-transformers are shown in the above figure; they are not included as part of the switchboard, but are furnished with the synchronous motor.

TYPE JD SWITCHBOARDS FOR MINES—Continued

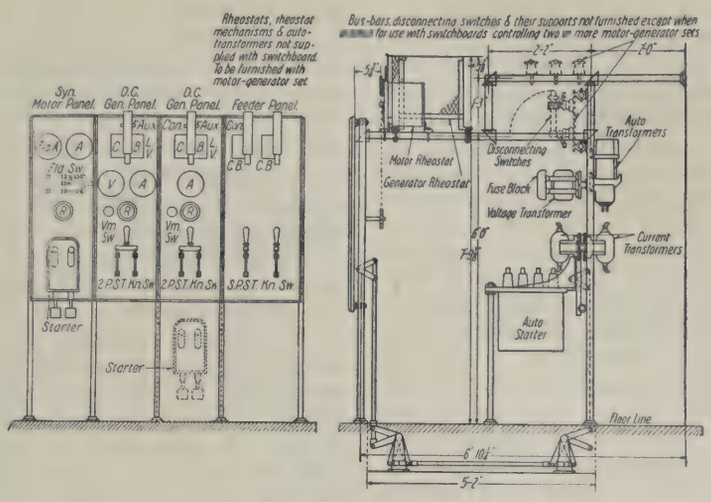


FIG. 1—TYPE JD SWITCHBOARD FOR MINES.

As the negative side of the circuit is grounded, no ground detector outfit is supplied. The type RS voltmeter switch is single-contact, the negative side of the voltmeter being connected to ground.

Panels for the control of 600- volt engine-driven generators are similar to the 275-volt panels described above, except that 600-volt apparatus is supplied.

Panels for the control of direct-current generators which are part of motor-generator sets with overload protection in the motor circuit, will have the connections modified in that carbon circuit-breaker will be inserted in the positive side of the circuit. (See diagrams). The carbon breaker will also be equipped with a low-voltage release for tripping it when the motor breaker opens.

Panels for the control of feeders are similar to type JD feeder panels, Style Nos. 168030 to 168034, except that a single-pole knife switch is furnished in place of each two-pole switch, and the switches are for 600 volts for the 600-volt panels.

Panels for the control of induction motors are furnished in the form of sub-panels to be mounted directly below the direct-current generator panel, on the pipe-frame legs

Panels for the control of self-starting synchronous motors are furnished as separate switchboard panels to stand adjacent to the direct-current generator panel.

Panels for control of 275-volt direct-current synchronous converters are arranged for starting the converter from the alternating-current end. The main panel contains the operating handle of the oil circuit-breaker for the high-tension side of the power transformers, and mounts the instruments and direct-current equipment with the exception of the field reversing switch. This field switch and the starting switch are arranged on a small separately mounted panel.

SWITCHING EQUIPMENT AND AUTOMATIC PROTECTION

For Motor-Generator Sets

The type QF starter is double-throw; non-automatic for starting, and automatic with overload inverse-time-limit and low voltage release for running. The handles are interlocked so that the starting side must be closed first and so that the running side cannot be closed except within a fixed time interval after the starting side has been opened.

The starting position magnetizes the auto-transformers and connects the motor to the starting voltage, the tap leads of the transformer being permanently connected to the motor leads. In passing to the running position the auto-transformers are disconnected from the line and full-line voltage is applied to the motor.

TYPE JD SWITCHBOARD FOR MINES—Continued

The type QF starter for three-phase service is four-pole double-throw with special moving contact arrangement. As listed with the motor panels, they are of two capacities, 300 amperes and 600 amperes.

As an alternative to the 300-ampere type QF, a combination of remote mechanically operated automatic three-pole and non-automatic four-pole type F-1 breakers can be had. The three-pole breaker constitutes the running breaker. It is overload automatic, with inverse-time-limit and low-voltage release mechanisms. The four-pole breaker is the starting breaker; it magnetizes the auto-transformers and connects the motor to the starting voltage from separate handles interlocked as described above. A two-handle cover plate and current transformers for use with the automatic breaker will be supplied. This combination is applicable only for starting with two single-phase auto-transformers.

The switching equipment for motors of capacities exceeding the ratings of the type QF starter are made up of either two or three single-throw breakers as follows:

(a) Motors started by means of two single-phase auto-transformers have a standard three-pole running breaker and a special four-pole starting breaker; (b) motors started by means of a three-phase auto-transformer have a standard three-pole running breaker and two special three-pole starting breakers operating in tandem.

The sequence interlock between handles is provided to prevent the possibility of impressing full line voltage upon a motor while at rest or widely out of synchronism.

The inverse-time-element feature is provided in connection with the overload trip on the circuit-breaker or auto-starter, so that the motor circuit will not be opened on momentary overloads, such as obtain when the switches are moved from the starting to the running position. The time in which the overload trip will operate is inversely proportional to the amount of overload, tripping being instantaneous in case of a short circuit.

The overload tripping range is from 80 to 160 per cent of the current rating of the current transformers included with the panel equipment.

All circuit-breaker equipments have a low-voltage trip which opens the running breaker when the voltage has dropped to approximately one-half its normal value. This feature is included to guard against an excessive current due to the return of power to a motor which may be out of phase or at rest. For voltages up to and including 550, the low-voltage coil with series resistance is connected directly to the line. For higher voltages, a voltage transformer with primary fuse blocks and fuses is included.

The handle of the running circuit-breaker is equipped with an auxiliary switch which serves to operate the low-voltage trip circuit of the direct-current generator breaker of the motor-generator set, when the alternating-current breaker opens.

If the direct-current generator of a motor-generator set operates in parallel with an independent source of direct-current power, the set will run inverted upon the interruption of the alternating-current power and hold up the alternating-current voltage. The independent source of direct-current power may be a motor-generator set (or a synchronous converter) supplied from a separate alternating-current source, a generator driven by a prime mover, or a battery. In order to prevent motoring from the direct-current bus-bars, and to disconnect the set, a reverse-current relay should be included with the direct-current panel equipment and so connected as to trip the alternating-current breaker upon current reversal. With the electrical interlock mentioned in the preceding paragraph the direct-current breaker is tripped on the opening of the alternating-current breaker and the set is thus completely disconnected in case of alternating-current power interruption.

For Synchronous Converters

The protection provided for synchronous converters is the same as described in the preceding four paragraphs except that the alternating-current breaker is instantaneous trip and as the converter is provided with an overspeed device, the direct-current carbon circuit-breaker is equipped with a low-voltage release, the coil of which is connected to the alternating-current circuit. This arrangement is made so that the operation of the overspeed device will open the alternating-current and direct-current breakers simultaneously.

Figures 2 and 3 respectively illustrate the simplified connections, including reverse-current relay, for protection of synchronous converters and motor-generator sets.

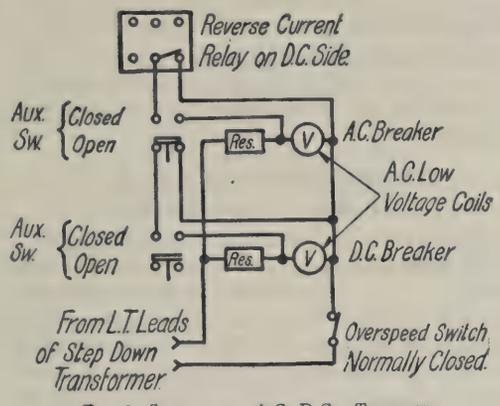


FIG. 2—SCHEME OF A.C.-D.C. TRIPPING CIRCUITS FOR SYNCHRONOUS CONVERTERS WHEN STARTED FROM A.-C. SIDE

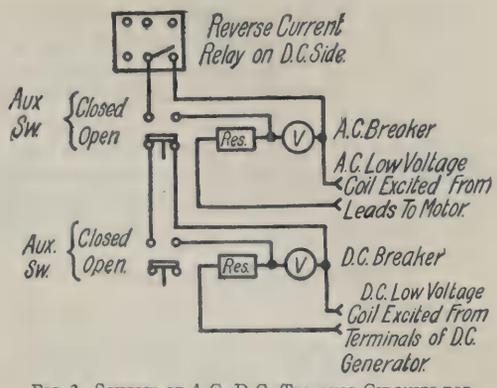


FIG. 3—SCHEME OF A.C.-D.C. TRIPPING CIRCUITS FOR MOTOR-GENERATOR SETS WHEN STARTED FROM A.C. SIDE

CIRCUIT-BREAKER APPLICATIONS

The remote control circuit-breakers furnished with the standard equipments have interrupting capacity ratings as follows:

Type of Starter or Breaker	Normal Voltage Rating	Amps	Interrupting Capacity Amperes Per Phase 550 Volts and Less	2200 Volts
QF	7500	300	15000	9800
QF	4500	600	25000	....
F-1	4500	300	15000	....
F-1	4500	200	10000	....
F-3	4500	800	32900	....
B-2	7500	1500	39000	....

For Motor-Generator Sets

The short circuit amperes which the breaker may be called upon to interrupt must be considered in every case before applying the standard equipments. If the total capacity of generating and synchronous apparatus connected close to the motor is sufficient to deliver, under short circuit, a current in excess of the rated interrupting capacity of the running breaker included in the standard equipment, special consideration is necessary. Where the interrupting capacity required is more than the rating of the breaker in the standard equipment, it is necessary either to replace the running breaker by one of suitable interrupting capacity or supply a breaker of suitable interrupting capacity in series, which is set to open ahead of the running breaker of the standard equipment in case of a short circuit. The breaker at the power house may often serve this purpose where the motor is supplied from a transmission line. In the latter case the breaker of the standard equipment must be given a definite minimum time delay by replacing the dash-pot inverse-time-limit attachment by direct-trip attachment and relay equipment giving a definite minimum time delay. It may be necessary also to use heavier duty starting breakers on a heavy capacity system.

It is important to note the conditions upon which the interrupting capacity ratings of circuit-breakers are based. A different inherent impedance in the generators, added impedance in step up and step down transformers and in transmission lines between the motor and the source of power and similar modified conditions, would make special consideration necessary. The matter of breaker application is fully covered in the section on "Oil Circuit-Breakers." Doubtful cases should be referred to the Company.

For Synchronous Converters

Due to the reliability obtained in the construction of power transformers, and the short length of leads between the high-tension oil circuit-breaker and the transformers, which reduces the possibility of a short circuit on the high-tension side to a minimum, a type F-1 oil circuit-breaker, which has sufficient interrupting ability to withstand any short circuits that might occur on the low-tension side of the power transformers, is furnished.

Rating of Equipment

The circuit-breakers and meters furnished are suitable for the guaranteed overload capacities of the motors which are contemplated by the standard equipments and for operation at the power factors listed. Equipments for 290 horsepower and below are suitable for 25 per cent overload, and those for 433 horsepower and above are suitable for 50 per cent overload, under the conditions of motor excitation specified for the motor-generator sets. These ratings are for two hours and the momentary overload capacity is 100 per cent for all sizes of equipments listed.

Equipment for synchronous converters is suitable for converters which have an overload rating of 25 per cent for two hours, and 100 per cent momentarily.

Blank Sub-Panels and Channel Iron Base

To meet the requirements of some operators for a switchboard with panels extending to the floor and supported on a channel iron base, the following optional equipment is listed. The sub-panel is 28 inches high, 1½ inches thick with the necessary brackets for supporting it from the type J frame, and a channel iron (2 inches by 6 inches) base of the same width as the panel is included.

Width of Panel	Increase in List Price
16 inches	$20 00
20 inches	22 00
24 inches	25 00

AUTOMATIC RECLOSING CARBON CIRCUIT-BREAKERS

Automatic reclosing carbon circuit-breakers can be applied where it is desired to insure that circuits will not unnecessarily remain open when overload conditions have been removed. Power is automatically put back on the circuit, as soon as conditions permit, and the expensive delays due to failure of power is reduced to a minimum.

Automatic reclosing circuit-breakers can be furnished in place of the plain, automatic, carbon breakers listed, at increased price, furnished upon specific request.

The automatic reclosing circuit-breaker is essentially a solenoid-operated breaker, the main contacts being held closed by the action of a solenoid.

When an overload or short circuit occurs on the load side of the line, the solenoid circuit is caused to open. This remains open for a definite time, resulting in an immediate opening of the carbon breaker (owing to a dash-pot element), and then automatically closes only when the overload or short circuit has disappeared.

Auxiliary devices are usually necessary.

When two or more generators operate in parallel and each generator circuit is provided with an automatic reclosable breaker, a special master relay is required so that all generator breakers will be opened or closed simultaneously.

When the feeder circuits are not independent, but tie with feeder circuits from other stations, a feeder relay is required with each tie-in feeder circuit to control the reclosing of the automatic reclosing breaker with reference to the load conditions, whether the line is energized from the remote source of power or not, at the particular time the breaker opens. This applies also to the automatic reclosable breaker of the generator circuit if there is only one connected to the bus from which several tie-in feeder circuits are fed, or to the master relay if there are several generators operating in parallel on a tied-in system.

When there is the possibility of a reversal, the generator breakers should also be equipped with a special reverse current relay which slips over the studs of the breaker.

When automatic reclosable breakers are used the panels are special and the delivery of same should be referred to the Works. It should be noted also that the generator panels must be 24 inches wide, single-circuit feeder panels 20 inches wide, and double-circuit feeder panels 32 inches wide. An additional panel may also be required to take care of the generator master relay and the feeder relay when used in conjunction with same.

Except for the two cases when straight automatic reclosable breakers can be applied without auxiliary devices, such as reverse current, master and feeder relays, the matter should be referred to the Works for prices and specifications. These two cases are: first, the case when only one generator is operating with one independent feeder, which requires an automatic reclosable breaker in the feeder circuit only; and secondly, the case when only one generator is operating with two or more independent feeders, which requires automatic reclosable breakers in both generator and feeder circuits.

GENERATOR PANELS FOR MINES

800 Amperes Maximum at 275 Volts; 600 Amperes Maximum at 600 Volts Direct-Current, Two-Wire, Grounded Negative

For the control of one generator operating singly or in parallel

Schedule of Apparatus

One panel 48x16x1½ inches with type J frame.

One type SL voltmeter.*

One type SL ammeter.

One drilling only for standard Westinghouse rheostat mounting.

One single-contact type RS voltmeter switch with removable handle (handle supplied only with style number panels including voltmeter).

One circuit-breaker two-pole for engine-driven generators, single-pole for motor-driven generators; type CD for capacities up to and including 300 amperes, type CC above 300 amperes. The breaker is equipped with a low-voltage release for use on panels controlling motor-driven generators.

One two-pole, single-throw type A knife switch.

*Furnished only with panels as indicated in tables.

			WITH VOLTMETER — List Price			WITHOUT VOLTMETER — List Price		
Volts	Amperes	K.W.	Panel Style No.	Individual Operation	Bus-Bar Operation	Panel Style No.	Individual Operation	Bus-Bar Operation
			Engine-Driven Generators					
275	30	7½	293616	$250 00	$260 00	293633	$210 00	$220 00
275	60	15	293617	255 00	265 00	293634	215 00	225 00
275	100	25	293618	260 00	270 00	293635	220 00	230 00
275	150	37½	293619	270 00	280 00	293636	230 00	240 00
275	200	50	293620	275 00	285 00	293637	235 00	245 00
275	300	75	293621	285 00	295 00	293638	240 00	250 00
275	400	100	293622	405 00	415 00	293639	370 00	380 00
275	600	150	293623	490 00	500 00	293640	455 00	465 00
275	800	200	293624	545 00	555 00	293641	510 00	520 00
600	30	15	293625	260 00	270 00	293642	225 00	235 00
600	60	30	293626	265 00	275 00	293643	230 00	240 00
600	100	50	293627	270 00	280 00	293644	235 00	245 00
600	150	75	293628	285 00	295 00	293645	240 00	250 00
600	200	100	293629	290 00	300 00	293646	245 00	255 00
600	300	150	293630	295 00	305 00	293647	255 00	265 00
600	400	200	293631	420 00	435 00	293648	390 00	400 00
600	600	300	293632	515 00	535 00	293649	475 00	490 00
			Motor-Driven Generators					
275	30	7½	247682	270 00	280 00	247691	225 00	235 00
275	60	15	247683	280 00	290 00	247692	230 00	240 00
275	100	25	247684	285 00	295 00	247693	235 00	245 00
275	150	37½	247685	295 00	305 00	247694	245 00	255 00
275	200	50	247686	300 00	315 00	247695	250 00	260 00
275	300	75	247687	325 00	335 00	247696	275 00	285 00
275	400	100	247688	380 00	390 00	247697	335 00	345 00
275	600	150	247689	435 00	445 00	247698	385 00	395 00
275	800	200	247690	495 00	530 00	247699	440 00	470 00
600	30	15	247700	285 00	295 00	247708	230 00	240 00
600	60	30	247701	290 00	300 00	247709	235 00	245 00
600	100	50	247702	295 00	305 00	247710	240 00	250 00
600	150	75	247703	310 00	320 00	247711	250 00	260 00
600	200	100	247704	315 00	325 00	247712	255 00	265 00
600	300	150	247705	335 00	345 00	247713	275 00	285 00
600	400	200	247706	395 00	405 00	247714	335 00	345 00
600	600	300	247707	440 00	455 00	247715	380 00	395 00

Approximate weight, boxed, 600 pounds.

Order by Style Number

INDUCTION MOTOR PANELS

290 Horsepower Maximum; 220, 440, 550, 2200 Volts; Three-Phase; 60 Cycles

For the control of induction motor, being part of A.C.-D.C. motor-generator set

FIG. 4

Schedule of Apparatus

One panel, 28x16x1½ inches, with necessary brackets for mounting as sub-panels on type J rames.

One type QF oil circuit-breaker equipment of capacity as listed in table; remote-control, manually operated, pipe-mounted with bell-cranks mounted below floor, or upright in a trench below the floor level, and with sequence-starting interlock, inverse-time-element dash-pots and low-voltage release.

One pipe framework for mounting the circuit-breaker, current, voltage and *auto-transformers.

Two type KR or FS current transformers of suitable ratio.

One 2000-100 voltage transformer with fuses, for motor circuits above 550 volts, for use with the low-voltage coil of the type QF circuit-breaker.

For description of oil circuit-breaker equipment see "Switching Equipment and Automatic protection"

*Auto-transformers are not included with these sections and must be ordered separately.

Motor Volts	Motor *Hp.	Amperes QF Starter	Ratings of Current Transformers	Panel Style No.	List Price
220	112	300	400–5	291355	$630 00
220	225	600	800–5	291356	690 00
220	290	†	1000–5	291357	805 00
440	225	300	400–5	291358	650 00
440	290	600	500–5	291359	795 00
550	290	300	400–5	291360	675 00
2200	290	300	100–5	291361	685 00

Approximate weight, boxed, 600 pounds.

*For motors of smaller capacity than listed order "same as Style No.....except for.....Hp. motor." Refer to synchronous motor panel tables for difference in current transformer capacity and difference in list prices.

†Two-breaker starter consisting of one 800-ampere, 3-pole, type F-3 breaker for running and a 200-ampere special 4-pole type F-1 breaker for starting.

Optional Equipment

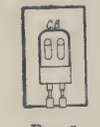


FIG. 5

The following type F-1 oil circuit-breaker combinations will be furnished, when desired, in place of the preceding style numbers at the prices listed below:

One panel, 28 by 16 by 1½ inches, with necessary brackets for mounting as sub-panels on type J frame.

One breaker combination comprising one automatic 3-pole type F-1 breaker with low-voltage release and inverse-time-element, squence interlocked with one non-automatic special 4-pole type F-1 breaker, remote mechanically operated, pipe frame mounted.

One pipe framework for mounting the circuit-breaker equipment, current, voltage and †auto transformers.

Two type KR current transformers of suitable ratio.

One 2000-100 voltage transformer with fuses, for motor circuits above 550 volts.

Motor Volts	Motor *Hp.	Amperes Ratio Current Transformer	Amperes Circuit-Breaker 3-Pole F-1	Amperes Circuit-Breaker 4-Pole F-1	Panel Style No.	List Price
220	75	250–5	200	200	291362	$525 00
220	112	400–5	300	200	291363	540 00
440	147	250–5	200	200	291364	535 00
440	225	400–5	300	200	291365	550 00
550	147	200–5	200	200	291366	545 00
550	290	400–5	300	200	291367	560 00
2200	290	100–5	200	200	291368	575 00

Approximate weight, boxed, 600 pounds.

*For motors of smaller capacity than listed order "same as Style No.....except for.....Hp. motor." Refer to synchronous motor panel tables for difference in current transformer capacity and difference in list prices.

†Auto-transformers not included and must be ordered separately.

Order by Style Number

SYNCHRONOUS MOTOR PANELS

Three-Phase, Sixty-Cycle

Remote-Control Pipe- or Wall-Mounting, 433 Hp. Max., 220, 440, 550, 2200 Volts

For the control of A.C. self-starting self-exciting synchronous motors, for standard Westinghouse A.C.-D.C. motor-generator sets

Schedule of Apparatus

One panel 48 inches by 16 inches by 1½ inches, with type J frame.

One type SM ammeter.

One type SL field ammeter.

One drilling only for Westinghouse sprocket operated rheostat mounting.

One manually operated, remote-control pipe-mounted oil circuit-breaker equipment with bell cranks above floor as given in table below, with sequence-starting interlock, inverse-time-element dash-pots, and low-voltage release.

One pipe framework for mounting the auto-starter or circuit-breaker equipment, current, voltage and *auto-transformers.

Two current transformers.

One 2000-100 voltage transformer with fuses, for motor circu ts above 550.

FIG. 6

PANELS WITH TYPE QF STARTER EQUIPMENT

Hp.	K.W. Gen.	Volts	% Power Factor	Amperes—QF Starter	Amperes—Main Ammeter	Amperes—†Field Ammeter	*Number of Auto-Transformers	Remote Control Style No.	Remote Control List Price
75	50	220	100	300	250	15	2–1 Ph.	268281‡	$775 00
112	75	220	100	300	450	15	2–1 Ph.	268282§	780 00
150	100	220	100	600	500	25	2–1 Ph.	268283§	930 00
225	150	220	100	600	800	25	2–1 Ph.	268284§	940 00
75	50	440	100	300	120	15	2–1 Ph.	268285‡	780 00
112	75	440	100	300	200	15	2–1 Ph.	268286‡	785 00
150	100	440	100	300	250	25	2–1 Ph.	268287‡	795 00
225	150	440	100	300	400	25	2–1 Ph.	268288§	800 00
290	200	440	100	600	500	25	2–1 Ph.	268289§	950 00
75	50	550	100	300	100	15	2–1 Ph.	268290‡	785 00
112	75	550	100	300	160	15	2–1 Ph.	268291‡	790 00
150	100	550	100	300	200	25	2–1 Ph.	268292‡	795 00
225	150	550	100	300	300	25	2–1 Ph.	268293§	800 00
290	200	550	100	300	400	25	2–1 Ph.	268294§	805 00
433	300	550	80	600	800	25	2–1 Ph.	291369§	960 00
75	50	2200	100	300	25	15	2–1 Ph.	268295‡	820 00
112	75	2200	100	300	40	15	2–1 Ph.	268296‡	825 00
150	100	2200	100	300	50	25	2–1 Ph.	268297‡	830 00
225	150	2200	100	300	80	25	2–1 Ph.	268298‡	835 00
290	200	2200	100	300	100	25	2–1 Ph.	268299‡	840 00
433	300	2200	80	300	200	25	2–1 Ph.	268300‡	845 00

Approximate weight, boxed, 800 pounds.

*Not included in Style No. and must be ordered separately.

†Field ammeter capacities are suitable for use with standard Westinghouse motor-generator sets having 275-volt excitation.

‡The 200-ampere type F-1 remote-control, mechanically operated, oil circuit-breaker equipment as described under "Switching Equipment and Automatic Protection" may be substituted for the type QF, 300-ampere, remote-controlled breaker, when desired, at a reduction in list price of $50.00.

§The 300-ampere type F-1 remote-control, mechanically operated, oil circuit-breaker equipment as described under "Switching Equipment and Automatic Protection" may be substituted for the type QF 300-ampere remote-controlled b reaker, when desired, at a reduction in list price of $28.00.

Order by Style Number

TYPE JD SWITCHBOARDS FOR MINES—Continued

PANELS WITH OIL CIRCUIT-BREAKER EQUIPMENT

Remote-Control, Pipe-Frame Mounting

Hp.	K.W. Gen.	Volts	% Power Factor	—Type Breaker— Running	Starting	—Amperes— Running Breaker	Starting Breaker	Main Ammeter	†Field Ammeter	*Number of Auto-Transformer	Style Number	List Price
290	200	220	100	F-3	Special F-1	800	200	1000	25	2-1 Ph.	291370	$1035 00
433	300	220	80	B-2	Special F-2	1500	500	2000	25	2-1 Ph.	291371	1550 00
433	300	440	80	F-3	Special F-1	800	200	1000	25	2-1 Ph.	291372	1050 00

*Not included in style number and must be ordered separately.

†Field ammeter capacities are suitable for use with standard Westinghouse motor-generator sets having 275-volt excitation.

Optional Equipment

Equipment for type JD synchronous motor panels can be furnished at the following additions to the list price of the panel:

One type SM voltmeter $55.00

One type SI power factor meter (one additional voltage transformer required*) 75.00

Omission price for type SL field ammeter (when type SI power factor meter is added and field ammeter is not desired) ... 35.00

One ammeter switch (for applications where it may be desirable to provide for reading the current in all phases) 12.00

One reverse-current relay, type D (when required) 105.00

One type D 100-ampere, two-pole, double-throw field switch (when required) 37.00

Standard panels have no field switches. A Westinghouse self-starting synchronous motor is started with the field circuit closed through the armature of its individual exciter if connected to the motor shaft; or if no exciter is provided and the motor is excited from the direct-current generator which it drives, the motor field is closed through the generator armature. The motor field is thus short-circuited at stand-still and is gradually excited as the motor comes up to speed.

A two-pole double-throw field switch must be supplied when the motor field is excited from a separate source of power, or from an exciter not connected to the motor shaft. The left-hand switch-studs are connected together by a copper strap. The field switch is in the left-hand position until the motor has come up to synchronous speed. It is thrown to the right-hand or normal position before the motor is connected to full-line voltage. The rheostat is in series with the field in the starting position as well as in the normal position of the field switch. Resistance for use with field-discharge switch is not included, as it is assumed to be part of the motor equipment.

Motor-generator sets for 275-volt direct-current service have the motor field excited across the direct-current generator terminals, for 200 kw. and below; the 300-kw. set has a 125-volt exciter. Motor-generator sets for 600-volt direct-current service may have a separate 125-volt exciter connected to the same shaft, or the motor field may be excited from an exciter independent of the motor-generator set.

Where a separate exciter is used in connection with the motor field the panels are drilled for standard Westinghouse combination rheostat mounting, but the mounting is not included in the list price of the panels. The panels are designed to have the exciter-field rheostat mounted on a tetrapod on the rear of the panels, with the motor-field rheostats separately mounted and operated by sprocket and chain. This mounting can be furnished at an addition to the list price of the panel.

*Not included in list price; add from section on Instruments and Relays.

Order by Style Number

INCOMING LINE PANELS

Remote-Control—Pipe or Wall Mounting

800 Kva., Max.—Three-Phase, 60-Cycle, 2200-Volt

The following panels match with the motor, generator, converter, and feeder panels listed for mine service, and control the power to the mine substation. These panels are desirable when more than one motor-generator set or converter are to be controlled, or when other equipments, such as pumps or fans are operated from the station bus.

Panels for other capacities and voltages than those listed can be furnished on special order.

Schedule of Apparatus

One panel, 48x16x1½ inches, ⅜-inch bevel
One ammeter, type SM.
*One three-pole single-throw, 200-ampere type F-1, oil circuit-breaker (wall mounting with bell cranks above floor when remote control).
One pipe framework for mounting the circuit-breaker and current transformers.
Two type KA Current Transformers.

*The 200 ampere type F-1 oil circuit-breaker has an interrupting ability of 7300 amperes per phase at 2500 volts.

FIG. 7

Kva.	Amperes	Ratings Current Transformers
100	40	40–5
200	80	80–5
300	120	120–5
400	160	160–5
500	200	200–5
600	250	250–5
800	400	300–5

Approximate weight, boxed, 600 pounds.

Panel Style No.	List Price Panel Frame Mounting	List Price Remote Wall Mounting
207921	$415 00	$430 00
207922	420 00	435 00
207923	425 00	440 00
207924	430 00	445 00
207925	435 00	450 00
207926	440 00	455 00
207927	450 00	465 00

Optional equipment—One type SM voltmeter at a list price of $55.00. Add a voltage transformer and fuses except when used with a 2200-volt synchronous motor panel which is provided with a voltage transformer. For list price see section on "Instruments and Relays."

SYNCHRONOUS CONVERTER PANELS FOR MINE SERVICE

For the control of 100, 150, and 200-kw., 275-volt, 6-phase, 60-cycles Synchronous converters for mine service

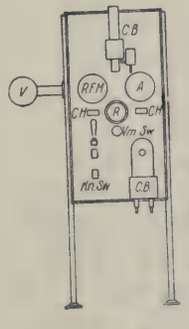


FIG. 8

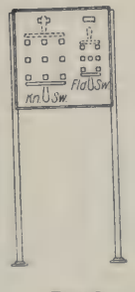


FIG. 9

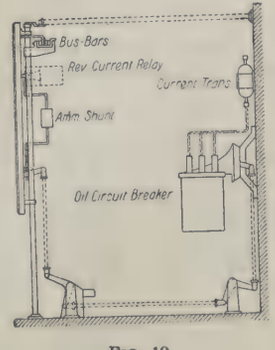


FIG. 10

SYNCHRONOUS CONVERTER PANELS—(Continued)

Schedule of Apparatus

One panel 48x24x1½ inches, ⅜-inch bevel, (Fig 8.)

One type CC carbon circuit-breaker with low-voltage release mechanism.

One type SL ammeter with shunt.

One type SI reactive factor meter.

One drilling for standard Westinghouse sprocket operated rheostat mounting.

One single-pole, single-throw, 250-volt, type A, knife switch.

One oil circuit-breaker equipment as listed; remote-control, manually operated, wall-mounted, bell-cranks above floor, with low-voltage release mechanism and hand reset.

One single-contact type RS voltmeter switch with removable handle.

One two-point voltmeter receptacle and plug.

One type SL voltmeter on swinging bracket, 300-volt scale.

Mounted Apart from Panel—

Two current transformers

One starting panel (Fig. 9) 25x24x1½ inches, ⅜-inch bevel, complete with pipe framework and braces to floor, and having mounted on it the following:

One three-pole, double-throw knife switch.

One two-pole, double-throw field reversing and discharge switch.

One current transformer on rear for reactive factor meter.

Capacity K.W.	Line Voltage	Type Line Breaker	Amperes: Line Breaker	D.C. Circuit Breaker	D.C. Ammeter	Knife Switch	Starting Switch	Field Switch	Current Transformer: For Line Breaker	For Reactive Factor Meter	Panel Style No.	List Price: Individual Operation	List Price: Bus-Bar Operation
100	440	F-1	200	400	600	400	200	100	200-5 KR	200-5 FR	245922	$1050 00	$1060 00
100	2200	F-1	200	400	600	400	200	100	40-5 KR	200-5 FR	245923	1055 00	1065 00
100	6600	F-2	300	400	600	400	200	100	15-5 KR	200-5 FR	245924	1090 00	1100 00
150	440	F-1	300	600	1000	600	400	100	300-5 FR	300-5 FR	245925	1110 00	1140 00
150	2200	F-1	200	600	1000	600	400	100	60-5 KR	300-5 FR	245926	1120 00	1145 00
150	6600	F-2	300	600	1000	600	400	100	20-5 KR	300-5 FR	245927	1150 00	1160 00
200	440	F-2	500	800	1200	800	400	100	400-5 FR	400-5 FR	245928	1200 00	1210 00
200	2200	F-1	200	800	1200	800	400	100	80-5 KR	400-5 FR	245929	1150 00	1160 00
200	6600	F-2	300	800	1200	800	400	100	30-5 KR	400-5 FR	245930	1190 00	1200 00

Approximate weight, boxed, 700 pounds.

Optional Equipment

When required, one reverse-current relay, type D, mounted on bracket on rear of panel, may be added at an addition to list price of **$105.00.**

When space is limited and the main panel is mounted adjacent to the transformers and converter, the starting panel, on special order, can be mounted as a sub-section beneath the main panel.

FEEDER PANELS FOR MINES

800 Amperes, Maximum, 275 to 600 Volts

DIRECT-CURRENT, GROUNDED NEGATIVE

These panels are similar to Style Nos. 168030 to 168034, type JD feeder panels, except that the switches are single-pole. Style number includes panel for two circuits. Size of panels 48 inches by 1½ inches with ⅜-inch bevels—width as per following table.

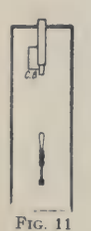


Fig. 11

Fig. 12

Amperes	Width Inches	275 VOLTS: Style No.	275 VOLTS: List Price Individual Operation	275 VOLTS: List Price Bus-Bar Operation	600 VOLTS: Style No.	600 VOLTS: List Price Individual Operation	600 VOLTS: List Price Bus-Bar Operation
Single-Circuit, Fig. 11							
100	16	207742	$120 00	$130 00	207928	$125 00	$135 00
200	16	207743	130 00	140 00	207929	135 00	140 00
300	16	207744	145 00	155 00	207930	150 00	160 00
400	16	207745	190 00	200 00	207931	195 00	205 00
600	16	207746	230 00	245 00	207932	235 00	260 00
800	16	234934	260 00	285 00	207933	265 00	295 00
Two-Circuits, Fig. 12							
100	20	183625	185 00	200 00	183630	190 00	210 00
200	20	183626	210 00	225 00	183631	215 00	230 00
300	20	183627	235 00	255 00	183632	240 00	275 00
400	20	183628	325 00	335 00	183633	330 00	360 00
600	20	234935	380 00	405 00	234937	390 00	425 00
800	20	234936	430 00	470 00	234938	440 00	475 00

Approximate weights—single circuit, boxed, 500 pounds; two circuits, boxed, 600 pounds.

Order by Style Number

TYPE JD SWITCHBOARDS FOR MINES—Continued

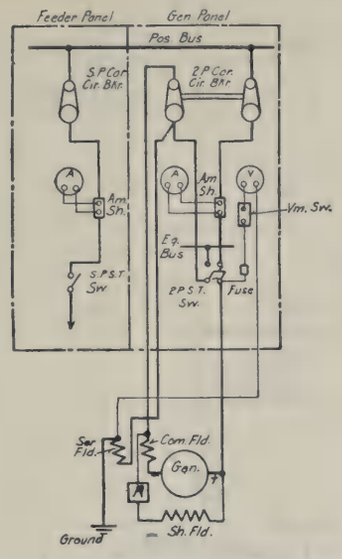


FIG. 13—MINE PANEL FOR ENGINE-DRIVEN GENERATOR

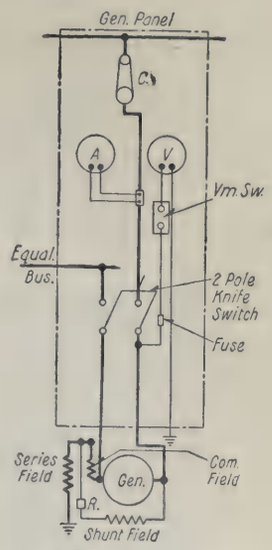


FIG. 14—MINE PANEL FOR MOTOR-DRIVEN GENERATOR

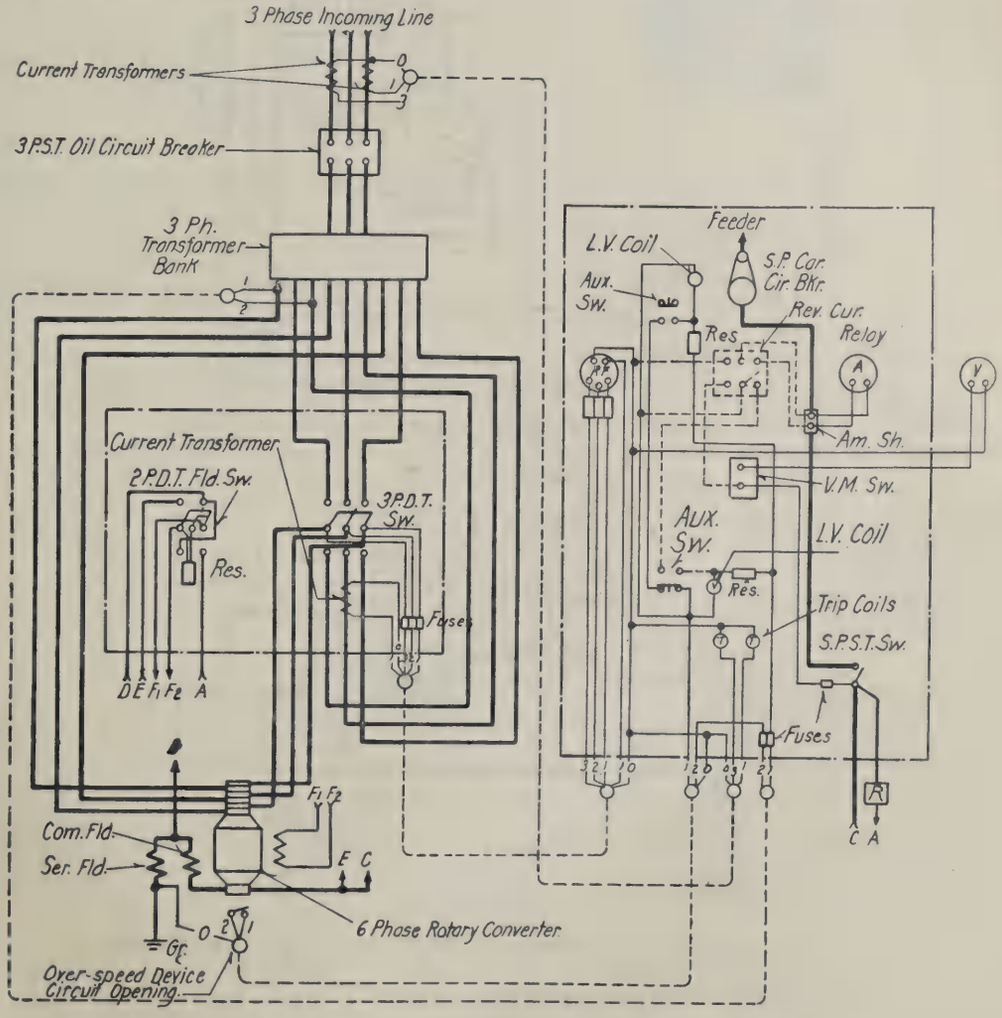


FIG. 15—CONNECTIONS FOR SYNCHRONOUS CONVERTER PANEL

TYPE JD SWITCHBOARDS FOR MINES—Continued

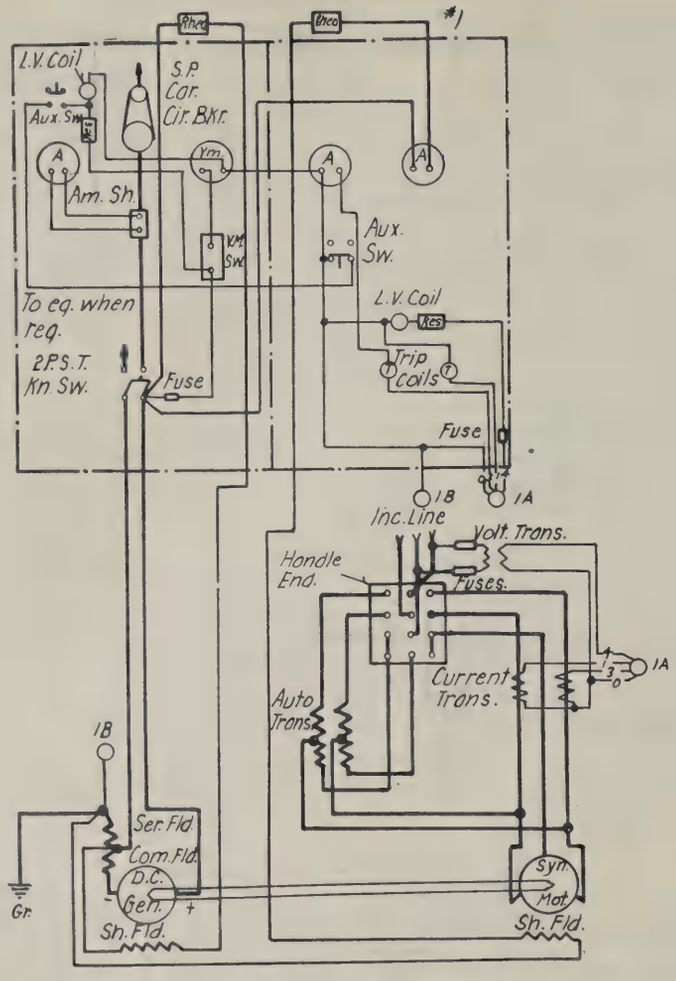


FIG. 16—CONNECTIONS FOR SYNCHRONOUS MOTOR, AND GENERATOR CIRCUITS.

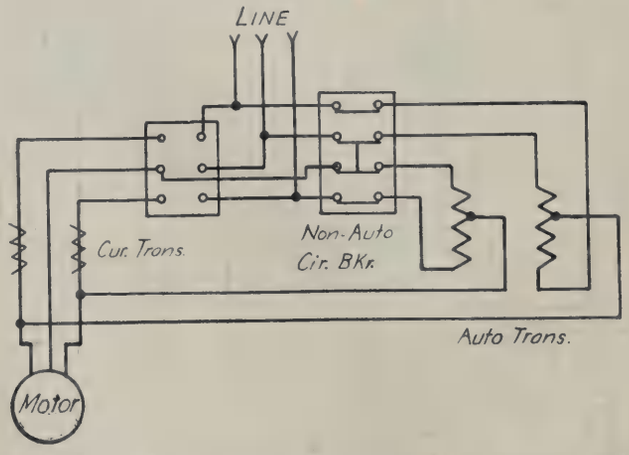


FIG. 17—DIAGRAM OF CONNECTIONS FOR TWO-BREAKER MOTOR-STARTING EQUIPMENT.

TYPE JD DIRECT-CURRENT COMBINATION GENERATOR-AND-FEEDER PANELS

110-220 VOLTS, TWO-WIRE

Application—Type JD combination panels are designed to provide a complete switchboard in a single panel for the control of one generator with four feeders. They are intended for use in isolated plants operating a single unit, direct-current, of 250 volts or less.

Capacity—The capacity of a panel is limited to 600 amperes for the generator and 200 amperes for each of the four feeders.

Type Designation—The type letter J signifies that the panel is mounted on a type J tubular frame, and the letter D denotes direct-current application.

Panel Construction—Each panel consists of a single section, 48 inches high by 20 inches or 24 inches wide, by 1½ inches thick, with ⅜-inch bevels on front edges, bolted at the four corners to the frame. The total height is 76⅜ inches.

Automatic Protection—Automatic protection is provided for the generator circuit by a single-pole type CD or CC carbon circuit-breaker, or by enclosed fuses mounted on the front of the panel; for the feeder circuits, by enclosed fuses mounted on the front of the panel.

Connections—The main connections on the back of the panels are of bare copper strap and are cut, bent, and assembled before shipment.

Shipment—Any one of the panels of this type can be shipped within 15 days after receipt of order at factory with full and complete information and

TYPE JD D.C. COMBINATION GENERATOR-AND-FEEDER PANEL

Data Sheet properly filled out. However, **any change or substitution** of apparatus as listed by style number will necessitate obtaining a **new delivery date** from factory.

Alterations from Panels Listed—The panels listed by style number may be adapted to control a smaller number of feeders than is specified, in which case a deduction from the list price of the panel will be made for each feeder circuit omitted, as follows:

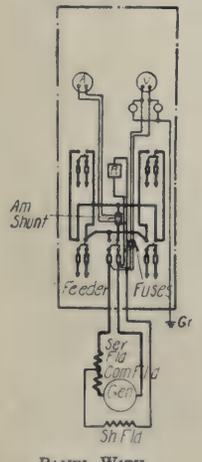
	Deduction from Panel List Price
30-ampere circuit	$ 5 00
60-ampere circuit	8 00
100-ampere circuit	12 50
200-ampere circuit	16 50

Panel style numbers include the frame, the panel with apparatus mounted thereon according to schedule given, and necessary details and connections.

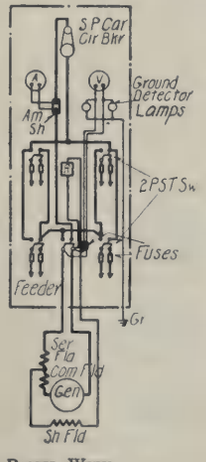
Each order for a switchboard should be accompanied by a **Data Sheet Form No. 2724** completely filled out.

See also Instructions for Ordering.

Typical Diagrams of Connections



PANEL WITH FUSED MAIN SWITCH



PANEL WITH CIRCUIT-BREAKER

TYPE JD D.C. COMBINATION GENERATOR-AND-FEEDER PANELS—Continued

PANELS WITH FUSED GENERATOR SWITCH

110-220 Volts, Two-Wire, Direct-Current

For the Control of One Generator and Four Feeder Circuits

Schedule of Apparatus

One voltmeter, type SL.
One ammeter type SL.
One drilling only for Westinghouse rheostat mounting.
One ground detector outfit.
One knife switch, type A, 2-pole, single-throw.
Two enclosed fuses with holders.
Four knife switches, type A, 2-pole, single-throw.
Eight enclosed fuses with holders.

Ampere Capacity				Panel	110 Volts		220 Volts	
Generator Switch	Generator Fuses	Ammeter Full Scale	Each Feeder	Width, Inches	Style No.	List Price	Style No.	List Price
100	100	200	30	20	167530	$300 00	167541	$305 00
100	100	200	60	20	167531	315 00	167542	320 00
200	150	200	30	20	167532	325 00	167543	330 00
200	150	200	60	20	167533	340 00	167544	345 00
200	200	300	60	20	167534	350 00	167545	355 00
200	200	300	100	20	167535	360 00	167546	365 00
400	300	400	60	20	167536	375 00	167547	380 00
400	300	500	100	20	167537	385 00	167548	390 00
400	400	600	100	20	167538	410 00	167549	415 00
400	400	600	200	24	167539	470 00	167550	475 00
600	600	1000	200	24	167540	515 00	167551	520 00

Approximate weight, boxed, 700 pounds.

PANELS WITH CIRCUIT-BREAKER PROTECTION

110-220 Volts, Two-Wire, Direct-Current

For the Control of One Generator and Four Feeder Circuits

Schedule of Apparatus

One voltmeter, type SL.
One ammeter, type SL.
One drilling only for Westinghouse rheostat mounting.
One ground detector outfit.
One knife switch, type A, 2-pole, single-throw.
One circuit-breaker, type CD or CC carbon-break, single-pole.
Four knife switches, type A, 2-pole, single-throw.
Eight enclosed fuses with holders.

Ampere Capacity				Panel	110 Volts		220 Volts	
Generator Switch	Circuit-Breaker	Ammeter Full Scale	Each Feeder	Width, Inches	Style No.	List Price	Style No.	List Price
100	100	200	30	24	167552	$340 00	167563	$345 00
100	100	200	60	24	167553	355 00	167564	360 00
200	150	200	30	24	167554	365 00	167565	370 00
200	150	200	60	24	167555	375 00	167566	380 00
200	200	300	60	24	167556	385 00	167567	390 00
200	200	300	100	24	167557	400 00	167568	410 00
400	300	400	60	24	167558	410 00	167569	420 00
400	300	500	100	24	167559	435 00	167570	445 00
400	400	600	100	24	167560	470 00	167571	480 00
400	400	600	200	24	167561	525 00	167572	535 00
600	600	1000	200	24	167562	580 00	167573	600 00

Approximate weight, boxed, 700 pounds.

Order by Style Number

TYPE JD THREE-WIRE D.C. SWITCHBOARD PANELS

Application—Type JD three-wire switchboards are designed for the control of from one to three generators in lighting and power plants of moderate capacity operating direct-current three-wire systems.

Capacity—The capacity of a single generator panel is limited to 600 amperes, and that of a complete switchboard composed of these panels to 1500 amperes. For greater capacities a switchboard composed of type GD panels is recommended.

Type Designation—The type letter J signifies that the panel is mounted on a type J tubular frame, and the letter D denotes direct-current application.

Panel Construction—Each panel consists of a single section, 48 inches high, 1½ inches thick, with ⅜-inch bevels on front edges, bolted at the four corners to the frame. The frame is made of 1¼-inch pipe uprights, resting in tapped floor flanges with the necessary panel brackets. The total height is 76⅜ inches.

Meters—Type SL ammeters and voltmeters, as specified, are regularly furnished with these panels. With the ammeters there are supplied ammeter shunts for mounting on the generator frame, and shunt leads 40 feet long.

Switches—Type A knife switches, either single- or double-throw, are used on generator and feeder panels.

Switches are not provided for disconnecting the balance coils from the collector rings on the generator, as these circuits can be opened by lifting the collector brushes. If switches are desired in these circuits, two double-pole single-throw knife switches can be provided at an additional price and mounted on the panel, or on a sub-panel. The omission of these switches from the balance-coil circuits effects a saving, as it eliminates the necessity of running eight cables from the collector brushes and balance coils to the switchboard.

Automatic Protection—Automatic protection for the generator circuit is provided by a 4-pole carbon circuit-breaker automatically tripped through relays actuated by the full armature current, or by a two-pole double-coil overload carbon breaker.

Automatic protection for feeder circuits is provided by (a) two-pole circuit-breakers, (b) three single-pole circuit-breakers actuated by a common trip, or (c) enclosed fuses.

Shipment—Any single standard panel can be shipped within 15 days after receipt of order at the Works giving full and complete information.

This promise of delivery applies only when a standard panel is furnished without any changes or additions other than those authorized in this section.

TYPE JD 3-WIRE SWITCHBOARD PANEL

Wall and Floor Brace Additions—Pipe sockets to receive ¾-inch gas pipe are provided for the switchboard end of wall braces, but no pipe or wall or floor flanges are supplied. For these additional details, see catalogue of "Westinghouse Switchboard Accessories" under "Switchboard Details."

Connections—The main connections on the back of the panel are of bare copper strap and are cut, bent, and assembled before shipment.

Data Sheet—Each order for a switchboard should be accompanied by a Switchboard Data Sheet, Form No. 2724, completely filled out. Full information given at the time of entering order prevents unnecessary correspondence and delay in shipment.

See also Instructions for Ordering.

Panel Style Numbers include the frame, the panel with apparatus mounted thereon according to schedules given, and the necessary details and connections on the panel and to the bus-bars when required.

Bus-bars are not included in the style numbers and must be added separately.

Equalizer Bus-Bars—Where generators are operating in parallel, positive and negative equalizer bus-bars are necessary in addition to the main bus-bars. These extend behind the generator panels but are not continued back of the feeder panels. Therefore when calculating the amount of copper in the bus-bars for parallel-operated generators on 3-wire service, it is necessary to add to the regular bus-bar material the copper required for the two equalizer

TYPE JD 3-WIRE D.C. PANELS—Continued

bus-bars, each of a capacity equal to that of the largest generator.

Generator panels not operating in parallel do not require equalizer bus-bars.

Omission of Feeder Circuits—Reductions of panel list price allowed for the omission of feeder circuits from panels as listed are as follows:

Ampere-Capacity Circuit	Reduction From List Price Per Circuit		
	Single-Throw Switch Fuses on Front	Single-Throw Switch Fuses on Rear	Double-Throw Switch Fuses on Rear
30	$10 25	$15 75	$19 50
60	12 25	17 50	22 00
100	18 00	29 00	32 50
200	24 50	31 00	36 50
300	45 00	50 00	60 00
400	50 00	56 50	64 00

Two-Wire Circuits—A full line of feeder panels for the control of two-wire circuits is given in another part of this catalogue.

These panels may easily be adapted for two-wire circuits fed from three-wire bus-bars.

Order panels for this service as follows: "Panel similar to Style No. . . . . but adapted to feed from three-wire bus."

GENERATOR PANELS

Four-Pole Circuit-Breaker Protection

To control one direct-current three-wire generator, operating singly or in parallel

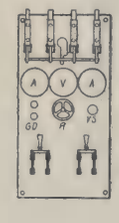


Fig. 1.

Fig. 2.

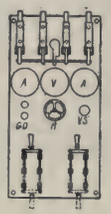


Fig. 3.

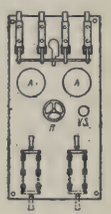


Fig. 4.

For a single-throw system, order panel Fig. 1 for first machine installed and Fig. 2 for each succeeding machine.

For a double-throw system, order panel Fig. 3 for first two machines installed and Fig. 4 for each succeeding machine.

Schedule of Apparatus

One switchboard panel.

One voltmeter—
One voltmeter switch handle } With panels Figs. 1 & 3 only.
One ground detector—

Two ammeters with shunts for mounting on machine frame.

One drilling for Westinghouse tetrapod rheostat mounting.

One double-contact type RS voltmeter switch.

†One type CD or CC carbon circuit-breaker, 4-pole, with low-voltage release mechanism. Automatic through relays actuated by total armature current.

Two type A two-pole knife switches.

†Type CC circuit-breakers will be supplied above 300 amperes capacity.

—Ampere Capacity— Switch	Breaker	Ammeter	Panel Width Inches	Maximum K. W. 250 Volts	Panel Style No.	List Price Individual Operation	List Price Bus-Bar Operation	Panel Style No.	List Price Individual Operation	List Price Bus-Bar Operation
Single-Throw System										
					Fig. 1				Fig. 2	
100	100	150	24	25	179359	$565 00	$590 00	179365	$510 00	$535 00
200	150	200	24	37.5	179360	605 00	625 00	179366	550 00	575 00
200	200	300	24	50	179361	610 00	630 00	179367	555 00	580 00
400	300	500	24	75	179362	635 00	675 00	179368	590 00	620 00
400	400	600	24	100	179363	845 00	870 00	179369	790 00	820 00
600	600	1000	32	150	179364	1030 00	1075 00	179370	970 00	1010 00
Double-Throw System										
					Fig. 3				Fig. 4	
100	100	150	24	25	179371	585 00	605 00	179377	530 00	555 00
200	150	200	24	37.5	179372	625 00	655 00	179378	570 00	600 00
200	200	300	24	50	179373	630 00	660 00	179379	575 00	605 00
400	300	500	24	75	179374	675 00	710 00	179380	620 00	660 00
400	400	600	24	100	179375	880 00	910 00	179381	835 00	880 00
600	600	1000	32	150	179376	1090 00	1160 00	179382	1040 00	1100 00

Approximate weight, boxed, 700 pounds.

Order by Style Number

GENERATOR PANELS
Two-Pole Circuit-Breaker Protection
To control one direct-current three-wire generator, operating singly or in parallel.

With 3-wire direct-current generators, the National Electrical Code requires that the "safety device consist of either: (1) a double-pole double-coil overload circuit-breaker, or (2) a four-pole circuit-breaker connected in the main and equalizer leads, and tripped by means of two overload devices, one in each armature lead." In short, the National Electrical Code requires that the safety device be actuated by the full armature current.

A comparison between the two methods shows the following:

Two-Pole Breaker Protection Requires

2-pole carbon breaker.
Six leads between generator and switchboard. (See diagram of connections.)
Cable duct and installation of same for six main generator leads.
Ammeter shunts mounted on switchboard.
Two sets of short ammeter shunt leads.

Four-Pole Breaker Protection Requires

4-pole carbon breaker with low-voltage release device for tripping by relays.
Two overload relays.
Four leads between generator and switchboard. (See diagram of connections.)
Cable duct and installation of same for four main generator leads.
Ammeter shunts mounted on generator frame.
Four sets of ammeter-shunt leads of a length at least sufficient to reach from ammeter shunt on generator frame to meters and relay on board, through main lead or separate ducts.

From the above comparison, it can be seen that the cost of the switchboard panel equipment is greater with the 4-pole breaker protection than with the 2-pole breaker protection. However, the added cable and cable duct cost, including also the added expense of installation, may be found to make the cost of the total equipment greater with the latter method of protection than with the former. This becomes true as the distance between the generator and the switchboard increases, and as the size of the cables and ducts increases.

The following table gives the distances between generator and switchboard beyond which it will be found in general that the total equipment cost of 2-pole breaker protection will be greater than total equipment cost of 4-pole breaker protection.

200 kw	250-volt generator	[illegible] feet
150 kw	250-volt generator	22 feet
100 kw	250-volt generator	[illegible] feet
75 kw	250-volt generator	33 feet
60 kw	250-volt generator	38 feet
50 kw	250-volt generator	[illegible] feet
25 kw	250-volt generator	50 feet

Schedule of Apparatus

For a single-throw system, order panel Fig. 1 for first machine installed and Fig. 2 for each succeeding machine.

For a double-throw system, order panel Fig. 3 for first two machines installed and Fig. 4 for each succeeding machine.

FIG. 1

FIG. 2

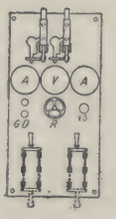


FIG. 3

FIG. 4

One switchboard panel.
One voltmeter
One voltmeter switch-handle.
One lamp ground detector outfit
} with panels Figs. 1 and 3 only.
Two ammeters with shunts mounted on panel.
One drilling for Westinghouse tetrapod rheostat mounting.
One double-contact type RS voltmeter switch.
*One type CD or CC 2-pole double-coil overload carbon breaker.
Two type A two-pole knife switches, single-throw with Figs. 1 and 2; double-throw with Figs. 3 and 4.

*Type CC circuit-breakers will be supplied above 300 amperes capacity.

—Amperes Capacity— Switch	Breaker	Ammeter	Panel Width Inches	Max. K.W. 250 Volts	Panel Style No.	List Price Individual Operation	List Price Bus-Bar Operation	Panel Style No.	List Price Individual Operation	List Price Bus-Bar Operation
Single-Throw System					Fig. 1			Fig. 2		
100	100	150	24	37	228977	$380 00	400 00	228983	$310 00	$335 00
200	150	200	24	37.5	228978	400 00	425 00	228984	340 00	350 00
200	200	300	24	50	228979	405 00	430 00	228985	345 00	365 00
400	300	500	24	75	228980	460 00	490 00	228986	400 00	425 00
400	400	600	24	100	228981	570 00	600 00	228987	505 00	540 00
600	600	1000	32	150	228982	705 00	735 00	228988	640 00	675 00
Double-Throw System					Fig. 3			Fig. 4		
100	100	150	24	37	228989	405 00	445 00	228995	340 00	380 00
200	150	200	24	37.5	228990	435 00	470 00	228996	365 00	405 00
200	200	300	24	50	228991	440 00	480 00	228997	370 00	415 00
400	300	500	24	75	228992	500 00	545 00	228998	445 00	495 00
400	400	600	24	100	228993	640 00	710 00	228999	565 00	620 00
600	600	1000	32	150	228994	790 00	850 00	229000	725 00	790 00

Order by Style Number

TYPE JD 3-WIRE D.C. PANELS—Continued

FEEDER PANELS WITH FUSE PROTECTION

To control one or more feeder circuits

Schedule of Apparatus

One switchboard panel.

Per circuit—

One 3-pole type A knife switch.

Three enclosed fuses with holders (mounted on rear of panel for Figs 1 and 2).

FIG. 1

FIG. 2

FIG. 3

Fig. No.	Ampere Capacity Circuit	Panel Width Inches	No. Circuits Controlled	Panel Style No.	List Price: Individual Operation	List Price: Bus-Bar Operation
1	30	16	10	179383	$ 420 00	$ 445 00
1	60	16	5	179384	275 00	295 00
1	100	16	4	179385	280 00	305 00
1	200	16	3	179386	355 00	365 00
1	300*	16	3	179387	470 00	495 00
1	400	16	3	179388	565 00	590 00
1	30	20	15	179389	625 00	655 00
1	60	20	10	179390	470 00	495 00
1	100	20	8	179391	525 00	545 00
1	200	24	6	179392	595 00	625 00
1	300*	24	6	179393	875 00	915 00
1	400	24	6	179394	1080 00	1120 00
2	30	16	6	179395	345 00	380 00
2	60	16	3	179396	220 00	250 00
2	100	16	2	179397	225 00	245 00
2	200	16	2	179398	280 00	310 00
2	300*	16	2	179399	415 00	460 00
2	400	16	2	179400	470 00	515 00
2	30	20	9	179401	460 00	510 00
2	60	20	6	179402	380 00	415 00
2	100	20	4	179403	380 00	425 00
2	200	24	4	179404	500 00	540 00
2	300*	24	4	179405	755 00	820 00
2	400	24	4	179406	860 00	945 00
3	30	16	8	179407	335 00	360 00
3	60	16	4	179408	205 00	215 00
3	100	16	3	179409	210 00	225 00
3	200	16	2	179410	200 00	220 00
3	300*	16	2	179411	290 00	315 00
3	400	16	2	179412	350 00	370 00
3	30	20	12	179413	485 00	520 00
3	60	20	8	179414	400 00	450 00
3	100	20	6	179415	380 00	430 00
3	200	24	4	179416	365 00	410 00
3	300*	24	4	179417	545 00	575 00
3	400	24	4	179418	665 00	705 00

*Capacity of switch is 400 amperes, fuses 300 amperes.
Approximate weight, boxed, 500 pounds.

FEEDER PANELS WITH CIRCUIT-BREAKER PROTECTION

To control one or more feeder circuits

Schedule of Apparatus

For Fig. 1

One switchboard panel.

*One 2-pole type CD or CC circuit-breaker.

One 3-pole single-throw type A knife switch.

For Fig. 2

One switchboard panel.

*One 2-pole type CD or CC circuit-breaker.

One 3-pole double-throw type A knife switch.

For Fig. 3

One switchboard panel.

*Three 3-pole CD or CC circuit-breakers having two trip coils and with independently closing poles, the neutral pole closing first.

FIG. 1

FIG. 2

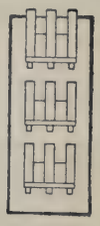


FIG. 3

*Type CC circuit-breaker will be furnished on 400-ampere panels.

(Continued on next page)

Order by Style Number

TYPE JD 3-WIRE D.C. PANELS—Continued

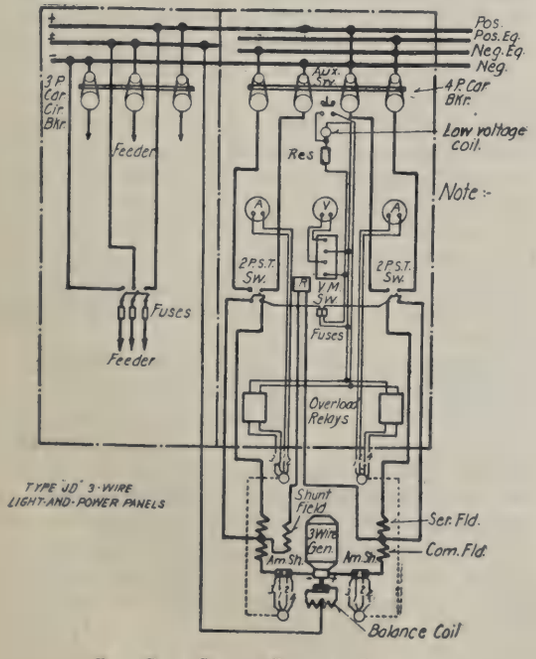
FEEDER PANELS WITH CIRCUIT-BREAKER PROTECTION—Continued.

Fig. No.	Ampere Capacity Circuit	Panel Width Inches	Panel Style No.	List Price Individual Operation	List Price Bus-Bar Operation
1	30	16	179419	$150 00	$170 00
1	60	16	179420	155 00	175 00
1	100	16	179421	165 00	185 00
1	150	16	179422	185 00	205 00
1	200	16	179423	190 00	210 00
1	300	16	179424	220 00	240 00
1	400	16	179425	335 00	355 00
2	30	16	179426	170 00	205 00
2	60	16	179427	175 00	210 00
2	100	16	179428	185 00	220 00
2	150	16	179429	210 00	250 00
2	200	16	179430	215 00	255 00
2	300	16	179431	265 00	310 00
2	400	16	179432	390 00	425 00
3	30	20	179433	455 00	475 00
3	60	20	179434	460 00	480 00
3	100	20	179435	470 00	495 00
3	150	20	179436	530 00	570 00
3	200	20	179437	535 00	575 00
3	300	20	179438	580 00	615 00
3	400	24	179439	970 00	1000 00

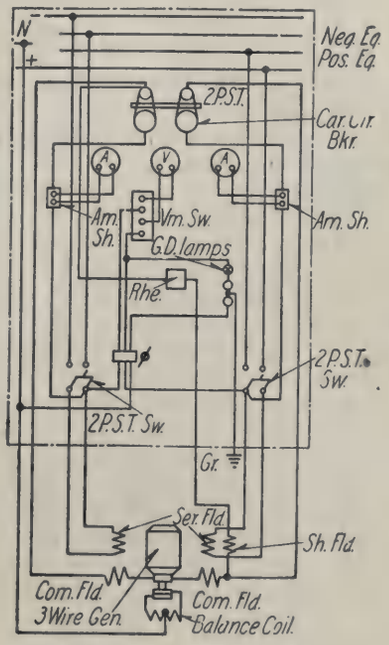
Approximate weight, boxed, 500 pounds.

Order by Style Number

DIAGRAMS OF TYPICAL CONNECTIONS



Four-Pole Circuit-Breaker Protection



Two-Pole Circuit-Breaker Protection

TYPE JD ARC-WELDING PANELS

General—Welding by means of the electric arc is accomplished by drawing an arc between a metal or carbon electrode of an electric circuit, and the metals to be welded. The electrode is usually the negative terminal of the circuit, whereas the metal to be welded is the positive terminal. Direct current is commonly used for arc welding, as it requires less current than alternating for the same welding effect and also gives the better results.

Arc welding is divided into two commercial processes: Carbon, or Graphite, Electrode Process, in which the arc is drawn between metal to be welded and a carbon, or graphite, electrode; and the Metal Electrode Process, in which the arc is drawn between metal to be welded and a metal electrode.

The current for arc welding may be obtained from any convenient direct-current source, although it is commonly taken from a motor-generator set. Several welding circuits can be connected to one generator circuit, the number depending on the capacity of the generating equipment and on the number of operators working at any one time.

Where only one welding circuit is connected to the generator, both the generator circuit and the welding circuit may be controlled from a single switchboard panel, which is known as a **combination control panel,** or an individual generator panel may be used to control the generator and a separate outlet panel to control the welding circuit. Where several welding circuits are connected to one generator circuit, the generator may be controlled either from a separate generator panel or from a combination control panel; in the latter case one of the welding circuits is connected to the combination panel and the remainder to outlet panels, while in the former case an outlet panel must be provided for each welding circuit.

Arc-welding switchboard panels designed for controlling the generator and welding circuits of stationary electric-arc-welding equipments are listed in the following pages.

All equipment listed is for a **service voltage of 60 volts,** which is standard. Panels and resistors, however, can be supplied for 75-volt service when desired at a slight increase in price.

Portable Equipments—Westinghouse arc-welding equipments in capacities of 150, 300, and 500 amperes can also be supplied for portable service when required. For this service, equipments are modified so as to reduce weight and size, and are mounted on trucks. See Catalogue No. 30, "Westinghouse direct currrent Motors and Generators."

Application—The main control panels listed are of two general classes: The **combination generator-and-welding panels,** arranged for the control of the generator and one welding circuit; and the **generator panels,** arranged for the control of the generator only and requiring separate welding outlet panels.

COMBINATION GENERATOR AND WELDING PANEL WITH PANEL OUTLET

The **welding panel outlets** listed are of four different forms depending on the nature of the work for which they are required: (a) Panels for metal electrode work exclusively; (b) light combination panels for metal and light graphite electrode work; (c) panels for graphite work exclusively; and (d) heavy combination panels for metal and heavy graphite work.

The graphite electrode process is in general best adapted for cutting metal, and for use on the heavier and rougher classes of work, that is, where the weld is large and where strength is not of first importance.

The metallic electrode process finds its greatest use on the finer grades of work, that is, where the welds are small or the strength is of prime importance, or where the maximum localization of heat is required.

Capacity—The combination generator-and-welding panels listed range in capacities from 150 amperes to 1000 amperes for the generator equipment and up to 750 amperes for the welding equipment. On the 1000-ampere combination panel the control for the welding circuit is of 750 amperes capacity; on all other combination panels the control for the welding circuit is of the same capacity as the generator circuit. The separate generator panels are listed for capacities ranging from 150 to 1000 am-

TYPE JD ARC-WELDING PANELS—Continued

peres; the outlet panels are listed for capacities of 200, 350 and 600 amperes.

Panel Construction—Each panel consists of a single section, 48 inches high by 16, 20 or 24 inches wide, and 1½ inches thick, thick ⅜-inch bevels on front edges, except the metal-electrode outlet panel, which is 36 inches high. The panels are mounted on 1¼-inch type J pipe frames, complete with floor brace, the total height of which is 76⅜ inches.

Automatic Protection—Single-pole carbon circuit-breakers provide automatic overload protection for both the generator and welding circuits.

Panel Style Numbers include the frame, the panel with apparatus mounted thereon according to schedules given, and necessary details and connections. The metal electrode holders and shield or mask are not included in the style number but are included in the list price and will be furnished. See also Instructions for Ordering.

CLASS I COMBINATION GENERATOR-AND-WELDING PANELS

To control one generator and one welding circuit of the same capacity as generator, except the 1000-ampere size, with which control for welding circuit will be 750 amperes capacity.

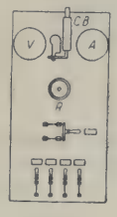


Fig. 1

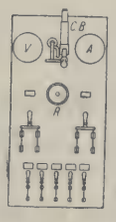


Fig. 2

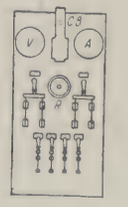


Fig. 3

Schedules of Apparatus

150-Ampere Panel (Fig. 1)

One type CD single-pole carbon circuit-breaker.
One type SL ammeter complete with ammeter shunt.
One type SL voltmeter.
One type A knife switch, two-pole single-throw.
Four type A knife switches, single-pole single-throw.
Five card holders.
One drilling for standard Westinghouse tetrapod rheostat mounting.

Apart from panel—

One welding resistor.
One metal electrode holder.
One shield.

300-Ampere Panel (Fig. 2)

One type CD single-pole carbon circuit-breaker.
One type SL ammeter complete with ammeter shunt.
One type SL voltmeter.
Two type A knife switches, two-pole single-throw.
Five type A knife switches, single-pole single-throw.
One drilling for standard Westinghouse tetrapod rheostat mounting.
Seven card holders.

Apart from panel—

One welding resistor.
One graphite electrode holder.
One mask.

500, 750, and 1000-Ampere Panels (Fig. 3)

One type CC or CA single-pole carbon circuit-breaker.
One type SL ammeter complete with ammeter shunt.
One type SL voltmeter.
Two type A knife switches, two-pole single-throw.
Four type A knife switches, single-pole, single-throw.
Six card holders.
One drilling for standard Westinghouse tetrapod rheostat mounting.

Apart from panel—

One welding resistor.
One graphite electrode holder.
One mask.

Fig.	Ampere Capacity	Type of Circuit-Breaker	Panel Width Inches	Weight Lbs., Boxed	Panel Style No.	List Price
1	150	CD	24	850	285999	$440 00
2	300	CD	24	950	286000	595 00
3	500	CC	24	900	286001	700 00
3	750	CC	24	1300	286002	800 00
3	1000	CA	24	1500	286003	910 00

Order by Style Number

CLASS II—GENERATOR PANELS

150, 300, 500, 750, and 1000 Amperes

Panel to be used for the control of generator

Schedule of Apparatus

FIG. 4

One type CD, CC or CA single-pole carbon circuit-breaker
One type SL ammeter complete with ammeter shunt.
One type SL voltmeter.
One type A knife switch, two-pole single-throw.
One card holder.
One drilling for standard Westinghouse tetrapod rheostat mounting.

Ampere Capacity	Type of Circuit-Breaker	Panel Width Inches	Weight Lbs. Boxed	Panel Style No.	List Price
150	CD	16	550	245939	$310 00
300	CD	16	600	245940	330 00
500	CC	16	650	283128	430 00
750	CC	16	750	283129	500 00
1000	CA	20	800	219843	590 00

WELDING PANEL OUTLETS

Each panel to control welding circuit for one operator on metal or graphite electrode service up to maximum capacity listed below

Schedules of Apparatus

Light Combination and Individual Metal or Graphite Panels (Figs. 5 and 6)

One type CD or CC* single-pole carbon circuit-breaker.
One type A knife switch, two-pole, single-throw.
†Four type A knife switches, single-pole, single-throw.
†Five card holders.

Apart from panel—

One welding resistor.
Electrode holder.
One metal electrode holder with type A panel.
One graphite electrode holder with type B panel.
One metal and one graphite electrode holder with panel Style No. 286005.
One mask.

Heavy Combination Panel (Fig. 7)

One type CC single-pole carbon circuit-breaker.
One type A knife switch, two-pole, single-throw.

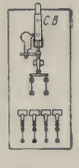


FIG. 5

FIG. 6

FIG. 7

Four type A knife switches, single-pole, double-throw.
Nine card holders.

Apart from panel—

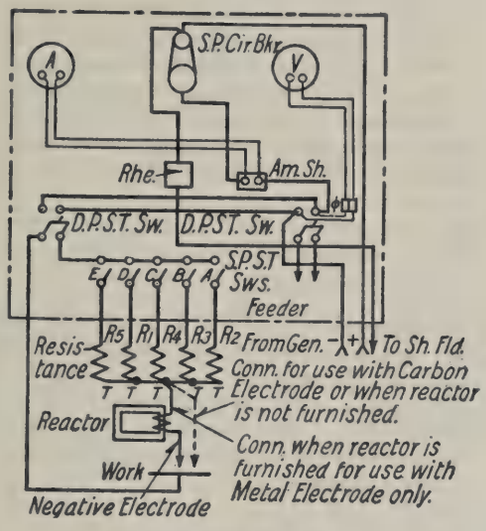
One welding resistor.
One metal electrode holder.
One graphite electrode holder.
One mask.

*Type CC breaker is supplied on 600-ampere panels.
†Type B panel has five S.P.S.T. switches and six cardholders.

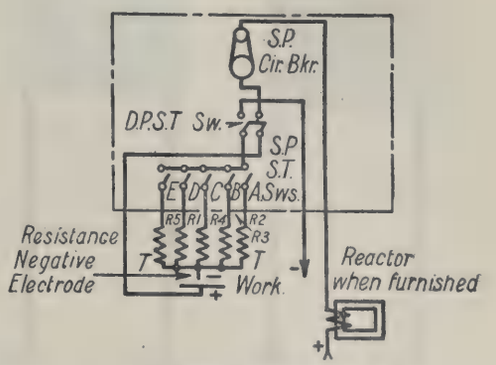
Fig	Type	Ampere Range—Metal Electrode	Ampere Range—Graphite Electrode	Number of Steps—Metal Electrode	Number of Steps—Graphite Electrode	Panel Width Inches	Weight Lbs., Boxed	Panel Style No.
5	A	80–170	.....	15	..	16	650	286004
6	B	80–170	200–350	15	14	16	1000	286005
6	C	.....	200–600	..	6	16	1125	286006
7	D	80–170	200–600	15	14	16	1550	286007

Order by Style Number

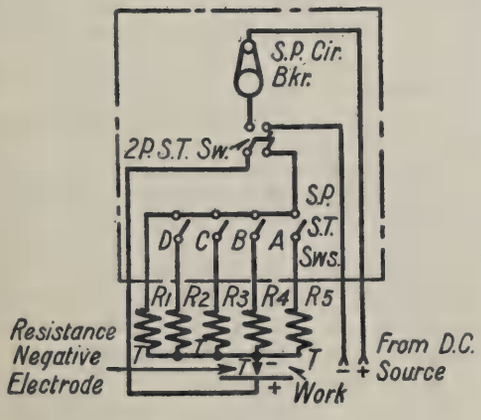
DIAGRAMS OF TYPICAL CONNECTIONS



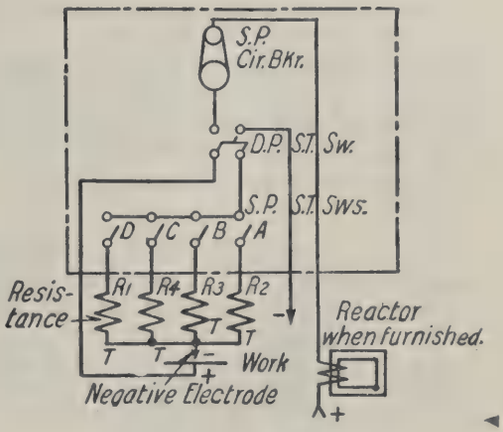
COMBINATION GENERATOR-AND-WELDING PANEL



COMBINATION CARBON-AND-METAL ELECTRODE WELDING PANEL



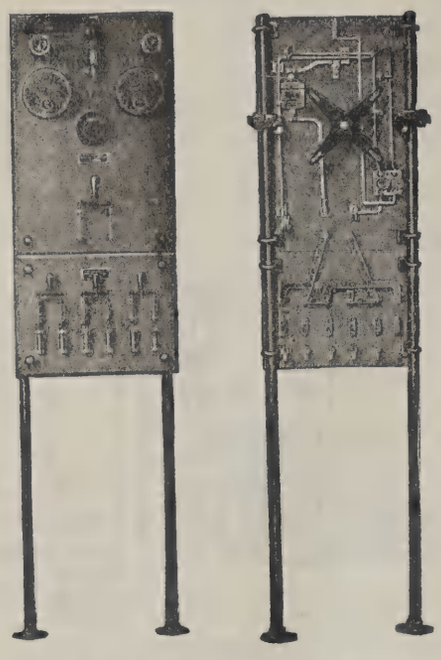
CARBON ELECTRODE WELDING PANEL



METAL ELECTRODE WELDING PANEL

TYPE KD GENERATOR AND FEEDER PANELS

DIRECT-CURRENT



TYPE KD GENERATOR AND FEEDER PANELS

Application—Type KD generator and feeder panels are designed to provide a complete switchboard in a single panel of one or two sections to control one generator with not more than four feeders. They are intended for small isolated plants operating direct-current systems of 250 volts or less.

Capacity—The capacity of a panel is limited to 400 amperes for the generator; and 200 amperes for each of two feeder circuits, or 60 amperes for each of four feeder circuits. Each panel forms a complete switchboard and is not designed to have panels added to it.

Construction—The panel consists essentially of either one or two sections 1 inch thick, 16 inches wide, with ¼-inch bevel on front edges; the upper section being 24 or 36 inches high, and the lower section 12, 18 or 24 inches high. The upper section contains the apparatus for the control of the generator and the lower section contains that for the control of the various feeder circuits.

Type Designation—In the make-up of the type designation, the letter K signifies that the panel is mounted on a type K tubular frame, and the letter D indicates that the panel is designed for direct-current application.

Various sizes of the type KD panels are designated by the addition of sub-numbers to the type letters as follows:

Type KD panel is 36 inches high.
Type KD-1 panel is 48 inches high (36 + 12).
Type KD-2 panel is 54 inches high (36 + 18).
Type KD-3 panel is 60 inches high (36 + 24).
Type KD-4 panel is 24 inches high.
Type KD-5 panel is 36 inches high (24 + 12).
Type KD-6 panel is 42 inches high (24 + 18).
Type KD-7 panel is 48 inches high (24 + 24).

The frame is light and simple, being made from ¾-inch gas-pipe uprights which are screwed into floor flanges. The total height of the frame is 64 inches. It is fitted with wall-brace ends for ¾-inch gas-pipe. Pipe and foot for bracing the frame to the floor or wall can be supplied at a small additional price.

Switches—Type A single-throw knife switches are used for generator and feeder circuits. When it is desired to provide for a separate source of power, the generator panel can be furnished with a double-throw switch at an additional price. This switch will be mounted horizontally instead of vertically.

Automatic protection is provided for the generator circuit by: (1) a single-pole type F carbon circuit-breaker up to 75 amperes, (2) type CD carbon circuit-breaker, or by (3) enclosed fuses mounted on the front of the panel. Feeder circuits are protected by enclosed fuses mounted on the front of the panel.

Shipment—Any type KD panel listed, or combination of a generator panel with its feeder sub-section, can be shipped within 15 days from receipt of order at the factory. It should be noted that this promise of delivery applies only when a standard panel, without changes or additions, is ordered. Drawings will not be furnished for approval.

Connections—The main connections on the back of the panel are of bare copper strap and are cut, bent, and put in place before shipment.

Wall and Floor Brace Additions—The pipe and foot for floor or wall brace, Style No. 253482, can be secured at a list price of $2.50. Two are required per panel.

Wall Brackets—If it is desired to mount the panel on the wall, four wall brackets, Style No. 116313, should be ordered and the type K frame omitted at a deduction of $1.50 from the list price.

Refer also to catalogue of "Westinghouse Switchboard Accessories" under "Switchboard Frames" for more complete details of frame.

Style number includes the panel and frame with the schedule of apparatus listed, including necessary details and connections for operating the panel.

Orders for panels, where any variation from the style number panels is required, must be accompanied by a **Data Sheet, Form No. 2724,** properly filled out.

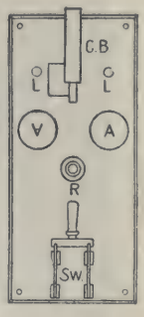
See also Instructions for Ordering.

GENERATOR PANELS

With Circuit-Breaker Protection

Schedule of Apparatus

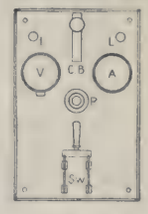
*One carbon circuit-breaker, single-pole; type CD for type KD panel, type F for type KD-4 panel.
One voltmeter, type FW.
One ammeter, type FW.
One ground detector outfit.
Drilling only, for Westinghouse tetrapod rheostat mounting.
One knife switch, type A two-pole, single-throw.
*Type CC circuit-breakers will be furnished on 400-ampere capacity panels.



TYPE KD

Ampere Capacity				50 Volts		125 Volts		250 Volts	
Panel	Switch	Circuit-Breaker	Ammeter	Style No.	List Price	Style No.	List Price	Style No.	List Price
Type KD†—36″ x 16″ x 1″									
25	30	25	50	191718	$170 00	268639	$172 00	268646	$174 00
50	60	50	75	191719	175 00	268640	177 00	268647	179 00
100	100	100	150	191720	184 00	268641	186 00	268648	188 00
150	200	150	200	.....	190 00	268642	192 00	268649	194 00
200	200	200	300	191721	195 00	268643	200 00	268650	205 00
300	400	300	500	191722	230 00	268644	235 00	268651	240 00
400	400	400	600	191723	275 00	268645	280 00	268652	285 00

Approximate weight, boxed, 175 pounds.



TYPE KD-4

Type KD-4†—24″ x 16″ x 1″									
12	30	12½	25	191714	140 00	268653	$142 00	268657	$144 00
25	30	25	50	191715	145 00	268654	147 00	268658	149 00
50	60	50	75	191716	150 00	268655	152 00	268659	154 00
75	100	75	150	191717	160 00	268656	162 00	268660	164 00

Approximate weight, boxed, 160 pounds.

†See preceding page for type designation when supplied with feeder section.

With Fuse Protection

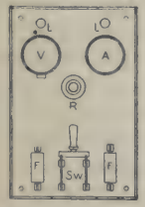
Schedule of Apparatus

One voltmeter, type FW.

One ammeter type FW.

One ground detector outfit.

Drilling only, for Westinghouse tetrapod rheostat mounting.
One knife switch, type A two-pole, single-throw.
Two enclosed fuse blocks and fuses.



TYPE KD-4

Ampere Capacity				125 Volts		250 Volts	
Panel	Switch	Fuses	Ammeter	Style No.	List Price	Style No.	List Price
Type KD-4†—24″ x 16″ x 1″							
10	30	10	25	268661	$124 00	268669	$125 00
20	30	20	50	268662	125 00	268670	126 00
30	30	30	50	268663	126 00	268671	127 00
50	60	50	75	268664	135 00	268672	136 00
60	60	60	100	268665	138 00	268673	139 00
100	100	100	150	268666	140 00	268674	142 00
150	200	150	200	268667	150 00	268675	152 00
200	200	200	300	268668	160 00	268676	162 00

Approximate weight, boxed, 160 pounds.

Type KD†—36″ x 16″ x 1″								
300	400	300	500	268677	$205 00	268679	$210 00
400	400	400	600	268678	215 00	268680	220 00

Approximate weight, boxed, 200 pounds.

†See preceding page for type designation when supplied with feeder section.

Order by Style Number

FEEDER SECTIONS

For Types KD and KD-4 Generator Panels

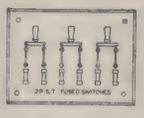
With Fuse Protection—50 to 250 Volts

Schedule of Apparatus

Per Circuit:

One knife switch, type A two-pole, single-throw.

Two enclosed fuse blocks and fuses.



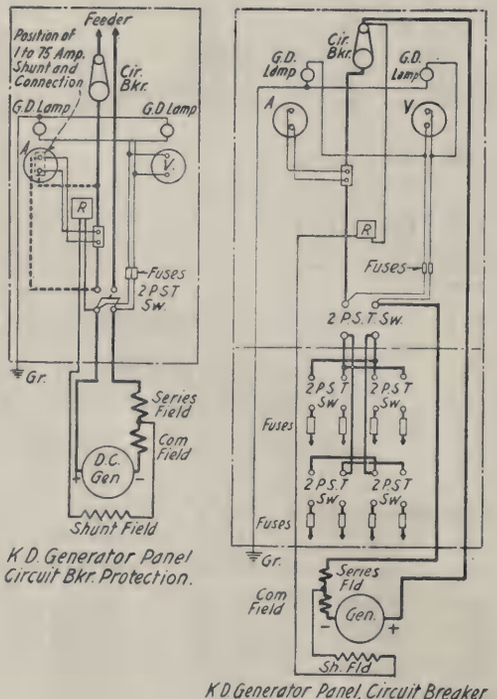
STYLE NO. 177700

Number of Circuits	Ampere Capacity Each Circuit	Ampere Capacity Fused Switch	Height of Section Inches	Style No.	List Price
2	30	30	12	268681	$ 55 00
3	30	30	12	268682	70 00
2	60	60	12	268683	65 00
3	60	60	24	268684	90 00
4	60	60	24	268685	115 00
2	100	100	18	268686	81 00
2	200	200	24	268687	115 00

Approximate weight, boxed, 50 pounds.

Order by Style Number

DIAGRAMS OF TYPICAL CONNECTIONS



K.D. Generator Panel Circuit Bkr. Protection.

K.D. Generator Panel, Circuit Breaker Protection, with Fused Feeders.

K.D. Fused Generator and Feeder Panel

TYPE KD BATTERY CHARGING PANELS

FOR TWO-WIRE SYSTEMS, 50 TO 250 VOLTS

These panels are designed for controlling the charging of batteries used in lighting service and on electric vehicles.

Lighting

One class of panels is intended for use in residences and small isolated plants that have a battery to supply current for lighting and a generator for charging the battery. Only single panels are listed and the capacity of the generator panels is limited to 75 amperes, while the battery panels are limited to a normal capacity of 60 amperes. On single-section panels the limit is 100 amperes for both generator and battery circuits. The circuit-breakers are equipped with reverse-current attachments in addition to the plain overload trip which will open the circuit in case the charging current is interrupted, and thus prevent the discharge of the battery.

When battery-charging apparatus is required with a generator panel, it will be mounted as a lower section of the panel, except when a single-section generator and battery-charging panel is specified.

Three conditions are provided for in charging batteries with these panels.

First, 50-volt generator charging 30-volt battery connected directly to the mains.

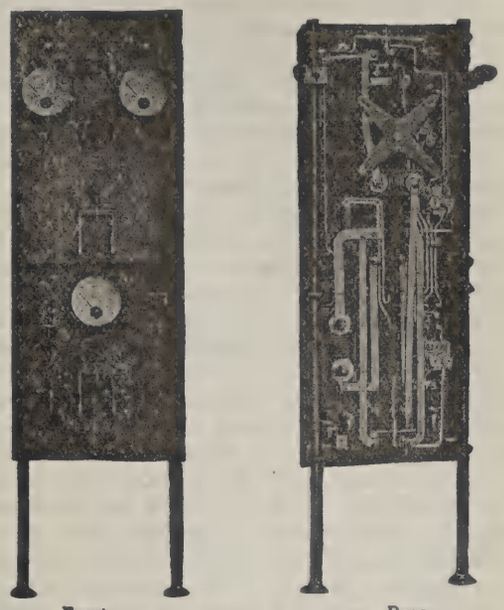
Second, 125-volt generator charging 30-volt battery. The battery is charged through a suitable resistance.

Third, 125-volt generator charging 125-volt battery. The battery, in this case, is charged with two sections in parallel, each section being connected through a suitable charging resistance. A fixed resistance is used for this work, the variation in voltage being taken care of by varying the field of the generator. See diagrams of connections at end of this section.

Charging Rheostats

Style numbers and list prices of the panels do not include any charging rheostats, and these must be ordered separately.

The method of charging by the type KD panel is the constant-potential charging method; that is, the battery is thrown directly on the circuit and allowed to become charged. When the battery and charging-circuit voltages differ sufficiently to produce a charging current of such a value that it may be injurious to the battery, a charging resistance is necessary. The value of the resistance depends on the number of cells in the battery; type of cells (or voltage at beginning of charge and at the end of charge); charging current desired; and the line or generator voltage. A variable resistance, that is, one provided with faceplate and rotating arm, mounted apart from the board can be used to obtain the constant-current method of charging. However, if there are but one generator and one battery circuit, the constant current can be obtained by adjusting the generator-field rheostat.



Front Rear

TYPE KD-4 GENERATOR PANEL WITH TYPE KD-6 CHARGING SUB-PANEL

Where a type KD panel is chosen to control a lighting circuit in addition to generator and battery circuit, the generator voltage must be maintained for the lighting circuit, and consequently a charging resistance is necessary, either of the fixed or variable type.

Electric Vehicle Charging

Electric vehicle charging panels are listed for private service, where one battery is to be charged and the charging current is taken from an outside source. They can, however, be used when the current is furnished by a motor-generator set or engine-driven generator, by adding the field rheostat for the generator to the panel, and in the case of the motor-generator sets by mounting one of the lower sections on the same frame.

Reverse-Current Protection—The reverse-current mechanism furnished with the type F carbon circuit-breaker depends for its action on the sum of the voltage and current-coil fields. The voltage-coil field is the stronger field on small reversal and strong enough at zero-current setting of the reverse-current devices to trip the breaker.

Normally, the field of the voltage coil is opposed to the field of the current coil, but when reversal takes place both coils act together and tripping usually results. Under certain conditions, however, the combined field may not be sufficient to cause tripping, as, for instance, when the voltage on reverse current is low. Good results can be expected only

TYPE KD BATTERY CHARGING PANELS—Continued

when the voltage at reversal is nearly equal to the normal charging voltage or when the reverse current is of sufficient value.

The current coil of the reverse-current mechanism is designed for the same capacity as the circuit-breaker. In case the battery is so small that only a small part of the breaker capacity is required, proper reverse-current protection is not assured unless a special combination of breaker and reverse-current attachment is made. In such a case, the matter should be referred to the Company.

For more detailed description of Reverse-Current and Under-Voltage Trip, refer to section on Type F Carbon Circuit-Breakers in catalogue of "Wiring Devices and Carbon Circuit-Breakers."

Types of Panels—The generator panels listed in the following pages are a modification of the standard type KD generator panels listed in another part of this catalogue, in that the circuit-breaker is equipped with reverse-current trip. The current coil in the relay is designed for the same carrying capacity as the circuit-breaker, and the relay is calibrated to operate with a battery which has the same capacity as the generator, or greater. In case the battery is so small that it requires only a portion of the generator capacity to completely charge it, a special relay or extra switches may be required and the matter should be referred to the Works. Lower sections are provided which correspond in type to the lower sections regularly used with the type KD generator panels.

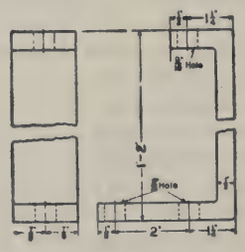
The lower sections are known as KD-6 and KD-7; the former is for use with 30-volt batteries, and the latter with 125-volt batteries. These when combined with the generator panel form the complete panel for controlling generator and battery for private service.

A modification of the above combinations can be furnished. These differ in that only one panel section is used and no ammeter is used in the generator circuit.

All panels upon which fuses are specified are fitted with enclosed fuses and main switches which conform to the requirements of the National Board of Fire Underwriters.

Wall Brackets—If it is desired to mount the panel on the wall, four wall brackets, Style No. 116313, should be ordered, and the type K frame omitted at a reduction of $1.50 from the list price.

Shipment—Any panel listed, or combination of a generator panel with its battery charging sub-section can be shipped within 15 days from receipt of order at the factory. It should be noted that this prompt



WALL BRACKET STYLE NO. 116313

delivery applies only to a standard panel without changes or additions. Drawings will not be furnished for approval.

Style number includes the panel and frame with the schedule of apparatus listed, including necessary details and connections for operating the panel.

Also see Instructions for Ordering.

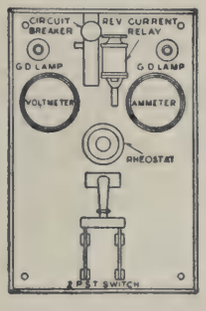
TYPE KD-4 GENERATOR PANELS FOR BATTERY CHARGING

50 to 125 Volts

These panels are for private service for control of the generator where a single battery is to be charged. They are especially suitable for use in connection with engine-driven generators, as the circuit-breaker is equipped with a reverse-current release which prevents the discharge of the battery in case the charging current is interrupted.

Schedule of Apparatus

One type FW ammeter.
One type FW voltmeter.
One type F circuit-breaker with reverse-current attachment.
One type A double-pole, single-throw knife switch.
One drilling only for Westinghouse rheostat mounting.
Two ground detector lamp sockets with lamps.



Ampere Capacity: Switch	Ampere Capacity: Circuit-Breaker	Ammeter	Style No.	List Price
50-Volt Generator for 30-Volt Battery				
24" x 16" x 1"				
30	12½	25	191760	$170 00
30	25	50	191761	175 00
60	50	75	191762	180 00
100	75	150	191763	185 00
125-Volt Generator for 125-Volt Battery				
24" x 16" x 1"				
30	12½	25	191768	172 00
30	25	50	191769	177 00
60	50	75	191770	182 00
100	75	150	191771	187 00

Approximate weight—boxed, 300 lbs.

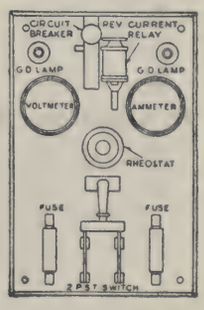
TYPE KD-4 GENERATOR PANELS FOR BATTERY CHARGING AND LIGHTING

125 Volts

These panels are for private service for the control of the generator where a single 30-volt battery is to be charged from a 125-volt generator, and a 125-volt lighting circuit to be maintained in addition. The apparatus to control the 30-volt battery circuit is listed on the next page under KD-6 sub-panels. They are especially suitable for use in connection with the engine-driven generator, as the circuit-breaker is equipped with a reverse-current release which prevents the discharge of the battery in case the charging current is interrupted.

Schedule of Apparatus

One type FW voltmeter.
One type FW ammeter.
One type F circuit-breaker with reverse-current attachment.
One type A double-pole single-throw knife switch.
One drilling only for Westinghouse rheostat mounting.
Two enclosed fuse holders and fuses.
Two ground detector lamp sockets and lamps.



Ampere Capacity: Switch	Ampere Capacity: Circuit-Breaker	Ammeter	Fuse	Style No.	List Price
125-Volt Generator for 30-Volt Battery					
24" x 16" x 1"					
30	12½	25	12	191764	180 00
30	25	50	25	191765	182 00
60	50	75	50	191766	185 00
100	75	150	75	191767	200 00

Approximate weight—boxed, 300 lbs.

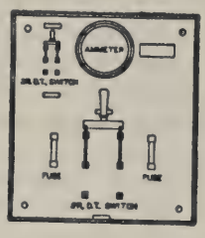
Order by Style Number

TYPE KD BATTERY CHARGING PANELS—Continued

TYPE KD-6 SUB-PANELS FOR BATTERY CHARGING

For Use With Generator Panels in Charging 30-Volt Batteries

These panels are for use with the KD-4 charging and lighting panels shown on the preceding page, and for the control of the 30-volt battery and 30-volt lighting circuits.



Schedule of Apparatus

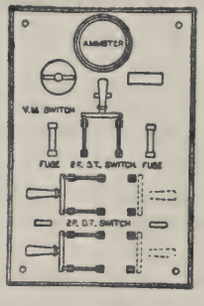
One type FW double-reading ammeter.
One type A double-pole double-throw knife switch.
One double-pole double-throw voltmeter switch.
Two enclosed fuse holders and fuses.

Ampere Capacity				
Fuses	Switch	Ammeter 18" x 16" x 1"	Style No.	List Price
10	30	15–0– 35	191772	$105 00
15	30	25–0– 50	191773	108 00
25	30	50–0–100	191774	110 00
30	30	50–0–100	191775	112 00
40	60	75–0–125	191776	115 00
50	60	100–0–150	191777	118 00
60	60	100–0–150	191778	120 00

Approximate weight—boxed, 100 lbs.

TYPE KD-7 SUB-PANELS FOR BATTERY CHARGING

For Use With 125-Volt Generator Panels in Charging 125-Volt Batteries



These panels are used in connection with KD-4 charging and lighting panels shown on the preceding page, and for the control of the 125-volt battery and 125-volt lighting circuits.

Schedule of Apparatus

One type FW double-reading ammeter.
Two type A double-pole double-throw knife switches.
One type A double-pole single-throw knife switch.
One four-circuit voltmeter switch.
Two enclosed fuse holders and fuses.

Ampere Capacity				
Fuses	Switches	Ammeter 24" x 16" x 1"	Style No.	List Price
10	30	15–0– 35	191779	$165 00
15	30	25–0– 50	191780	168 00
25	30	50–0–100	191781	170 00
30	30	50–0–100	191782	172 00
40	60	75–0–125	191783	180 00
50	60	75–0–125	191784	182 00
60	60	100–0–150	191785	184 00

Approximate weight—boxed, 200 lbs.

Order by Style Number

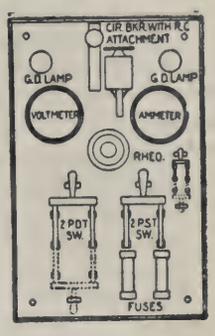
TYPE KD SINGLE-SECTION BATTERY CHARGING PANELS

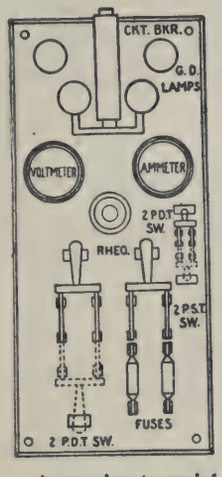
These type KD single-section battery charging panels are essentially the same as the panels previously described, except that the generator ammeter is omitted and all apparatus mounted on one panel.

Charging Battery in One Section

Schedule of Apparatus

One type FW double-reading ammeter.
One type FW voltmeter.
One type F circuit-breaker with reverse-current attachment.
One double-pole double-throw voltmeter switch.
One type A double-pole double-throw knife switch.
One type A double-pole single-throw knife switch.
Two enclosed fuse holders and fuses.
Two ground detector lamp sockets with lamps.
One drilling only for Westinghouse rheostat mounting.





Generator Switch	Battery Switch	Ampere Capacity: Circuit-Breaker	Fuse	Ammeter	Style No.	List Price
50-Volt Generator for 30-Volt Battery						
		24" x 16" x 1"				
30	30	25	15	25–0– 50	191989	$210 00
60	60	50	50	50–0–100	191990	215 00
60	60	75	60	75–0–125	191991	220 00
		36" x 16" x 1"				
100	100	100*	100	150–0–150	191992	265 00
125-Volt Generator for 30-Volt Battery						
		25" x 20" x 1"				
30	30	12½	12	15–0– 35	192002	215 00
30	30	25	25	20–0– 50	192003	220 00
30	30	25	25	50–0–100	192004	230 00
60	60	50	40	50–0–100	192005	235 00
60	60	50	50	75–0–125	192006	236 00
60	60	50	60	75–0–125	192007	238 00
60	60	75	60	75–0–125	192008	240 00
60	60	75	60	100–0–150	192009	245 00
100	60	75	60	100–0–150	192010	250 00

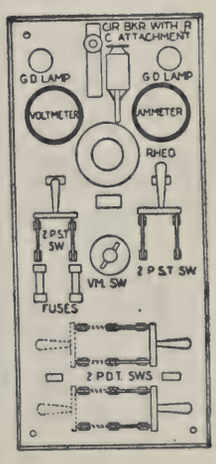
*Circuit-breaker type CD instead of type F.

Approximate weight—boxed, 300 lbs.

Charging Battery in Two Sections

Schedule of Apparatus

One type FW double-reading ammeter.
One type FW voltmeter.
One type F circuit-breaker with reverse-current attachment.
One four-circuit voltmeter switch.
Two type A double-pole double-throw knife switches.
Two type A double-pole single-throw knife switches.
Two enclosed fuse holders and fuses.
Two ground detector lamp sockets with lamps.
One drilling only for Westinghouse rheostat mounting.



Generator Switch	Battery Switch	Ampere Capacity: Line Switch	Circuit Breaker	Fuse	Ammeter	Style No.	List Price
125-Volt Generator for 125-Volt Battery							
			36" x 16" x 1"				
30	30	30	12½	10	15–0– 35	191993	$300 00
30	30	30	25	15	25–0– 50	191994	305 00
30	30	30	25	25	50–0–100	191995	310 00
60	60	60	50	40	50–0–100	191996	315 00
60	60	60	50	40	75–0–125	191997	320 00
60	60	60	50	50	75–0–125	191998	325 00
60	60	60	75	60	75–0–125	191999	330 00
60	60	60	75	60	100–0–150	192000	335 00
100	60	60	75	60	100–0–150	192001	340 00

Approximate weight—boxed, 300 lbs.

Order by Style Number

TYPE KD BATTERY CHARGING PANELS—Continued

TYPE KD ELECTRIC VEHICLE CHARGING PANELS

For Private Service—125-Volt Circuits

These panels are intended for private service where only one battery is to be charged and where the charging current is taken from an outside source. They can, however, be used where the current is furnished by a motor-generator set or engine-driven generator, by adding to the panel, the rheostat for generator, and in the case of motor-generator sets by mounting on the same frame one of the panels shown below.

Schedule of Apparatus

One type FW voltmeter.
One type FW ammeter.
One drilling only for Westinghouse rheostat mounting (if desired).
One double-pole single-throw type A fused switch.
One single-pole over-voltage circuit-breaker.
Two 2-point voltmeter receptacles and one plug.

Number of Cells	Ampere Capacity—Ammeter	Ampere Capacity—Switch	Fuses	Style No.	List Price
	36" x 16" x 1"				
10	75	60	60	191786	$205 00
12	75	60	60	191787	205 00
14	75	60	60	191788	205 00
16	75	60	60	191789	205 00
20	75	60	60	191790	205 00
24	75	60	60	191791	205 00
28	75	60	60	191792	205 00
40	100	100	75	191793	215 00
44	100	100	75	191794	215 00
48	100	100	75	191795	215 00
60	150	200	150	191796	230 00
66	150	200	150	191797	230 00

Approximate weight—boxed, 200 lbs.

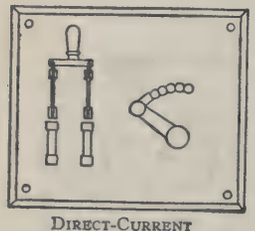
TYPE KD-2 SUB-PANELS FOR MOTOR STARTING

For Electric Vehicle Charging Panels

These panels are used for controlling motor-generator sets.

Schedule of Apparatus

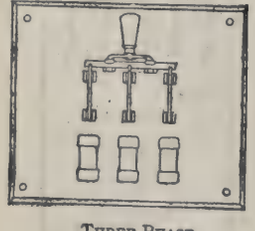
One single-throw type A fused knife switch with enclosed fuses.
One motor starting rheostat, mounting only, for direct-current sub-panels only.



DIRECT-CURRENT

SINGLE-PHASE

TWO-PHASE



THREE-PHASE

Phase	Volts	Amperes, Capacity of Switch	Style No.	List Price
		For Direct-Current 18" x 20" x 1"		
D.C.	125–250	30	80126	$45 00
D.C.	125–250	60	80127	50 00
		For Alternating-Current 18" x 16" x 1"		
1	220	30	80128	45 00
1	220	60	80129	50 00
2	220	30	80130	60 00
2	220	60	80131	65 00
3	220	30	80132	50 00
3	220	60	80133	55 00

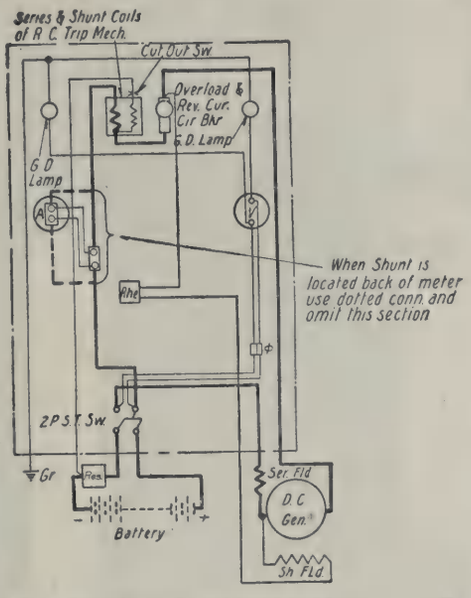
Sub-panels for 500-volt direct-current service and for 440-volt alternating-current service can be furnished.

Approximate weight—boxed, 150 lbs.

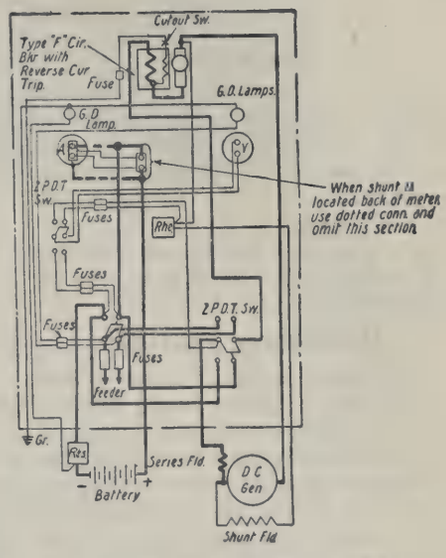
Order by Style Number

TYPE KD BATTERY CHARGING PANELS—Continued

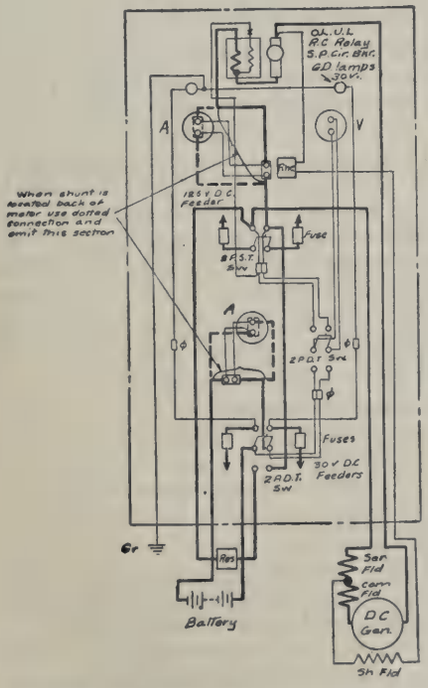
DIAGRAMS OF TYPICAL CONNECTIONS



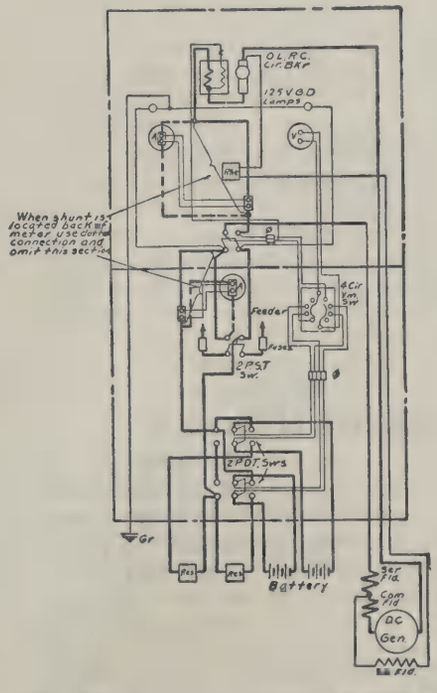
TYPE KD-4 GENERATOR AND BATTERY CHARGING PANEL



TYPE KD SINGLE-SECTION BATTERY CHARGING PANEL CHARGING BATTERY IN ONE SECTION



TYPE KD-4 CHARGING AND LIGHTING GENERATOR PANEL AND TYPE KD-6 SUB-PANEL FOR CHARGING



TYPE KD-4 CHARGING AND LIGHTING GENERATOR PANEL AND TYPE KD-7 SUB-PANEL FOR CHARGING

TYPE SD BATTERY-CHARGING PANELS
For Charging Electric Vehicle Batteries

SECTIONAL TYPE
For 110-Volt D. C. Service

Application

These panels and sections are designed primarily for use in public and private garages where electric vehicle batteries will be charged. The charging rheostats specified are designed for charging batteries recommended by the Society of Automotive Engineers, namely: 40 to 44 cells for lead batteries and 60 to 62 cells for Edison batteries.

Distinctive Features

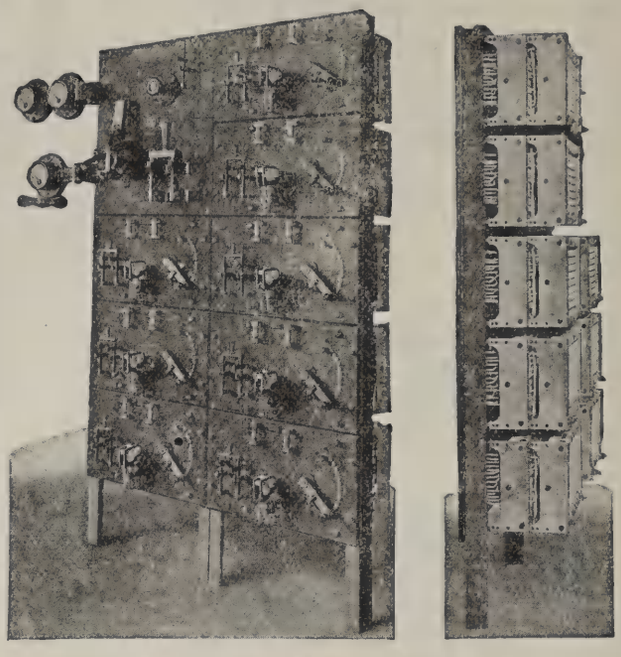
Each panel consists of three or more sections, together with charging rheostats selected from those described in this section. This sectional construction provides a large variety of combinations, thus making an installation very flexible, as the number of charging circuits may be increased at any time after the switchboard has been installed, by the addition of suitable sections and rheostats.

A switchboard built of these sections is very convenient and easy to operate, as the control of a large number of batteries is centralized. The entire equipment is simple to operate and the average garage employee can easily and efficiently attend to the charging of a large number of batteries at one time.

Each battery charging rheostat consists of a resistor of cast iron grids supported on the rear of each panel section between steel end frames with contact buttons and moving arm on the front of the panel section. Bolts through the panel hold the end frames of each charging rheostat to the panel so that the rheostat forms an integral part of the section equipment. By disconnecting the wires connecting the grids to the contact button terminals, the resistor can be easily removed from the panel. With this construction, any rheostat may be readily removed and quickly repaired, in case of accidental injury, or replaced by another rheostat of different characteristics without disturbing the other sections.

Assembly of Sections

The sections of each panel are assembled one above another and securely bolted to a vertical angle iron frame of suitable height. The simplest panel consists of one or more charging sections and a power control section mounted above the charging sections. Swinging brackets at the side of the panel will mount the power section ammeter, if used, and the battery voltmeter and ammeter. It is not advisable to use panels exceeding 84 inches in height,



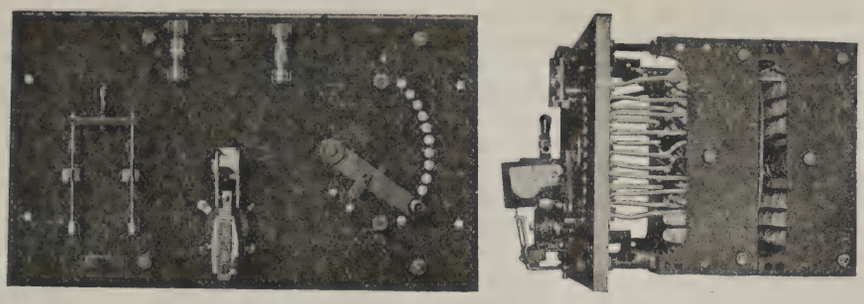
TYPICAL BATTERY-CHARGING SWITCHBOARD

because some of the switching apparatus would be inconveniently high for the operator. A panel not exceeding 84 inches in height permits mounting three charging sections below a generator section or an incoming line section with circuit-breaker protection. A fused-switch incoming line section permits the mounting of four charging sections beneath it. When more sections are required than can be mounted on a frame 84 inches high, they may be arranged in two or more panels of uniform height. Where the number of necessary sections is not sufficient to make all panels the same height, blank sections may be readily added to some of the panels.

The frame will be made of such height that a space of 6½ inches or more will be left between the floor and the lower edge of the bottom section.

Every switchboard or panel which controls one or more direct current generators must be equipped with an individual power control section for each generator. If generators are compound wound and generator control sections with circuit-breaker protection are used then one side of the generator switch will be connected to the equalizer bars; the other side to the negative bus; and the circuit-breaker will be connected in the positive lead. If generator control section provides fuse protection only, then an equalizer switch must be provided.

TYPE SD BATTERY-CHARGING PANELS—Continued



TYPICAL CHARGING PANEL, FRONT AND SIDE

Regulations of National Board of Fire Underwriters

A Rule, incorporated in the National Electric Code, specifies that charging panels located in garages where gasoline is handled must have all spark producing devices mounted 4 ft. or more above the floor. If such devices are mounted less than 4 ft. above the floor, the charging panel must be surrounded by a vapor-proof enclosure, unless the panel is located in a room or enclosure provided for this purpose.

Switchboards or panels controlling several charging circuits will regularly have the switching apparatus mounted less than 4 ft. above the floor and the purchaser will be expected to install the panels as provided for by the Code. In most cases, the simplest method is to mount the board on a concrete platform, 4 ft. high. If the purchaser desires that no spark-making device be mounted less than 4 ft. above the floor, such instructions should be furnished the Company. A switchboard for control of a given number of charging circuits under these conditions will be composed of more panels than would be required otherwise.

Regulations of the Safety Code

The arrangement of the panel sections, and combination of them, is such as to provide a maximum of protection to the operator. Power control sections employing carbon circuit-breakers will be located at the top of the panel. The contactors on the charging sections are provided with blow-out coil and shield. The operator is thus protected against possible injury due to moving parts or to the arcing of automatic devices.

It is understood, however, that purchaser's operator is a competent operator as defined by the safety code and that purchaser will install any grill work, cage, or other means to keep unauthorized persons away from the switchboard.

Construction of Sections

The various sections are made up of slabs 1 inch thick, ¼ inch bevel. These sections will be of two heights, 14 inches and 28 inches, depending upon the apparatus mounted on the section, as per schedules hereinafter given.

Assembly and Connection of Panels

Each panel is completely assembled at the Works, with all copper detail connections properly formed and fitted. All connections between sections are designed to facilitate the addition of sections to the panels at a later date.

Each panel is furnished complete and forms a unit including framework and sockets for wall braces. Braces, however, are not included.

When horizontal bus-bars for connecting two or more panels are required, these will be supported from the studs of the apparatus, or if horizontal bus-bars are of large capacity, brackets will be furnished for their support.

Section Schedules

Following are the various sections listed:

- Charging Sections
  - With magnetically operated switch — Schedule 1.
  - Without magnetically operated switch — Schedule 2.
- Generator Control Section
  - With circuit breaker protection. Schedule 3.
  - With fused switch
    - With low voltage relay switch—Schedule 4.
    - Without low voltage relay switch—Schedule 5.
- Line Control Section
  - With circuit breaker protection. Schedule 6.
  - With fused switch
    - With low voltage relay switch—Schedule 7.
    - Without low voltage relay switch—Schedule 8.
- Ampere Hour Meter Section. Schedule 9.
- Bracket Apparatus (Battery Voltmeter and Ammeter). Schedule 10.
- Bracket Apparatus (Generator Ammeter and Ground Detector). Schedule 11.

Amperehour Meter Sections

Amperehour meter sections are equipped with amperehour meters of the auto type, with a zero contact reset device and variable resistor element. The meter is designed so that it will run "slow."

when the charging current of a battery passes through it, the speed being adjustable to approximately compensate for the charging efficiency of any battery. When a given number of amperehours for which the meter has been set have been supplied to the battery, the pointer will again be at the zero position and will close the zero contact; this will cause the contactor in the circuit to open, thus terminating the charge. Therefore to charge a battery, it is only necessary to set the meter pointer at the amperehours, as previously discharged from the battery, and when this number of amperehours (automatically corrected for charging efficiency by the resistor element of the meter) have been returned to the battery it will be automatically disconnected.

Each amperehour meter section will be regularly furnished, drilled for two amperehour meters. When only one amperehour meter is to be used the drilling for the second amperehour meter will be provided with plugs to cover the drilling. Each amperehour meter section, therefore, will be designed for use with two charging circuits, the amperehour meter mounted at the left hand of the section will be intended for use with the charging section mounted immediately above, and the amperehour meter mounted at the right hand side of the section will be intended for use with the charging section mounted immediately below.

When amperehour-meter sections are used, for the purpose of automatically terminating the charge of a battery, it is necessary to use charging sections, employing a contactor (see Schedule 1).

When an order is placed for these sections the Company should be advised the amperehour calibration desired for each meter, otherwise these will be furnished calibrated as deemed best by the Company.

Field Rheostats for Direct-Current Generators

Each power control section to be used for the control of a direct-current generator is scheduled with drilling for a Westinghouse field rheostat mounting of the switchboard tetrapod type.

Ground Detector Outfit

Each switchboard that controls a source of power such as direct-current generator must be equipped with a ground detector outfit. For such panels, two 110-volt incandescent lamps are furnished and are mounted with the generator ammeter on the swinging bracket. Each of the lamps is connected between one side of the line and ground, thus forming a continuous indicator. Under normal conditions each lamp will glow red due to the fact that it is operating on about one-half normal voltage. If the positive line becomes grounded, the lamp connected to that line will grow dim or cease to glow at all, while the other lamp will increase in brilliancy. If the negative side is grounded, the order of brilliancy is reversed. When power is received from incoming direct-current lines the lamps are supplied in order that grounds on batteries may be detected.

Limitation of Direct-Current Power Control Section

When a direct-current power control section is required having a greater capacity than that of the largest direct-current power control section scheduled, it will be necessary to select a separate 125-volt panel from the catalogue section covering type GD panels. To make all panels of uniform height, it will be necessary in most cases to add blank sections to one or more of the charging panels, or to increase the height of the generator panels.

Automatic Protection

Plain overload protection is regularly furnished for all sections. For this purpose there is furnished for each charging circuit a National Electrical Code fuse holder and enclosed fuse for each side of the circuit.

To protect the battery ammeter against overload, a fuse is provided and is connected between the battery ammeter bus-bar and the main negative bus-bar. This fuse is regularly mounted on a bracket on the rear of the panel.

When it is desired to use two or more battery ammeters independently, each ammeter must be protected by its own fuse.

If each charging circuit is to be protected against reversal of current, it is necessary to select charging sections as per Schedule No. 1 and power control sections either as per Schedules No. 3 and 6 or as per Schedules No. 4 and 7.

Power control sections scheduled with circuit-breaker protection (Schedules 3 and 6) are regularly furnished with a low-voltage release mechanism, attached to each circuit-breaker to protect the source of power against reversal of current. When this circuit-breaker opens, due to reversal of current, the auxiliary contacts with which the circuit-breaker is supplied will open all charging circuits which are provided with magnetically operated switches.

In case power control sections (Schedules 4 and 7) equipped with fuse switch protection and with the low-voltage relay switch are used, the reversal of current will cause the low-voltage relay switch to open and thereby open all the charging circuits, if charging sections, schedule No. 1, are used.

The low-voltage coil of the carbon circuit-breaker and of the low-voltage relay switch will be suitable for 115 volts D. C. In case the generators are driven by A. C. induction motors, it is possible to obtain A. C. low-voltage coils, so that on failure of the A. C. power the low-voltage relay switch and carbon circuit-breaker will be tripped.

However, when several generators operate in parallel and obtain their power from separate sources it will be necessary to use reverse-current

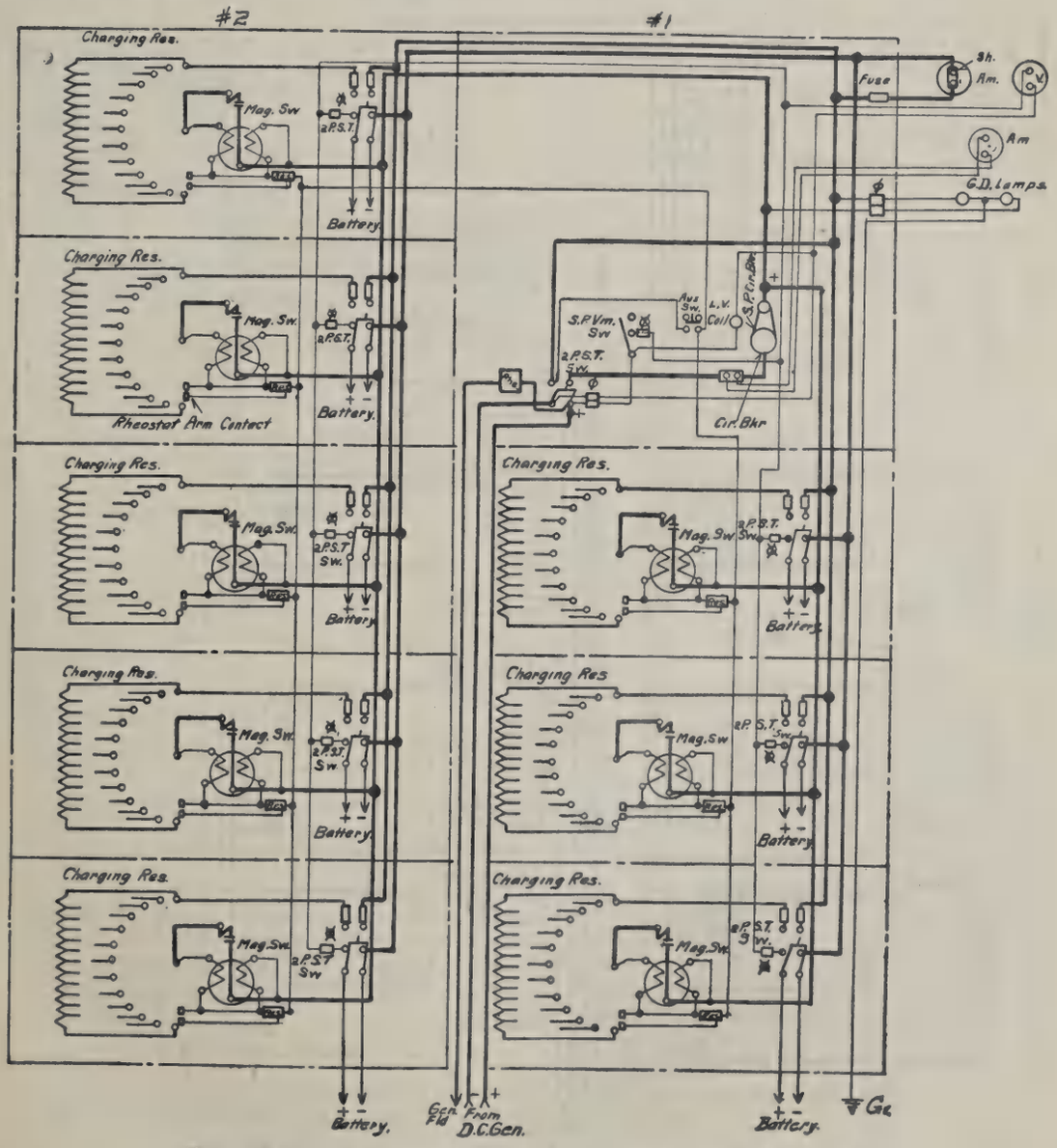
TYPE SD BATTERY-CHARGING PANELS—Continued

relays, in order to insure absolute protection against the occurrence of reverse current.

From the battery standpoint, it is very desirable to have battery circuits protected against reverse current. If only the generator or main circuit is protected against reverse current, the batteries remain connected in parallel to the bus-bars (after the circuit-breaker opens). Therefore the batteries having the highest terminal voltage will discharge into the other batteries connected to the system.

Operation and Setting of Low-Voltage Release Mechanism—The use of the low-voltage release mechanism, as part of the circuit-breaker equipment, or the use of the low-voltage relay switch, is adaptable for protection against the reversal of current from a storage battery, because at ordinary temperatures (from 60° to 90° F.) the voltage of a good battery discharging at the normal rate is always lower than the minimum voltage required to start the charging of that battery at the normal starting rate. Furthermore, the charging resistance connected in series with the battery further reduces the voltage across the coil of the circuit-breaker or the low-voltage relay switch (upon reversal of battery current), thus insuring the tripping of the breaker or the low-voltage relay switch.

Since the sections, listed in this catalogue, are all for use on 115 volt D. C. service only, the low-voltage coils will be adjusted for operation at this voltage. The generator, or source of power, must be maintained at approximately a constant voltage of 115 volts D. C.



TYPICAL DIAGRAM OF CONNECTIONS—WITH MAGNETICALLY OPERATED SWITCHES

TYPE SD BATTERY-CHARGING PANELS—Continued

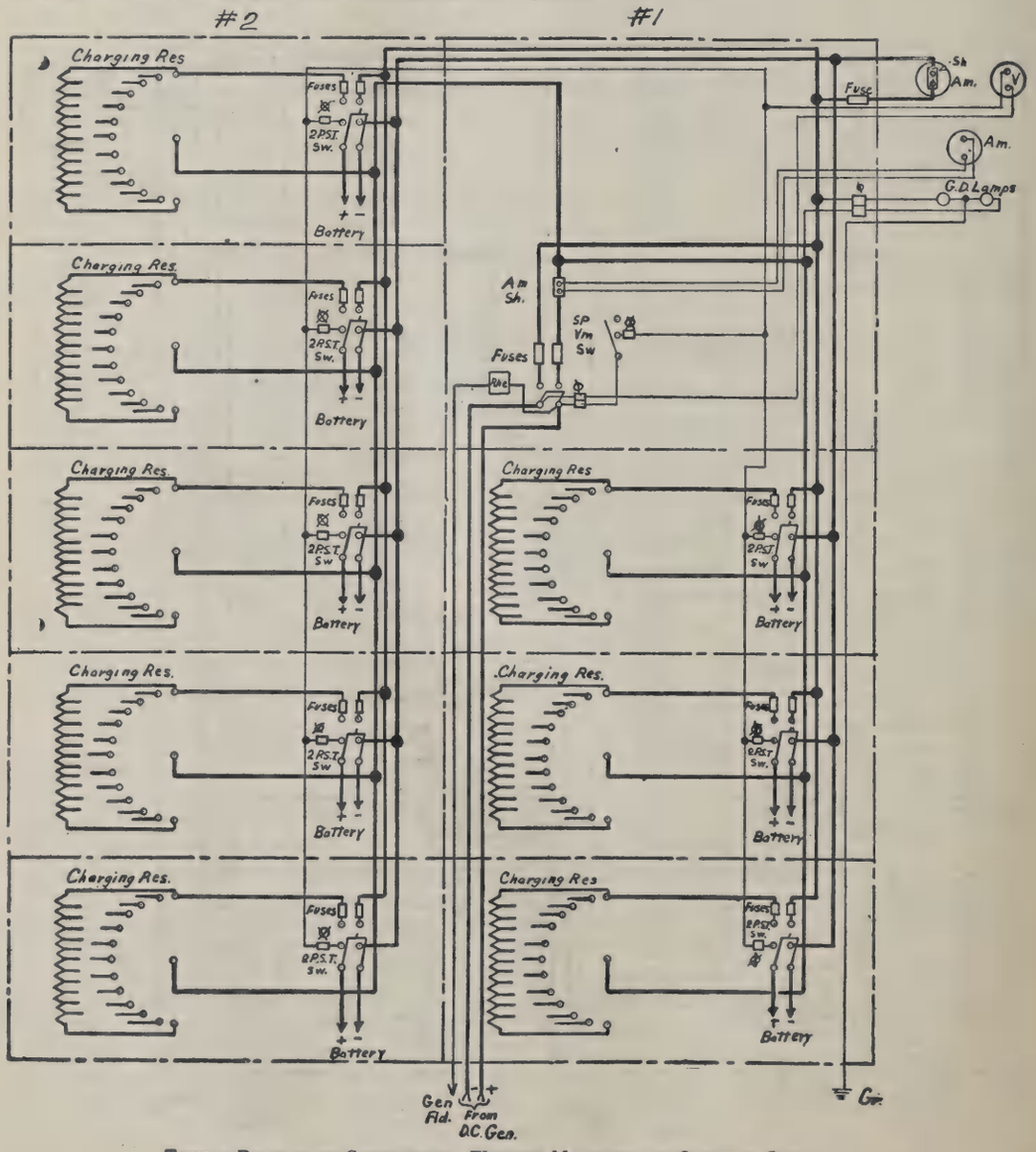
Each charging section is equipped with a special two-pole knife switch which may be moved to a position (without opening the circuit) so that the battery ammeter and voltmeter are connected to the charging circuit, thereby indicating the charging rate in amperes and the voltage of the battery at once.

Charging Rheostats

The battery charging rheostats, listed herein, provide 12 steps.

The rheostats scheduled are each designed for the particular number of cells, as indicated. However, each rheostat may be used for charging a battery composed of a slightly larger number of cells, requiring the same charging rate; but it must be observed that in this case the number of resistance steps available for adjustment will be reduced. If a battery is to be boosted at a rate higher than that scheduled, a special rheostat will be required. For such service complete information should be furnished the Company.

For lead batteries, the voltage applied across the battery terminals will be increased as the charge progresses and the charging current will be maintained approximately constant, that is, at the given starting rate until near the end of the charging period; then the current will be reduced to a given finishing rate, and will be maintained approximately constant throughout the remainder of the charging period.



TYPICAL DIAGRAM OF CONNECTIONS—WITHOUT MAGNETICALLY OPERATED SWITCHES

For nickel-iron (Edison) batteries the voltage applied across battery terminals will be increased as the charge progresses and the charging current will be maintained approximately constant at the required rate.

Assembly of Rheostats

Each rheostat will be completely assembled and wired at the Works and will be mounted on the panel.

ORDERING INSTRUCTIONS

Style Numbers for Rheostats

The style number for each rheostat includes the grid resistors with the frames and will be of suitable dimensions for mounting on the charging section. The faceplate is not included in the rheostat style number, but is included in the charging section style number. Charging rheostats as scheduled by style number will be suitable for mounting on any charging section, but care must be exercised so that the charging section is of proper capacity for use with the particular charging rheostat.

Style Numbers for Sections

The style number of each section includes all wiring and connections mounted on the rear of the section and a proportional amount of vertical copper bars and framework in addition to the apparatus scheduled.

Horizontal Bus-Bars

When a switchboard consists of two or more panels, there will be required, in addition to the equipment scheduled, a set of horizontal bus-bars comprising positive, negative and ammeter bus-bars. In estimating the amount of bus-bars required for these switchboards, the following values should be used.

One ⅛ inch by 1 inch copper strap will carry 200 amperes direct current.

One ⅛ inch by 1½ inch copper strap will carry 300 amperes direct current.

One ⅛ inch by 2 inch copper strap will carry 400 amperes direct current.

One ⅛ inch by 3 inch copper strap will carry 600 amperes direct current.

Two straps of the same dimensions, when connected in parallel, will carry twice the current allowed for one strap of the same dimensions.

Bus-bars between panels ordinarily need not exceed 2 inches in width. However, when generators of more than 400 amperes capacity are used, it is advisable to use 3-inch bus-bars. The ammeter bus-bar need not exceed 1 inch in width in any case.

Data Sheet

Each order for a switchboard should be accompanied by a switchboard data sheet, Form 2724, and with complete information regarding the batteries to be charged. This information should include the following:

Battery maker's name.
Type and number of cells in series.
Number of plates per cell.
Charging rate at start.
Charging rate at finish.
Boosting rate desired.

Weights

The shipping weight of a panel 90 to 96 inches high, including framework and charging rheostats, will be approximately 1200 pounds.

Special Sections

It is urged that sections be selected from those scheduled because drilling templates, permanent manufacturing information and a stock of parts are available for such sections and therefore, better delivery can be made.

Features Provided With the Charging Section

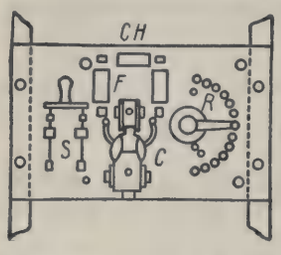
Each charging section is equipped with a special two-pole knife switch which may be moved to a position (without opening the circuit) so that the battery ammeter and voltmeter are connected to the charging circuit, thereby indicating the charging rate in amperes and the voltage of the battery at once.

In addition to the special knife switch for voltmeter and ammeter readings, charging sections provided with a magnetically operated switch have the following features, which purchasers will find very desirable. The charging rheostat dial plate is provided with auxiliary mechanism which is engaged by the rheostat arm at the "IN," or start position, that is, the position which inserts all the resistance in the battery circuit. This mechanism makes it necessary for the operator to have all charging resistance in circuit before the contactor will close, thereby insuring against an initial high charging current. Also the operating coils of the contactor are connected in the circuit so that the contactor will not close if the battery polarity is reversed. Provision is made also for tripping the circuit from a remote point.

CHARGING SECTIONS

With Magnetically Operated Switch or Contactor

Schedule No. 1.



One section, 14 by 24 by 1 inches.

One 2-pole single-throw knife switch (S) with intermediate voltmeter and ammeter jaws.

One contactor (C) with blow-out and operating coils.

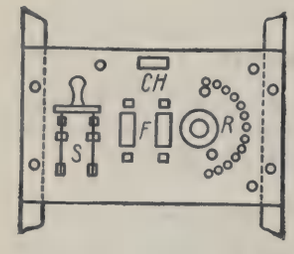
*One charging rheostat face plate (**R**).
Four enclosed fuse holders (**F**).
Two enclosed fuses (**F**).
One card holder (**CH**).
Necessary copper connections and wiring on rear.

*Charging resistor not included. Select charging resistor from page on "Battery Charging Resistors."

Capacity Amperes	Style No.	List Price
50	279468	$115 00
100	279469	140 00
200	279470	205 00

Without Magnetically Operated Switch or Contactor

Schedule No. 2.



One section, 14 by 24 by 1 inches.

One two-pole single-throw knife switch (S) with intermediate voltmeter and ammeter jaws.

*One charging rheostat face plate (**R**).
Four enclosed fuse holders (**F**).
Two enclosed fuses.
One card holder (**CH**).
Necessary copper connections and wiring on rear.

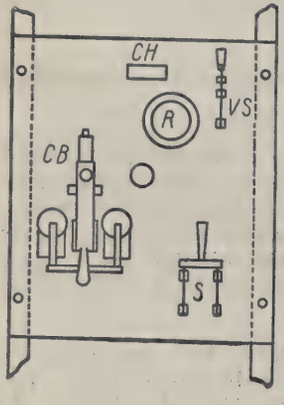
*Charging resistor not included. Select charging resistor from page on "Battery Charging Resistors."

Capacity Amperes	Style No.	List Price
50	279471	$100 00
100	279472	110 00
200	279473	155 00

GENERATOR SECTIONS

With Circuit-Breaker Protection

Schedule No. 3.



One section, 28 by 24 by 1 inches.

One circuit-breaker (**CB**) with low voltage release attachment and auxiliary contact.

One two-pole single-throw 250-volt knife switch (**S**).

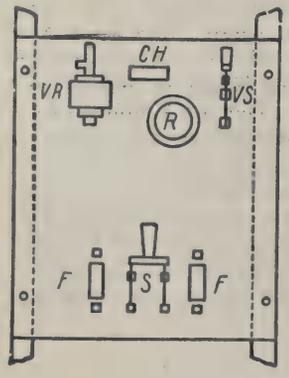
One drilling for rheostat mounting, tetrapod (**R**).

One voltmeter switch (**VS**).
One type FW ammeter and shunt. Ammeter mounted on bracket at side of board.
One card holder (**CH**).
Necessary connections and wiring on rear.

Capacity Amperes	Ammeter and Shunt—Amp.	Style No.	List Price
60	100	279474	$175 00
100	150	279475	180 00
200	300	279476	185 00
300	500	279477	210 00
400	600	279478	265 00
600	1000	279479	295 00
800	1200	279480	320 00

With Fused Switch and with Low-Voltage Relay Switch Protection

Schedule No. 4.



One section, 28 by 24 by 1 inches.

One two-pole single-throw 250-volt knife switch (**S**).

Four enclosed 250-volt fuse holders (**F**).

Two enclosed fuses (**F**).

One drilling for rheostat mounting—tetrapod (**R**).

One voltmeter switch (**VS**).
One card holder (**CH**).
One type FW ammeter and shunt. Ammeter mounted on bracket at side of board.
One low voltage relay switch (**VR**).
Necessary connections and wiring on rear.

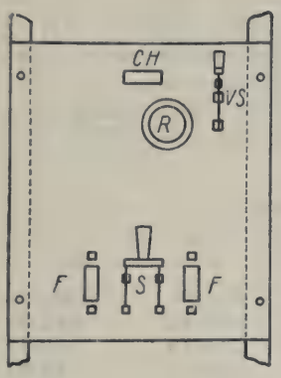
Capacity Amperes	Ammeter and Shunt—Amp.	Style No.	List Price
60	100	279481	$145 00
100	150	279482	155 00
200	300	279483	165 00
300	500	279484	205 00
400	600	279485	210 00
600	1000	279486	250 00

TYPE SD BATTERY-CHARGING PANELS—Continued

GENERATOR SECTIONS

With Fused Switch Protection Only

Schedule No. 5.



One section, 28 by 24 by 1 inches.

One two-pole single-throw 250-volt fused knife switch (**S**).

Four enclosed fuses (**F**).

One drilling for rheostat mounting, tetrapod (**R**).

One voltmeter switch (**VS**).

One type FW ammeter and shunt. Ammeter mounted on bracket at side of board.

One card holder (**CH**).

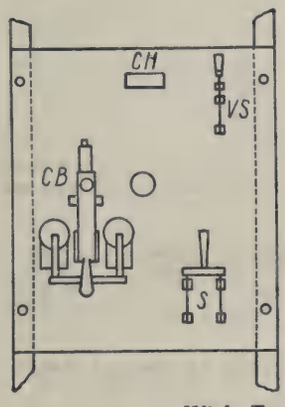
Necessary connections and wiring on rear.

Capacity Amperes	FW Ammeter and Shunt Amperes	Style No.	List Price
60	100	279487	$115 00
100	150	279488	120 00
200	300	279489	135 00
300	500	279490	170 00
400	600	279491	180 00
600	1000	279492	220 00

LINE SECTIONS

With Circuit-Breaker Protection

Schedule No. 6.



One section, 28 by 24 by 1 inches.

One circuit-breaker (**CB**) with low-voltage release attachment and auxiliary contact.

One two-pole single-throw 250-volt knife switch (**S**).

One voltmeter switch (**VS**).

One type FW ammeter and shunt. Ammeter mounted on bracket at side of board.

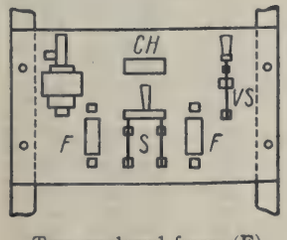
One card holder (**CH**).

Necessary connections and wiring on rear.

Capacity Amperes	FW Ammeter and Shunt Amperes	Style No.	List Price
60	100	279493	$170 00
100	150	279494	180 00
200	300	279495	185 00
300	500	279496	210 00
400	600	279497	265 00
600	1000	279498	295 00
800	1200	279499	320 00

With Fused Switch and Low-Voltage Relay Switch Protection

Schedule No. 7.



One section (see table for dimensions).

One two-pole single-throw 250-volt knife switch (**S**).

Four enclosed 250-volt fuse holders (**F**).

Two enclosed fuses (**F**).

One voltmeter switch (**VS**).

One card holder (**CH**).

One type FW ammeter and shunt. Ammeter mounted on bracket at side of board.

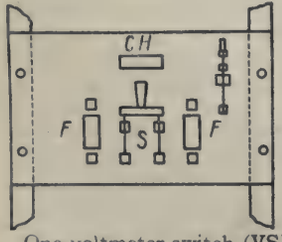
One low-voltage relay switch (**VR**).

Necessary connections and wiring on rear.

Capacity Amperes	FW Ammeter and Shunt Amperes	Style No.	Slab	List Price
60	100	279500	14 by 24 by 1	$135 00
100	150	279501	14 by 24 by 1	140 00
200	300	279502	28 by 24 by 1	165 00
300	500	279503	28 by 24 by 1	205 00
400	600	279504	28 by 24 by 1	210 00
600	1000	279505	28 by 24 by 1	250 00

With Fused Switch Protection Only

Schedule No. 8.



One section. 14 by 24 by 1 inches.

One two-pole single-throw 250-volt knife switch (**S**).

Four enclosed fuses (**F**).

One voltmeter switch (**VS**).

One FW ammeter and shunt. Ammeter mounted on bracket at side of board.

One card holder (**CH**).

Necessary connections and wiring on rear.

Capacity Amperes	FW Ammeter and Shunt Amperes	Style No.	List Price
60	100	279506	$100 00
100	150	279507	105 00
200	300	279508	115 00
300	500	279509	150 00
400	600	279510	160 00
600	1000	279511	200 00

AMPEREHOUR METER SECTIONS

Schedule No. 9

One section 14 by 24 by 1 inches.

Drilling for two amperehour meters, auto type, complete with zero contact and reset device, and variable resistor element.

Necessary connections and wiring on rear.

Capacity Amperes		*Style No.	List Price
30 to 200	One Amperehour Meter	279512	$18 50
30 to 200	Two Amperehour Meters	279513	21 00

NOTE:—Plugs will be provided for one drilling when only one amperehour meter is required.

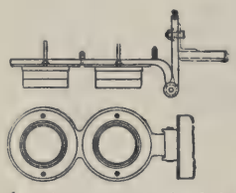
*Style No. does not include amperehour meters.

In ordering amperehour meter sections state capacity and amperehour calibration desired.

BRACKET APPARATUS

For Type FW Voltmeter and Battery Ammeter

Schedule No. 10



One double meter bracket for mounting on angle iron frame.

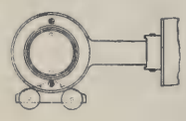
One FW voltmeter, 0-150 volt scale.

One FW ammeter with shunt—as per schedule (shunt mounted on rear of panel, in bus).

FW Ammeter and Shunt Amperes	FW Voltmeter Volts	Style No.	List Price
75	150	279514	$75 00
100	150	279515	80 00
150	150	279516	85 00
200	150	279517	90 00
300	150	279518	95 00

For Type FW Generator or Line Ammeter

Schedule No. 11



One single meter bracket for mounting on angle iron.

One mounting for FW ammeter and shunt, included with generator or line section.

One ground detector outfit.

Bracket	Gr. Det. Outfit	Style No.	List Price
1	1	279519	$23 00

BLANK SECTIONS

For multi-panel switchboards, in order to provide panels of uniform height, and to provide for the insertion of future charging sections, blank sections should be ordered. List price includes four mounting bolts.

Height Inches	Width Inches	Thickness Inches	Bevel Inches	List Price
14	24	1	¼	$ 8 00
28	24	1	¼	14 00

BATTERY CHARGING RESISTORS

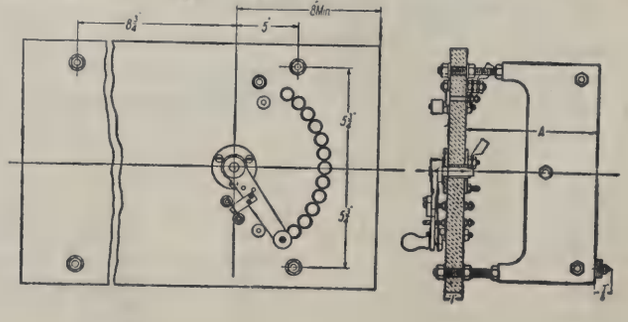
For 40 to 44 Lead Cells

Charging Rate Amperes Maximum	Minimum	Ohms in Resistor	Number of Frames	Dimension A—Inches	Style No.	List Price
12	5	3.05	1	8½	280061	$10 50
14	6	2.53	1	8½	280062	12 50
17	7	2.16	1	8½	280063	16 50
19	8	2.16	1	8½	200863	16 50
24	10	1.5	1	8½	280064	16 50
30	12	1.5	1	8½	280064	16 50
35	14	1.03	1	8½	280065	25 50
40	16	1.03	1	8½	280065	25 50
45	18	.89	1	8½	280066	27 00
51	20	.74	1	8½	280067	30 00
56	22	.74	1	8½	280067	30 00
61	24	.64	2	14	280068	39 00
66	26	.64	2	14	280063	39 00
68	30	.76	2	14	280069	49 50

*Includes resistor complete with wire for connecting to panel.

For 60 to 62 Edison Cells at Normal Rate

Charging Rate Amperes Maximum	Minimum	Ohms in Resistor	Number of Frames	Dimension A—Inches	Style No.	List Price
22½	....	1.06	1	8½	280070	$13 50
30	....	1.06	1	8½	280070	13 50
37½	....	.70	1	8½	280071	15 50
45	....	.56	1	8½	280072	19 50
52½	....	.48	1	8½	280073	29 25
60	....	.48	1	8½	280073	29 25
67½	....	.385	1	8½	280074	27 25
75	....	.35	1	8½	280075	25 00
82½	....	.30	2	14	280076	36 50
90	....	.30	2	14	280076	36 50
105	....	.24	2	14	280077	51 00
135	....	.19	2	14	280078	44 50
45	22½	1.06	1	8½	280079	27 50
60	30	.81	2	14	280080	39 25
75	37½	.67	2	14	280081	41 50
90	45	.56	2	14	280082	55 75
105	52½	.48	3	19½	280083	45 75
120	60	.43	3	19½	280084	48 75
135	67½	.385	3	19½	280085	48 75
150	75	.33	3	19½	280086	63 50



TYPE JA A.C. SWITCHBOARD PANELS

240-480 VOLTS—TWO- AND THREE-PHASE—60-CYCLE

Application—The type JA switchboards are particularly designed for the control of from one to three generators in small industrial plants and central stations operating alternating-current systems below 500 volts.

Capacity—The capacity of a single generator panel is limited to 600 amperes, and that of a complete switchboard composed of these panels, to 1500 amperes, with the number of panels limited to five. For greater capacities, a switchboard composed of type EA panels is recommended.

Panel Construction—Each panel consists of a single section, 48 inches high by 16 or 20 inches wide, 1½ inches thick, with ⅜-inch bevels on front edges. As indicated by the type letter J, each panel is mounted on a type J 1¼-inch pipe frame. The total height of the panel is 76⅜ inches.

Automatic Protection—No overload protection is provided for the main or field circuits of alternating-current generators. The panels for feeder circuits include enclosed fuses mounted on the rear of the panel.

Apparatus—On generator panels, one ammeter is furnished for each phase. On feeder panels, one ammeter is furnished for each two- or three-phase circuit.

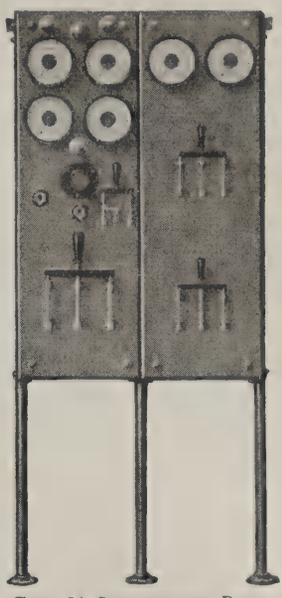
Field Rheostats—The generator panels are designed to have the exciter rheostat supported on a tetrapod mounted on the rear of the panel, with the generator rheostat separately mounted and operated by a remote control mechanism.

Synchronizing—Type JA panels are designed for synchronizing between the incoming machine and the bus-bars. A rotary type synchronizing switch and an incandescent lamp are furnished with each generator panel and one removable synchronizing switch handle is supplied with each switchboard.

A synchronoscope with the necessary voltage transformers can be supplied, if desired, at an additional price.

Exciter Panels—Each generator panel is designed to have the generator field connected through a two-pole switch with field-discharge contact to a single exciter. If parallel operation of exciters is desired, exciter panels should be ordered.

Alterations From Standard Panels Listed—The feeder panels listed may be adapted to control a smaller number of circuits than is included under the style number, in which case a deduction from the list price of the panel will be made for each feeder circuit omitted, as follows:



TYPE JA SWITCHBOARD PANELS

Ampere Capacity Circuit	——DEDUCTION FROM LIST PRICE—— Two-Phase Switch Ammeter and Fuses	Two-Phase Switch and Fuses	Three-Phase Switch Ammeter and Fuses	Three-Phase Switch and Fuses
100	$ 73 00	$34 00	$ 66 00	$26 00
200	115 00	36 00	100 00	28 00
300*	150 00	73 00	130 00	53 00
400	154 00	74 00	133 00	54 00

*400-ampere switch..

Generator or feeder panels can be supplied for 25-cycle service without change in price. In ordering these panels, order the 60-cycle Style Number and specify for 25 cycles.

Data Sheet—Each order for a switchboard should be accompanied by a Swtichboard Data Sheet, Form No. 2724, completely filled out. Full information given at the time of entering order prevents unnecessary correspondence and delay in shipment.

Shipment—Any one of the panels listed herein can be shipped within 15 days after receipt of order at the Works, with full and complete information and Data Sheet properly filled out. However, **any change or substitution** of apparatus as listed by style number will necessitate obtaining a **new delivery promise from the Works.**

Panel style numbers include the frame, the panel with apparatus mounted thereon according to schedules given, and necessary details and connections for operating a single panel.

Bus-bars when required, must be ordered separately.

See also Instructions for Ordering.

Voltage Readings—On any of the generator panels, provisions can be made, if desired, to read voltage across any phase. Add $6.00 to the list price for 2-phase and $7.00 for 3-phase.

Additional Feeder Panels—Any of the type JD, 2-wire feeder panels listed in this catalogue may be adapted for the control of single-phase feeders by simply altering the bus connections.

In ordering these panels for single-phase feeder service, specify as follows: "Single-phase feeder panel, similar to style No..... but adapted for type JA switchboard, (**two or three**) phase, (**240 or 2£0**) volts."

Sub-Sections for Watthour Meters—The following style numbers include black marine slate section with mounting brackets and bolts, for mounting on type J frame immediately below the main section, and drilling for a polyphase type OA switchboard-mounting, glass-cover watthour meter, together with brackets for meter transformers and necessary wiring. The meter and transformers are not included.

Panel Style No.	Size of Sub-Section	List Price
168667	16″x16″x1½″	$31 00
168668	20″x16″x1½″	33 00
168669	24″x16″x1½″	35 00

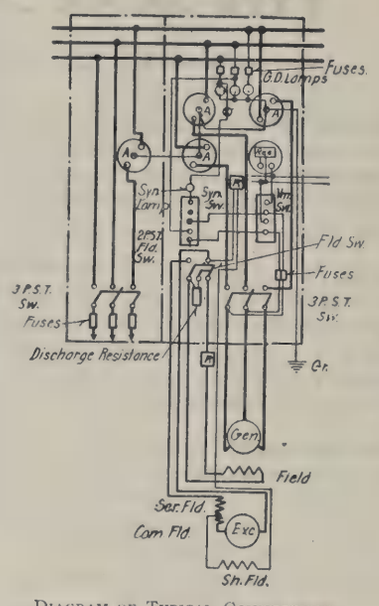


DIAGRAM OF TYPICAL CONNECTIONS

TWO-PHASE GENERATOR PANEL

240-480 Volts, 60 Cycles

For the control of one generator, operating separately or in parallel, panel Fig. 1 should be ordered with the first machine installed, and Fig. 2 with the second and each succeeding machine.

Schedule of Apparatus

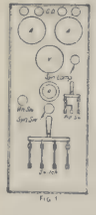


FIG. 1

One panel, 20 inches wide.
*One voltmeter, type SM, with voltmeter switch handle.
Two ammeters, type SM.
One drilling only for Westinghouse rheostat mounting.
One synchronizing outfit.
*One ground detector outfit.
One double-contact type RS voltmeter switch.
One field switch with discharge contact, two-pole, single-throw, type D.
One knife switch, four-pole, single-throw, type A.
Two current transformers, type A, for ammeters of 300 and 400 amperes capacity, and type FB, for 600 and 1000 amperes capacity.

*With panel Fig. 1 only.

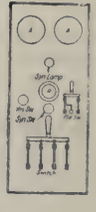


FIG. 2

Ampere Capacity			——WITH VOLTMETER, FIG. 1——			——WITHOUT VOLTMETER, FIG. 2——		
				List Price			List Price	
Volts	Switch	Ammeter	Style No.	Individual Operation	Bus-Bar Operation	Style No.	Individual Operation	Bus-Bar Operation
240	100	200	167895	$395 00	$405 00	167925	$330 00	$335 00
240	200	300	167896	425 00	435 00	167926	360 00	370 00
240	400	400	167897	450 00	460 00	167927	390 00	400 00
240	400	600	167898	480 00	495 00	167928	415 00	435 00
240	600	1000	167899	525 00	555 00	167929	455 00	490 00
480	100	200	167905	415 00	425 00	167935	335 00	345 00
480	200	300	167906	450 00	460 00	167936	365 00	375 00
480	300	400	167907	475 00	485 00	167937	395 00	405 00
480	400	600	167908	500 00	515 00	167938	420 00	445 00
480	600	1000	167909	545 00	580 00	167939	465 00	495 00

Approximate weight, boxed, 700 pounds.

Bus-bars and bus connections are not included in the above style numbers.

Order by Style Number

TWO-PHASE FEEDER PANELS

240-480 Volts, 60 Cycles

For the control of two-phase feeders with ammeter in one phase of each feeder, or without ammeters.

Fig. 1

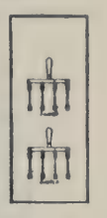


Fig. 2

Schedule of Apparatus

One panel, 20 inches wide.

Two ammeters, type SM, Fig. 1 only.

Two current transformers, type A, for ammeters of 300 and 400 amperes capacity, and type FB, for 600 amperes capacity.

Two knife switches, four-pole, single-throw, type A.

Enclosed fuses mounted on rear of panel.

Ampere Capacity			—WITH AMMETERS, FIG. 1— List Price		—WITHOUT AMMETERS, FIG. 2— List Price		
Volts	Switch and Fuses	Ammeter	Style No.	Individual Operation	Bus-Bar Operation	Style No.	Individual Operation	Bus-Bar Operation
240	100	200	167944	$330 00	$355 00	167972	$230 00	$255 00
240	200	300	167945	415 00	445 00	167973	290 00	325 00
240	300†	400	167946	570 00	610 00	167974	445 00	480 00
240	400	600	167947	595 00	640 00	167975	470 00	510 00
480	100	200	167952	335 00	360 00	167976	235 00	260 00
480	200	300	167953	420 00	450 00	167977	295 00	330 00
480	300†	400	167954	575 00	615 00	167978	450 00	485 00
480	400	600	167955	610 00	655 00	167979	475 00	520 00

†400-ampere switch.

Approximate weight, boxed, 500 pounds.

Bus-bars and bus connections are not included in the above style numbers.

THREE-PHASE GENERATOR PANELS

240-480 Volts, 60 Cycles

For control of one generator, operating separately or in parallel, panel Fig.1 should be ordered with the first machine installed, and Fig. 2 with the second and each succeeding machine.

Schedule of Apparatus

Fig. 1

One panel, 16 inches wide.

*One voltmeter, type SM, with voltmeter switch handle.

Three ammeters, type SM.

One drilling only for Westinghouse rheostat mounting.

One synchronizing outfit.

*One ground detector outfit.

One double-contact, type RS, voltmeter switch.

One field switch with discharge contact, two-pole, single-throw, type D.

One knife switch, three pole, single-throw, type A.

Two current transformers, type A, for ammeters of 300 and 400 amperes capacity, and type FB, for 600 and 1000 amperes capacity.

*With panel, Fig. 1 only.

Fig. 2

Ampere Capacity			—WITH VOLTMETER, FIG. 1— List Price			—WITHOUT VOLTMETER, FIG. 2— List Price		
Volts	Switch	Ammeter	Style No.	Individual Operation	Bus-Bar Operation	Style No.	Individual Operation	Bus-Bar Operation
240	100	200	167835	$425 00	$435 00	167865	$360 00	$370 00
240	200	300	167836	465 00	475 00	167866	400 00	410 00
240	400	400	167837	485 00	495 00	167867	420 00	435 00
240	400	600	167838	490 00	505 00	167868	425 00	440 00
240	600	1000	167839	525 00	555 00	167869	455 00	490 00
480	100	200	167845	450 00	460 00	167875	365 00	375 00
480	200	300	167846	490 00	505 00	167876	410 00	420 00
480	400	400	167847	505 00	520 00	167877	425 00	440 00
480	400	600	167848	510 00	535 00	167878	430 00	445 00
480	600	1000	167849	545 00	580 00	167879	460 00	495 00

Approximate weight, boxed, 700 pounds.

Bus-bars and bus connections are not included in the above style numbers.

Order by Style Number

THREE-PHASE FEEDER PANELS

240-480 Volts, 60 Cycles

For the control of two three-phase feeders, with ammeter in one phase of each feeder, or without ammeters.

FIG. 1

FIG. 2

Schedule of Apparatus

One panel, 16 inches wide.

Two ammeters type SM, with Fig. 1 only.

Two current transformers, type A, for ammeters of 300 and 400 amperes capacity, and type FB, for 600 amperes capacity.

Two knife switches, three-pole, single-throw, type A.

Enclosed fuses mounted on rear of panel.

Ampere Capacity			—WITH AMMETERS, FIG. 1— List Price			—WITHOUT AMMETERS, FIG. 2— List Price		
Volts	Switch and Fuses	Ammeter	Style No.	Individual Operation	Bus-Bar Operation	Style No.	Individual Operation	Bus-Bar Operation
240	100	200	167960	$295 00	$325 00	167980	$195 00	$215 00
240	200	300	167961	365 00	390 00	167981	250 00	265 00
240	300†	400	167962	470 00	505 00	167982	350 00	375 00
240	400	600	167963	495 00	540 00	167983	375 00	405 00
480	100	200	167968	300 00	330 00	167984	200 00	220 00
480	200	300	167969	370 00	395 00	167985	255 00	275 00
480	300†	400	167970	475 00	510 00	167986	355 00	380 00
480	400	600	167971	500 00	550 00	167987	385 00	415 00

†400-ampere switch.

Approximate weight, boxed, 500 pounds.

Bus-bars and bus connections are not included in the above style numbers.

Order by Style Number

TYPE JB ALTERNATING-CURRENT SWITCHBOARD PANELS

1200—2400 VOLTS, 100 AMPERES MAXIMUM

Application—Type JB switchboards are particularly adapted to the control of single or parallel-operated alternators in small industrial plants and central stations.

Capacity—The capacity of a single generator or feeder panel, as listed, is limited to 100 amperes and that of a complete switchboard to 400 amperes. However, special panels may be ordered of a capacity of 200 amperes for generators and for feeders, when desired, by taking the matter up with the Works. For greater capacities, a switchboard from the type E lines is recommended.

Panel Construction—Each panel consists of a single section, 48 inches high by 1½ inches thick, with ⅜-inch bevels on front edges, bolted at the four corners to a type J 1¼-inch pipe frame. The total height of the panels is 76⅜ inches. As indicated by the type letter B, the equipment consists of panel-mounting manually-operated oil circuit-breakers.

Automatic Protection—Standard panels provide no automatic protection for the main or field circuits of alternating-current generators.

Feeder panels are listed with the following kinds of overload protection:

(a) Non-automatic oil circuit-breakers with rear-connected fuses. These fuses are removable from the front of panel, but have no live parts exposed.

(b) Automatic oil circuit-breakers.

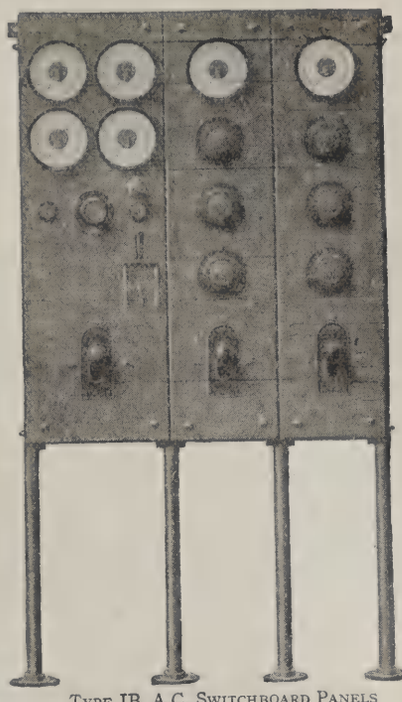
Feeder panels having a non-automatic oil circuit-breaker, but without fuses, are also listed. When these panels are selected, necessary fuses should be ordered extra for mounting apart from the switchboard.

When a single-generator panel controlling one feeder is installed, automatic protection for the feeder side of the non-automatic oil circuit-breaker may be obtained by providing a sub-section with fuses, to be mounted immediately below the generator panel on the type J frame. An automatic oil circuit-breaker can be substituted, at a difference in price, for the non-automatic circuit-breaker and fuse section. The advantages of the automatic circuit-breaker are that it is quickly and easily closed after opening the circuit, cannot be held in a closed position while an overload condition exists on the line, and eliminates the trouble and expense of replacing the fuses.

One set of fuses is supplied with each panel equipped with fuse blocks.

Apparatus—The voltmeters provided are the type SM; the ammeters, the type SM, self-contained up to 200 amperes; the non-automatic oil circuit-breakers, the types I and D; the automatic oil circuit-breakers, the type F-1; and the fuses are of the enclosed rear-connected type.

Field Rheostats—The generator panels are designed to have the exciter rheostat supported on a tetrapod mounted on the rear of the panel, with the generator rheostat separately mounted and operated by a remote control mechanism.



TYPE JB. A.C. SWITCHBOARD PANELS

Ground Detector Equipments—Ground detectors are not supplied as part of the standard panel equipments and must be ordered separately when required. For 2400-volt, 3-phase systems specify:

1. Ground Detector Equipment, Style No. 202302, list price $80.00.

The style number includes one 3-phase static ground detector, the necessary condensers, bracket for mounting the detector above the switchboard, and the necessary connecting leads.

The question of detectors for all 1200-volt systems and 2400-volt 2-phase systems should be referred to the Works.

Synchronizing—A rotary type synchronizing switch and an incandescent lamp for synchronizing between machines are furnished with each generator panel. The same transformer used in connection with the voltmeter is used for synchronizing. If synchronizing between bus and machine is desired, add one voltage transformer with fuses for connecting to bus. A type SI synchronoscope will be supplied at extra cost.

Exciter Control—Each generator panel is designed to have the generator field connected through a two-pole field switch with field discharge contact, to a single exciter. If parallel operation of exciters is desired, exciter panels should be ordered.

TYPE JB A.C. SWITCHBOARD PANELS—Continued

Bus-bars—Bus-bars, when necessary, should be ordered separately. They will be supplied at the following prices:

Maximum Bus-bar Capacity Amperes	Conductors	List Price Per Foot Length of Switchboard Single-Phase	Two-Phase	Three-Phase
150	.365 R. I. F. P. wire	$1 50	$ 3 00	$2 50
225	.460 R. I. F. P. wire	3 00	6 00	5 00
300	½" dia. Copper rod } insulated	4 00	8 00	6 50
400	¾" dia. Copper rod }	5 00	10 00	8 00

Sub-Sections for Watthour Meters—The following style numbers include a sub-section with mounting brackets, meter-transformer brackets, and wiring, for mounting immediately below the main sections. The meter and transformers are not included. The section is drilled for a polyphase glass-cover type OA switch board-mounting watthour meter.

Panel Style No.	Size of Section	List Price
168666	12"x16"x1½"	$29 00
168667	16"x16"x1½"	31 00
168668	20"x16"x1½"	33 00
168669	24"x16"x1½"	35 00
168670	32"x16"x1½"	38 75

Interrupting Capacity of Oil Switches and Oil Circuit-Breakers

Apparatus	Interrupting Capacity Amperes per Phase at 2500 Volts
Type I, 60 Amperes, 4500 Volt Oil Switch	610
Type D, 200 Amperes, 4500 Volt Oil Switch	1630
Type F-1, Oil Circuit-Breaker, Transformer-Trip	5100

Panel Style Numbers—The panel style numbers include the frame, the panel with apparatus mounted thereon according to the schedule given, and necessary details and connections for operating a single panel.

See also Instructions for Ordering.

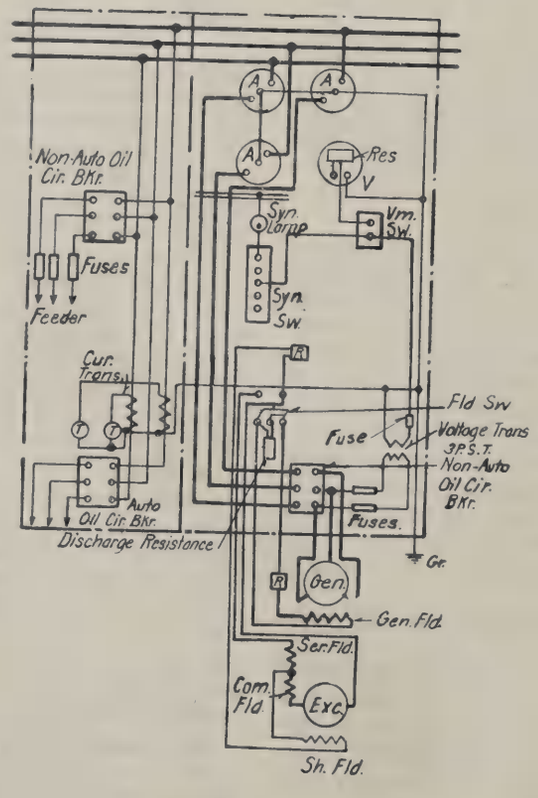


Diagram of Typical Connections

TYPE JB TWO-PHASE GENERATOR PANELS

1200—2400 Volts, 60 Cycles

For the Control of One Generator, Operating Separately or in Parallel

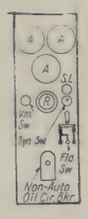


FIG. 1

FIG. 2

Panel Fig. 1 should be ordered with the first machine installed, and Fig. 2 with the second and each succeeding machine.

Schedule of Apparatus

One panel 16 inches wide.
*One voltmeter, type SM.
Two ammeters, type SM.
One drilling only for Westinghouse tetrapod rheostat mounting.
One type RS synchronizing switch with removable *handle and lamp.
One single-contact type RS voltmeter switch with removable *handle.

One field switch with discharge contact, two-pole single-throw.

One non-automatic oil circuit-breaker, four-pole single-throw, type I for 10 to 60 amperes, type D for 80 and 100 amperes.

One voltage transformer with double-pole fuse block and two fuses.

*With panel Fig. 1 only.

	Ampere Capacity		—With Voltmeter, Fig. 1— List Price			—Without Voltmeter, Fig. 2— List Price		
Volts	Switch	Ammeters	Panel Style No.	Individual Operation	Bus-Bar Operation	Panel Style No.	Individual Operation	Bus-bar Operation
1200	10	15	268688	$365 00	$375 00	268702	$245 00	$255 00
1200	20	30	268689	375 00	390 00	268703	255 00	270 00
1200	30	40	268690	385 00	400 00	268704	265 00	280 00
1200	40	60	268691	395 00	410 00	268705	275 00	290 00
1200	60	80	268692	405 00	420 00	268706	285 00	300 00
1200	80	120	268693	430 00	450 00	268707	315 00	335 00
1200	100	160	268694	440 00	460 00	268708	325 00	345 00
2400	10	15	268695	385 00	400 00	268709	260 00	275 00
2400	20	30	268696	395 00	410 00	268710	270 00	285 00
2400	30	40	268697	405 00	420 00	268711	280 00	295 00
2400	40	60	268698	415 00	430 00	268712	290 00	305 00
2400	60	80	268699	425 00	440 00	268713	300 00	315 00
2400	80	120	268700	455 00	470 00	268714	325 00	340 00
2400	100	160	268701	465 00	480 00	268715	335 00	350 00

Approximate weight, boxed, 700 pounds.
Bus-bars and bus connections are not included in the above style numbers.

Optional

(a) **Where panels are not required for parallel operation** the following apparatus may be omitted from generator panels having voltmeters, at a decrease in panel list price of $16.00.

One synchronizing switch, handle, and lamp.

One voltmeter switch and handle.

(b) **If voltmeter indication is required for both phases** the voltmeter switch (Figs. 1 and 2) can be replaced by a single-contact two-circuit type RS voltmeter switch, and a voltage transformer with double-pole fuse block and two fuses added, at an increase in list price of $50.00 for 1200-volt panels, and $55.00 for 2400-volt panels

TYPE JB THREE-PHASE GENERATOR PANELS

1200—2400 Volts, 60 Cycles

For the Control of One Generator, Operating Separately or in Parallel

FIG. 1

FIG. 2

Panel Fig. 1 should be ordered with the first machine installed, and Fig. 2 with the second and each succeeding machine.

Schedule of Apparatus

One panel 16 inches wide.

*One voltmeter, type SM.

Three ammeters, type SM.

One drilling only for Westinghouse tetrapod rheostat mounting.

One type RS synchronizing switch with removable *handle and lamp.

One single-contact type RS voltmeter switch with removable* handle.

One field switch with discharge contact, two-pole single-throw type D.

One non-automatic oil circuit-breaker, three-pole single-throw, type I for 10 to 60 amperes, type D for 80 and 100 amperes.

One voltage transformer with double-pole fuse block and two fuses.

*With panel Fig. 1 only.

Volts	Ampere Capacity Switch	Ampere Capacity Ammeter	—WITH VOLTMETER, FIG. 1— Panel Style No.	List Price Individual Operation	List Price Bus-Bar Operation	—WITHOUT VOLTMETER, FIG. 2— Panel Style No.	List Price Individual Operation	List Price Bus-Bar Operation
1200	10	15	268716	$400 00	$410 00	268730	$280 00	$290 00
1200	20	30	268717	410 00	425 00	268731	290 00	305 00
1200	30	40	268718	420 00	435 00	268732	300 00	315 00
1200	40	60	268719	430 00	445 00	268733	310 00	325 00
1200	60	80	268720	440 00	455 00	268734	320 00	335 00
1200	80	120	268721	450 00	465 00	268735	330 00	345 00
1200	100	160	268722	460 00	475 00	268736	340 00	355 00
2400	10	15	268723	420 00	435 00	268737	290 00	305 00
2400	20	30	268724	430 00	445 00	268738	300 00	315 00
2400	30	40	268725	440 00	455 00	268739	310 00	325 00
2400	40	60	268726	450 00	465 00	293466	320 00	335 00
2400	60	80	268727	460 00	475 00	293467	330 00	345 00
2400	80	120	268728	470 00	485 00	293468	340 00	355 00
2400	100	160	268729	480 00	495 00	293469	350 00	365 00

Approximate weight boxed, 700 pounds.

Bus-bars and bus connections are not included in the above style numbers.

Optional

(a) **Where panels are not required for parallel operation** the option given on the preceding page may be taken advantage of.

(b) **If voltmeter indication is required for all three phases** the voltmeter switch (Figs. 1 and 2) can be replaced by three-phase type RS voltmeter switch, and a voltage transformer with double-pole fuse block and two fuses added at an increase in the list price of $50.00 for 1200-volt panels, and $55.00 for 2400-volt panels.

Order by Style Number

TYPE JB A.C. SWITCHBOARD PANELS—Continued

TYPE JB FEEDER PANELS

With Fuses on Front of Panel—For One Feeder

One, Two, and Three-Phase—1200 and 2400 Volts—60 Cycles—Single-Throw

For the control of one, two, and three-phase feeders; with ammeter in one phase of each feeder, or without ammeters; and with fuses in each leg of each feeder

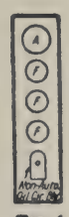


FIG. 1

FIG. 2

FIG. 3

Schedule of Apparatus

One panel.
One ammeter, type SM, Figs. 1 and 3 only.
One set fuse holders and fuses.
One non-automatic oil circuit-breaker, single-throw; two-pole for single-phase, three-pole for three-phase, four-pole for two-phase; type I for 60 amperes, type D for 100 amperes.

Phase	Amperes Each Feeder	Ammeter Scale	Panel Width Inches	Fig. No.	WITH AMMETER — List Price Panel Style No.	Individual Operation	Bus-Bar Operation	WITHOUT AMMETER — List Price Panel Style No.	Individual Operation	Bus-Bar Operation
1	10	15	12	1	168616	$175 00	$185 00	168658	$120 00	$130 00
1	20	30	12	1	168617	180 00	190 00	168659	135 00	145 00
1	30	40	12	1	168618	185 00	195 00	168660	138 00	148 00
1	40	60	12	1	168619	190 00	200 00	168661	140 00	150 00
1	60	60	12	1	168620	195 00	205 00	168662	145 00	155 00
1	75	120	12	1	168621	255 00	265 00	168663	205 00	215 00
1	100	160	12	1	168622	260 00	270 00	168664	210 00	220 00
1	10	15	12	2	.....	.....	.....	168665	195 00	205 00
1	20	30	12	2	.....	.....	.....	168707	200 00	210 00
2	30	40	12	2	.....	.....	.....	168708	205 00	220 00
2	40	60	12	2	.....	.....	.....	187802	210 00	225 00
1	60	60	12	2	.....	.....	.....	187803	215 00	230 00
2	75	120	12	2	.....	.....	.....	187804	345 00	360 00
2	100	160	12	2	.....	.....	.....	187805	350 00	375 00
2	10	15	20	3	168623	250 00	260 00	.....	.....	.....
1	20	30	20	3	168624	255 00	265 00	.....	.....	.....
2	30	40	20	3	168625	253 00	268 00	.....	.....	.....
2	40	60	20	3	168626	260 00	270 00	.....	.....	.....
1	60	60	20	3	168627	265 00	275 00	.....	.....	.....
2	75	120	24	3	168628	410 00	420 00	.....	.....	.....
1	100	160	24	3	168629	420 00	430 00	.....	.....	.....
1	10	15	12	1	168630	210 00	220 00	187806	160 00	175 00
1	20	30	12	1	168631	215 00	225 00	187807	165 00	180 00
3	30	40	12	1	168632	220 00	235 00	187808	168 00	182 00
1	40	60	12	1	168633	225 00	240 00	187809	170 00	185 00
3	60	60	12	1	168634	230 00	245 00	187810	175 00	190 00
3	75	120	12	1	168635	320 00	355 00	187811	270 00	285 00
3	100	160	12	1	168636	325 00	365 00	187812	275 00	290 00

Approximate weight, boxed, 700 pounds.
Bus-bars and bus connections are not included in the above style numbers.

Order by Style Number

TYPE JB FEEDER PANELS

With Fuses on Front of Panel—For Two Feeders

One, Two, and Three-Phase—1200 and 2400 Volts—60 Cycles—Single-Throw

For the control of one, two, and three-phase feeders; with ammeters in one phase of each feeder, or without ammeters, and with fuses in each leg of each feeder

FIG. 1

FIG. 2

FIG. 3

Schedule of Apparatus

One panel.

Per Feeder:

One ammeter, type SM, Figs. 1 and 3 only.

One set fuse holders and fuses.

One non-automatic oil circuit-breaker, single-throw; two-pole for single-phase, three-pole for three-phase, four-pole for two-phase; type I for 60 amperes, type D for 100 amperes.

Phase	Amperes Each Feeder	Ammeter Scale	Panel Width Inches	Fig. No.	WITH AMMETER — List Price Panel Style No.	Individual Operation	Bus-Bar Operation	WITHOUT AMMETER — List Price Panel Style No.	Individual Operation	Bus-Bar Operation
1	10	15	20	1	168637	$305 00	315 00	187813	$210 00	$220 00
1	20	30	20	1	168638	310 00	320 00	187814	215 00	225 00
1	30	40	20	1	168639	312 00	322 00	187815	218 00	228 00
1	40	60	20	1	168640	315 00	325 00	187816	220 00	230 00
1	60	80	20	1	168641	320 00	330 00	187817	225 00	235 00
1	75	120	24	1	168642	470 00	480 00	187818	365 00	370 00
1	100	160	24	1	168643	480 00	490 00	187819	375 00	380 00
2	10	15	20	1	.....	.....	.....	187820	340 00	355 00
2	20	30	20	2	.....	.....	.....	187821	345 00	365 00
2	30	40	20	1	.....	.....	.....	187822	348 00	368 00
2	40	60	20	1	.....	.....	.....	187823	350 00	370 00
2	60	80	20	1	.....	.....	.....	187824	355 00	375 00
2	75	120	24	1	.....	.....	.....	187825	645 00	670 00
2	100	160	24	2	.....	.....	.....	187826	655 00	680 00
2	10	15	32	3	168644	450 00	465 00	.....	.....	.....
2	20	30	32	3	168645	455 00	475 00	.....	.....	.....
2	30	40	32	1	168646	458 00	478 00	.....	.....	.....
2	40	60	32	1	168647	460 00	480 00	.....	.....	.....
2	60	80	32	3	168648	465 00	485 00	.....	.....	.....
2	75	120	32	1	168649	745 00	775 00	.....	.....	.....
2	100	160	32	1	168650	750 00	780 00	.....	.....	.....
3	10	15	20	1	168651	370 00	385 00	187827	280 00	295 00
3	20	30	20	1	168652	375 00	395 00	187828	285 00	300 00
3	30	40	20	1	168653	378 00	398 00	187829	288 00	305 00
3	40	60	20	1	168654	380 00	400 00	187830	290 00	310 00
3	60	80	20	1	168655	385 00	405 00	187831	295 00	320 00
3	75	120	24	1	168656	595 00	620 00	187832	500 00	520 00
3	100	160	24	1	168657	600 00	625 00	187833	510 00	530 00

Approximate weight, boxed, 700 pounds.

Bus-bars and bus connections are not included in the above style numbers.

Order by Style Number

TYPE JB FEEDER PANELS

Without Fuses—For One Feeder

One, Two, and Three-Phase—1200 and 2400 Volts—60 Cycles—Single-Throw

For the control of one, two, or three-phase feeders; with ammeters in one phase of each feeder, or without ammeters

FIG. 1

FIG. 2

Fuse blocks are not furnished with these panels, and should be ordered extra for separate mounting.

Schedule of Apparatus

One panel 12 inches wide.

One ammeter, type SM, Fig. 1 only.

One oil circuit-breaker, non-automatic, single-throw; two-pole for single-phase, three-pole for three-phase, four-pole for two-phase; type I for 60 amperes, and type D for 100 amperes.

Phase	Amperes Each Feeder	Ammeter Scale	—WITH AMMETER, FIG. 1— Panel Style No.	List Price Individual Operation	List Price Bus-Bar Operation	—WITHOUT AMMETER, FIG. 2— Panel Style No.	List Price Individual Operation	List Price Bus-Bar Operation
1	10	15	187876	$130 00	$140 00	187918	$ 85 00	$ 95 00
1	20	30	187877	135 00	145 00	187918	90 00	100 00
1	30	40	187878	140 00	150 00	187918	95 00	105 00
1	40	60	187879	145 00	155 00	187918	.....	.....
1	60	80	187880	150 00	160 00	187918	110 00	120 00
1	75	120	187881	165 00	175 00	187919	115 00	125 00
1	100	160	187882	175 00	185 00	187919	120 00	130 00
2	10	15	187883	155 00	165 00	187920	105 00	115 00
2	20	30	187884	158 00	168 00	187920	110 00	120 00
2	30	40	187885	160 00	170 00	187920	115 00	125 00
2	40	60	187886	165 00	175 00	187920	120 00	130 00
2	60	80	187887	168 00	178 00	187920	170 00	185 00
2	75	120	187888	220 00	235 00	187921	175 00	190 00
2	100	160	187889	225 00	238 00	177921	180 00	195 00
3	10	15	187890	145 00	155 00	187922	100 00	110 00
3	20	30	187891	150 00	160 00	187922	105 00	115 00
3	30	40	187892	155 00	165 00	187922	110 00	120 00
3	40	60	187893	160 00	170 00	187922	115 00	125 00
3	60	80	187894	165 00	175 00	187922	140 00	150 00
3	75	120	187895	185 00	200 00	187923	145 00	155 00
3	100	160	187896	195 00	210 00	187923	150 00	160 00

Approximate weight, boxed, 800 pounds.

Bus-bars and bus connections are not included in the above style numbers.

Feeder Panels Without Fuses—For Two or Four Feeders

One, Two, and Three-Phase—1200 and 2400 Volts—60 Cycles—Single-Throw

For the control of one, two, or three-phase feeders; with ammeters in one phase of each feeder, or without ammeters

Fuse blocks are not furnished with these panels and should be ordered extra for separate mounting.

Schedule of Apparatus

One panel.

Per Feeder:

One ammeter, type SM, Fig. 1 only.

One oil circuit-breaker, non-automatic, single-throw; two-pole for single-phase, three-pole for three-phase, four-pole for two-phase; type I for 60 amperes, and type D for 100 amperes.

FIG. 1

FIG. 2

(Continued on next page)

TYPE JB A.C. SWITCHBOARD PANELS—Continued

TYPE JB FEEDER PANELS

Without Fuses—For Two or Four Feeder (Continued)

Phase	Number of Feeders	Amperes Each Feeder	Ammeter Scale	Panel Width Inches	Fig. No.	WITH AMMETER — List Price: Panel Style No.	Individual Operation	Bus-Bar Operation	WITHOUT AMMETER — List Price: Panel Style No.	Individual Operation	Bus-Bar Operation
1	2	10	15	16	1	187897	$215 00	$225 00	187924	$120 00	$130 00
1	2	20	30	16	1	187898	220 00	230 00	187924	125 00	135 00
1	2	30	40	16	1	187899	225 00	235 00	187924	130 00	140 00
1	2	40	60	16	1	187900	230 00	240 00	187924	135 00	145 00
1	2	60	80	16	1	187901	235 00	245 00	187924	140 00	150 00
1	2	75	120	16	1	187902	280 00	295 00	187925	180 00	195 00
1	2	00	160	16	1	187903	285 00	300 00	187925	185 00	200 00
2	2	10	15	16	1	187904	255 00	270 00	187926	160 00	180 00
2	2	20	30	16	1	187905	260 00	275 00	187926	165 00	185 00
2	2	30	40	16	1	187906	265 00	280 00	187926	170 00	190 00
2	2	40	60	16	1	187907	270 00	285 00	187926	175 00	195 00
2	2	60	80	16	1	187908	275 00	290 00	187926	180 00	200 00
2	2	75	120	16	1	187909	385 00	410 00	187927	290 00	315 00
2	2	100	160	16	1	187910	395 00	420 00	187927	295 00	320 00
3	2	10	15	16	1	187911	235 00	250 00	187928	140 00	160 00
3	2	20	30	16	1	187912	240 00	254 00	187928	145 00	165 00
3	2	30	40	16	1	187913	245 00	260 00	187928	150 00	170 00
3	2	40	60	16	1	187914	250 00	265 00	187928	155 00	175 00
3	2	60	80	16	1	187915	255 00	270 00	187928	160 00	180 00
3	2	75	120	16	1	187916	325 00	345 00	187929	225 00	250 00
3	2	100	160	16	1	187917	330 00	350 00	187929	235 00	260 00
1	4	60(Max.)	..	20	2	.....	.....	.....	187930	185 00	200 00
1	4	100	..	24	2	.....	.....	.....	187931	310 00	330 00
2	4	60(Max.)	..	20	2	.....	.....	.....	187932	265 00	280 00
2	4	100	..	24	2	.....	.....	.....	187933	525 00	540 00
3	4	60(Max.)	..	20	2	.....	.....	.....	187934	220 00	245 00
3	4	100	..	24	2	.....	.....	.....	187935	400 00	420 00

Approximate weight, boxed, 800 pounds.

Bus-bars and bus connections are not included in the above style numbers.

Feeder Panels With Automatic Oil Circuit-Breakers—For One Feeder One, Two and Three-Phase—1200 and 2400 Volts—60 Cycles—Single-Throw

For the control of one, two, or three-phase feeders, with ammeter in one phase of each feeder, or without ammeters

Schedule of Apparatus

One panel 16 inches wide.

One ammeter, type SM, Fig. 1 only.

One automatic type F-1 transformer-trip oil circuit-breaker,* single-throw; two-pole for single-phase, three-pole for three-phase, four-pole for two-phase.

One type KR current transformer for single-phase; two for two- and three-phase.

FIG. 1

FIG. 2

Phase	Amperes Each Feeder	Ammeter Scale	WITH AMMETER, FIG. 1 — List Price: Panel Style No.	Individual Operation	Bus-Bar Operation	WITHOUT AMMETER, FIG. 2 — List Price: Panel Style No.	Individual Operation	Bus-Bar Operation
1	5	10	268551	$250 00	$260 00	268530	$215 00	$225 00
1	10	15	268552	255 00	265 00	268531	220 00	230 00
1	15	20	268553	260 00	270 00	268532	225 00	235 00
1	25	40	268554	265 00	275 00	268533	230 00	240 00
1	50	80	268555	270 00	280 00	268534	235 00	245 00
1	75	120	268556	275 00	285 00	268535	240 00	250 00
1	100	160	268557	280 00	290 00	268536	245 00	255 00
2	5	10	268558	340 00	355 00	268537	300 00	320 00
2	10	15	268559	345 00	360 00	268538	305 00	325 00
2	15	20	268560	350 00	365 00	268539	310 00	330 00
2	25	40	268561	355 00	370 00	268540	315 00	335 00
2	50	80	268562	360 00	375 00	268541	320 00	340 00
2	75	120	268563	365 00	380 00	268542	325 00	345 00
2	100	160	268564	370 00	385 00	268543	330 00	350 00
3	5	10	268565	305 00	315 00	268544	265 00	275 00
3	10	15	268566	310 00	320 00	268545	270 00	280 00
3	15	20	268567	315 00	325 00	268546	275 00	285 00
3	25	40	268568	320 00	330 00	268547	280 00	290 00
3	50	80	268569	325 00	335 00	268548	285 00	295 00
3	75	120	268570	330 00	340 00	268549	290 00	300 00
3	100	160	268571	335 00	350 00	268550	295 00	305 00

*Overload tripping range of the circuit-breaker is adjustable from 80 per cent to 160 per cent of the rating of the feeder.

Approximate weight boxed, 800 pounds.

Bus-bars and bus connections are not included in above style numbers.

The oil-circuit-breakers may be equipped with the usual auxiliaries, such as inverse-time-limit attachments as listed in the catalogue section in Oil Circuit-Breaker Accessories

TYPE JB A.C. SWITCHBOARD PANELS—Continued

TYPE JB FEEDER PANELS

Double-Throw, Single-Phase, 1200 and 2400 Volts, 60 Cycles

For the control of one single-phase double-throw feeder with or without ammeter, and with or without fuses and for balancing single-phase feeders on various phases

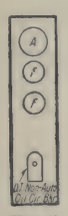


FIG. 1

FIG. 2

FIG. 3

FIG. 4

Fuse blocks are not supplied with panels Figs. 3 and 4, and should be ordered separately.

Schedule of Apparatus

One panel 16 inches wide.

One ammeter, type SM, with Figs. 1 and 3 only.

Two fuse holders and fuses, switchboard type, rear connected, with Figs. 1 and 2 only.

One oil circuit-breaker, non-automatic, 2-pole double-throw type D, 100 amperes.

Amperes Each Feeder	Ammeter Scale	WITH AMMETER — List Price: Panel Style No.	Individual Operation	Bus-Bar Operation	WITHOUT AMMETER — List Price: Panel Style No.	Individual Operation	Bus-Bar Operation
			With Fuses				
		Fig. 1.			Fig. 2.		
10	15	188052	$225 00	$235 00	188066	$180 00	$190 00
20	30	188053	230 00	240 00	188067	185 00	195 00
30	40	188054	235 00	245 00	188068	190 00	200 00
40	60	188055	240 00	250 00	188069	195 00	205 00
60	80	188056	245 00	255 00	188070	200 00	210 00
75	120	188057	275 00	285 00	188071	225 00	235 00
100	160	188058	280 00	290 00	188072	230 00	240 00
			Without Fuses				
		Fig. 3.			Fig. 4.		
10	15	188059	180 00	190 00	188073	135 00	145 00
20	30	188060	185 00	195 00	188073	140 00	150 00
30	40	188061	190 00	200 00	188073	145 00	155 00
40	60	188062	195 00	205 00	188073	150 00	160 00
60	80	188063	200 00	215 00	188073	160 00	170 00
75	120	188064	210 00	225 00	188073	165 00	175 00
100	160	188065	220 00	235 00	188073	175 00	185 00

Approximate weight, boxed, 600 pounds.

TYPE JB PANEL SUB-SECTIONS FOR FUSES

1200—2400 Volts

These sections are designed to be mounted on the type J frame immediately below the main generator sections.

They provide automatic protection on the feeder side of the non-automatic oil circuit-breaker when control of only a single generator and a single feeder is required, thus eliminating the feeder panel.

Style number includes sub-section, frame mounting brackets, fuse blocks, and one set of fuses.

Schedule of Apparatus

One sub-panel 16 inches wide, 25 inches high, 1½ inches thick.

Per wire:

One fuse holder and fuse, rear connected.

Ampere Capacity	TWO-PHASE — Panel Style No.	Number FuseBlocks	List Price*	THREE-PHASE — Panel Style No.	Number Fuse Blocks	List Price*
10	188081	4	$135 00	188088	3	$115 00
20	188082	4	140 00	188089	3	120 00
30	188083	4	145 00	188090	3	125 00
40	188084	4	150 00	188091	3	130 00
60	188085	4	155 00	188092	3	135 00
75	188086	4	230 00	188093	3	185 00
100	188087	4	235 00	188094	3	190 00

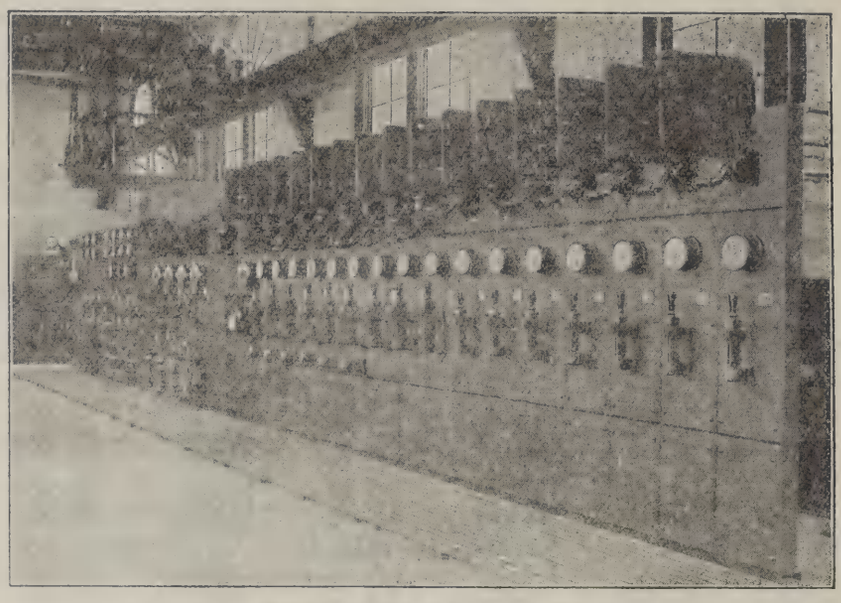
*List price for either individual or bus-bar operation.

Approximate weight, boxed, 100 pounds.

Order by Style Number

TYPE GD D.C. SWITCHBOARD PANELS

For 250 Volt, 2-Wire and 3-Wire, Light and Power Service and 600-Volt Railway Service



FRONT VIEW OF TYPICAL TYPE GD RAILWAY SWITCHBOARD

REAR VIEW OF SAME BOARD
Showing laminated Stud knife switches and circuit-breakers, neat and symmetrical arrangement of copper connections.

Application—Type GD switchboards have manually-operated circuit-breakers and are for the control of direct-current generators, direct-current feeders, and the direct-current side of synchronous converters. These panels should be used for all service of this class above 250 volts (except 600-volt mine service) and for other service beyond the capacity of type JD switchboards.

Capacity—Individual generator panels are listed up to 9000 amperes capacity. A complete switchboard composed of these panels is limited in ampere capacity only by the interrupting ability of the circuit-breakers. The limit is not reached in ordinary stations and for all practical purposes, the capacity of these boards may be considered as unlimited.

Panel Construction—Each panel consists essentially of three sections—bottom section 20 inches, middle 45 inches, and top 25 inches high—mounted on an angle-iron frame with channel base. The total height of the panel, including base is 92 inches.

General Description—The illustrations show more clearly than a written description, the first class appearance, rugged construction and symmetrical design of this line of panels.

Type SL seven-inch D'Arsonval round type ammeters and voltmeters, are regularly furnished with these panels. Customers preferring type GL illuminated dial meters may order them at an additional price, in place of the type SL.

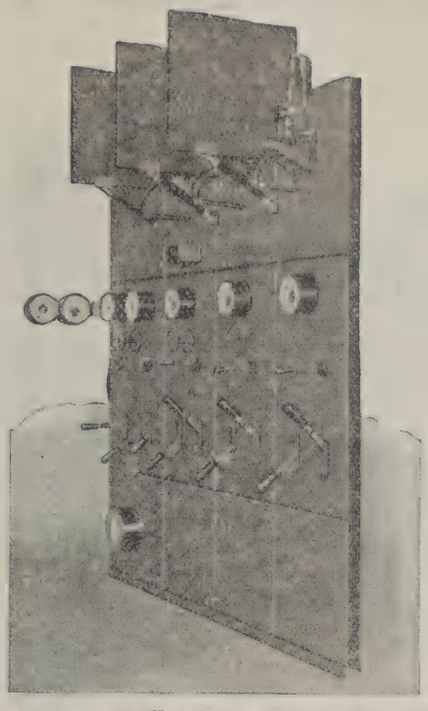
Knife switches and carbon circuit-breakers are of the highest grade of their respective kind, and are furnished with laminated studs for capacities above 1200 amperes. The carbon circuit-breakers furnished with this line of panels are type CA, the inherent features of design of which have been demonstrated by many years of satisfactory service, to be entirely adequate to meet the most exacting operating requirements.

A wiring diagram showing complete connections is furnished with each switchboard.

Further information will be furnished on request.

DIRECT-CURRENT SWITCHBOARD PANELS

For 1200- to 1500-Volt Service



TYPICAL 1200 OR 1500-VOLT DIRECT-CURRENT SWITCHBOARD
(WITH END BARRIER OMITTED)

Application—These panels are designed to control synchronous converters and motor-generator sets in 1200- to 1500-volt direct-current railway service. They are listed for the control of:

300 and 500 K. W., 3-phase, 25-cycle, 1200-volt D. C. synchronous converters.

500 and 1000 K. W., 6-phase, 60-cycle, 1200-volt D. C. synchronous converter sets, consisting of two synchronous converters in series.

500 and 750 K. W., 1200-volt D. C. generators driven by synchronous motors.

All of these panels are suitable for 1500-volt operation.

Panel Construction—Each panel consists of three sections, 2 inches thick with ½-inch bevels. The lower section is 25 inches high, the middle section 45 inches high, and the upper section 30 inches high. They are mounted on angle-iron frame with channel-iron base. The total height of the panel, including the base is 102 inches.

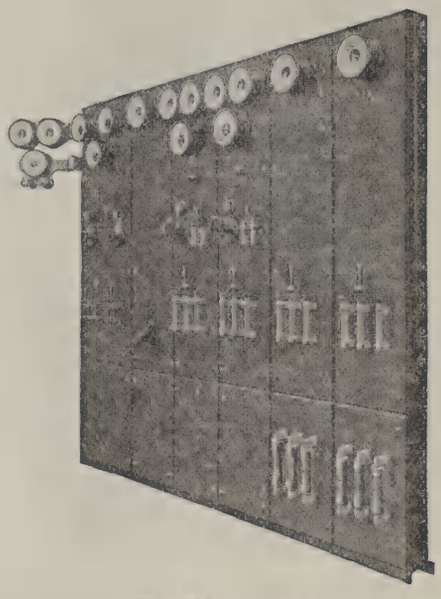
General Description—The quality of the apparatus provided is of the best. Type SL 7-inch D'Arsonval round-type ammeters and voltmeters, type A knife switches, and type CA carbon circuit-breakers are regularly furnished with these panels. The carbon breakers are mounted on the upper section of the panel, and are operated from an operating handle similar to that used with an oil switch, the handle being mounted on the middle section, and connected to the oil circuit-breaker by means of the usual bell crank and connecting rod mechanism. A type A knife switch in series with the carbon breaker is mounted on a small panel supported from the panel framework on the rear of the board. The knife switch is operated from a handle identical in appearance, location and method of operation, as the carbon breaker. Large barriers are installed between the carbon breakers on adjacent panels. providing ample insulation distances.

A wiring diagram, showing complete connections, is supplied with each switchboard.

Further information will be furnished on request.

TYPE EA SWITCHBOARD PANELS

For 240—480-Volt Alternating-Current Service



TYPE EA SWITCHBOARD

Application—Type EA switchboards are designed to control the alternating-current electrical equipment of industrial plants and small central and distributing stations where voltages are not over 480. They are applicable where service conditions permit the use of knife switches and enclosed fuses, and where the cost of a switchboard with oil switches and circuit-breakers is not justified.

Capacity—The capacity of a single generator panel is limited to 1000 amperes, a single feeder circuit to 600 amperes, and a complete switchboard composed of these panels to 2000 amperes in any section of the bus bars.

Where currents above these limits are involved special designs are usually necessary.

Where higher voltages than 480 are involved types EB, EC, EH, or EE switchboards should be selected, although switchboards of the type EA construction can be supplied for 600-volt service on special order.

Panel Construction—Each panel consists of two sections, 2 inches thick with ½-inch bevels. The lower section is 25 inches high and the upper section is 65 inches high. The panel is mounted on type E angle-iron frame with channel iron base, and the total height of the panel including the base is 92 inches.

General Description—The quality of the apparatus provided is of the best and conforms to the well known Westinghouse standard of excellence.

All indicating meters are of the well known 7-inch diameter type of highest grade, highly damped, accurate and with long open scales, making them more easily read than any other type. They can be supplied with either white or black dials.

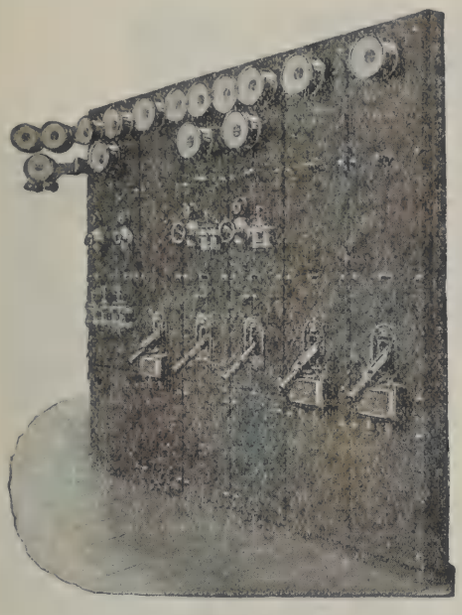
Type A knife-switches are furnished with standard panels. Enclosed fuses provide automatic overload protection for the feeder circuits. All fuses supplied are of the enclosed type.

A wiring diagram showing complete connections is supplied with each switchboard.

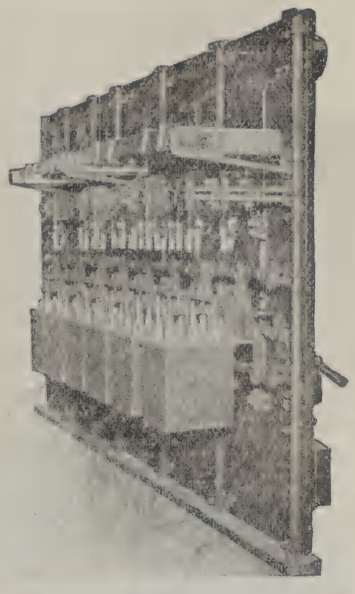
Further information will be furnished on request.

TYPE EB SWITCHBOARD PANELS

For 2400-Volt Alternating-Current Service Employing Hand-Operated Panel-Mounting Oil Circuit-Breakers



TYPE EB SWITCHBOARD



REAR OF TYPE EB SWITCHBOARD WITH PANEL-FRAME-MOUNTED OIL CIRCUIT-BREAKERS

Application—Type EB switchboards are designed to control the alternating-current electrical equipment of industrial plants and central and distributing stations, not exceeding 3000 kv-a. capacity and 2400 volts.

This type of construction is advisable for simple installations, where the oil switching devices are small and a very extensive switching equipment is not required. In considering the type of switchboards to apply, it should be remembered that good engineering avoids the crowding of apparatus and provides for large insulation distances. This point, which is kept foremost in Westinghouse panel design, contributes to the safety of attendants who must remove oil tanks, replace fuses, or do other work on the rear of the board.

Additional advantages in construction can often be obtained by the use of breakers mounted on panel frame work.

Where space on the rear of panels is limited, and it is desired to gain more accessibility at a limited expense, type EC construction with wall-mounted apparatus is recommended.

Capacity—The capacity of the individual generator or feeder circuits, where panels are to be incorporated as part of a type EB switchboard, is limited to 800 amperes, and that of a complete switchboard composed of these panels, to 2000 amperes in any section of the bus bars.

Panel Construction—Each panel consists of two sections, 2 inches thick with ½-inch bevels. The lower section is 25 inches high and the upper section 65 inches high. The panel is mounted on type E angle iron frame with channel iron base and the total height of the panel including base is 92 inches.

General Description—All indicating meters are of the well known seven-inch diameter, round type, of highest grade, highly damped and accurate, with long open scales, making them more easily read than any other type. They can be supplied with either white or black dials.

Automatic overload protection is provided for the feeder circuits. The oil circuit-breakers furnished with this class of panels are the type F.

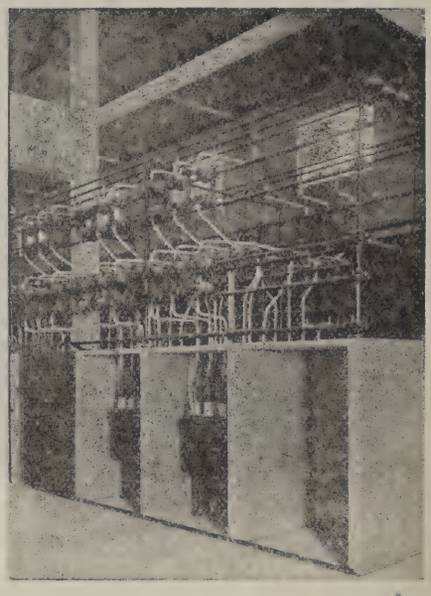
A wiring diagram showing complete connections is supplied with each switchboard.

Further information will be furnished on request.

TYPE EC AND EH SWITCHBOARD PANELS

For Moderate Capacity Alternating-Current Systems Employing Remote Hand-Operated Oil Circuit-Breakers

TYPE EC SWITCHBOARD CONSTRUCTION—WITH PIPE-FRAME-MOUNTING OIL CIRCUIT-BREAKERS



TYPE EH SWITCHBOARD CONSTRUCTION—WITH CELL-MOUNTING CIRCUIT-BREAKERS

Types EC and EH switchboards are essentially the same as type EB as far as front appearance of the switchboard panels themselves are concerned. The same high grade instruments are furnished, and panel construction is the same, the chief difference being the method of mounting the oil circuit-breaker equipment. With the type EC construction, the oil circuit-breakers are mounted on pipe-framework, and with the type EH construction, the oil circuit-breakers are arranged for cell-mounting.

Application—The electrical limitations in applying these EC and EH switchboards are 240 to 13200 volts for generator panels, 240 to 66000 volts for feeder panels, and a maximum capacity of 3000 amperes in any section of the main busbars.

The mechanical limitations in applying these switchboards are:

(a) The distance between the switchboard panels to the corresponding oil switching device.

(b) The power required to operate the switching devices through the system of bell cranks and connecting rods.

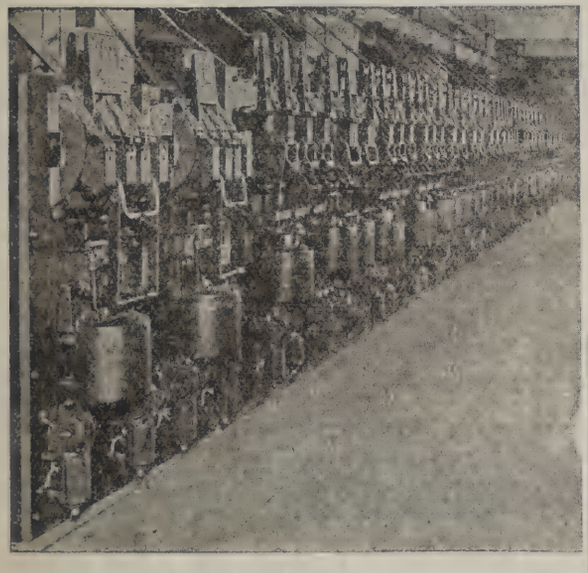
In general the total length of operating rods should not exceed 50 feet. For plants where the arrangement of the station requires a greater length of operating rods, and for larger plants and heavier capacities, electrically operated apparatus is recommended, as covered by the type EE switchboards.

Further information will be furnished on request.

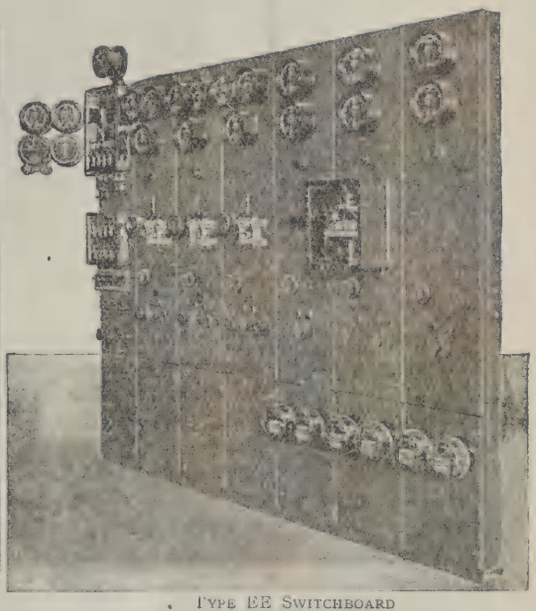
TYPE EE SWITCHBOARD PANELS

For Large Capacity Alternating-Current Systems Employing Electrically Operated Oil Circuit-Breakers

THE STRUCTURE IN THE BACKGROUND SHOWS A TYPICAL ARRANGEMENT USING CELL MOUNTED OIL CIRCUIT-BREAKERS



ELECTRICALLY-OPERATED HEAVY CAPACITY TYPE CA CARBON CIRCUIT-BREAKERS



TYPE EE SWITCHBOARD

Application—Type EE switchboards are designed to control the alternating-current electrical equipment of central and distributing stations and industrial plants. They are applicable for station capacity or voltages so high as to make it desirable to mount the switching equipment apart from the panels and where the station arrangement necessitates the use of electrically operated oil switches and circuit-breakers.

Electrically operated switchboards are also used for the control of heavy capacity direct-current carbon circuit-breakers.

Apparatus—The instruments, relays, oil switches and circuit-breakers, instrument transformers, disconnecting switches, etc., are of the highest grade of their respective kind.

A wiring diagram showing complete connections is supplied with each switchboard.

Further information will be furnished on request.

TYPES JD AND ED EXCITER AND VOLTAGE REGULATOR PANELS

For 125- and 250-Volt Exciter Circuits

TYPE JD EXCITER PANEL
For One Exciter.

TYPE ED EXCITER PANEL
For Two Exciters.

Application—These panels are for the control of the exciters used with alternating-current generators and are essentially the same as other two-wire direct-current generator panels except that no automatic protection is provided. Panels are also included suitable for Westinghouse generator voltage regulators, either with or without control for motor driven exciters. They are designed to match and form a part of the standard alternating-current switchboards.

Panel Construction—Each type JD panel consists of a single slab 48 inches high, 1½ inches thick, with ⅜-inch bevels on front edges, mounted on a type J switchboard pipe frame. The total height of the panel is 76⅜ inches.

Each type ED panel consists of two sections, 2 inches thick with ½-inch bevels on front edges. The lower section is 25 inches high and the upper section 65 inches high. The panel is mounted on a type E angle-iron frame, with channel-iron base. The total height of panel including the base is 92 inches.

General Description—The apparatus included for these panel equipments is of the highest grade. The instruments are the 7-inch diameter type SL, operating on the D'Arsonval principle, with single air-gap. Knife switches are the type A with plain break. Standard practice in supplying switchboard apparatus for control of exciter circuits is to furnish non-automatic switching devices. Where exciters are driven by alternating-current motors, the automatic circuit-breaker in the motor supply circuit will be furnished with a high overload setting. This practice is justified both because contrary practice would jeopardize the continuity of the alternating-current service, and because modern exciting apparatus is very reliable.

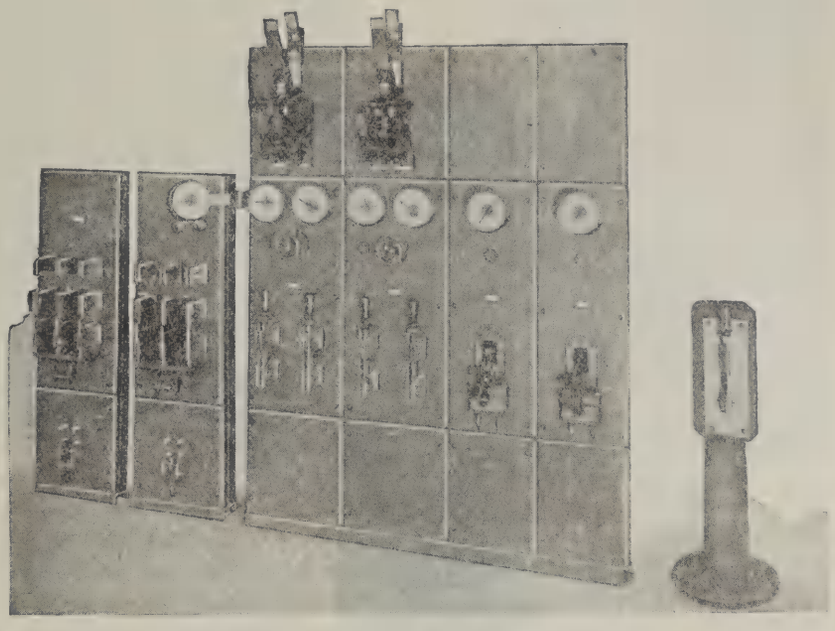
However, if, in the judgment of a purchaser, special conditions make it necessary to provide automatic protection in an exciter circuit, the Company is prepared to supply suitable devices on request, even though at variance with its usual recommendations and practice.

A wiring diagram showing complete connections is furnished with each switchboard.

Further information will be furnished on request.

TYPE GC AND GE SYNCHRONOUS-CONVERTER SWITCHBOARD PANELS

For 6-Phase Synchronous Converters—2000 KW Maximum
600 Volts—1500 KW Maximum, 250 Volts—Direct Current



TYPICAL ROTARY CONVERTER SWITCHBOARD

Application—These panels are designed for the control of commutating-pole synchronous converters. They match up with and present a uniform appearance when made a part of the standard 90-inch alternating-current or direct-current switchboard. This line of panels includes designs for the complete line of Westinghouse six-phase converters of the maximum ratings given above, and contemplate the use of both hand and electrically operated oil circuit-breaker equipments on the A.C. side for the protection of the step-down transformer and the converter.

Apparatus—Type S seven-inch meters with long scales, full open face and dead-beat characteristics are regularly furnished. Reactive-factor meters are supplied with the standard synchronous converter equipments, as they give an emphatic indication of the idle component of the volt-amperes. These meters are single phase and indicate the reactive-factor of one phase of the converter which is sufficient for all operating conditions.

The knife switches are type A and are furnished with round studs up to 1200 amperes D. C. and 1000 amperes A. C. and with laminated studs for higher capacities. Laminated stud switches have the latest design pressure-moulded studs of hour-glass cross-section; the former insuring high and dependable conductivity and the latter ample radiation surface. Studs will be furnished with either vertical or horizontal laminations or a combination of both as may be required.

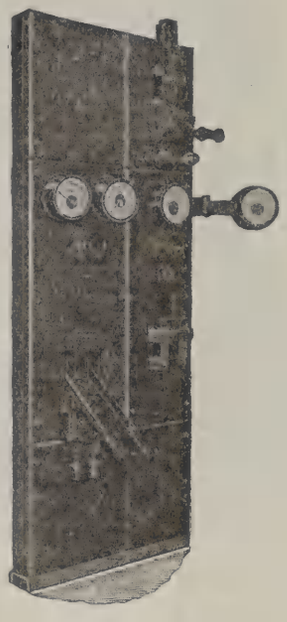
Oil circuit-breakers are of the standard types as required for the various commercial voltages,—either hand or electrically operated, and arranged for either wall or pipe-frame mounting.

A wiring diagram showing complete connections is supplied with each switchboard.

Further information will be furnished on request.

TYPE GB AND GC SYNCHRONOUS-MOTOR SWITCHBOARD PANELS

Voltages and Maximum Capacities are: 220, 440 and 550 Volts, 433 H.P.; 2200, 6600 and 13200 Volts, 2140 H.P.



Application—These panels are designed for the control of synchronous motors in their various applications: as synchronous condensers, for driving mechanical load, and for the combination of these two uses. Only panel designs for self-starting motors are listed as standard, although by the addition of optional equipment panels can be adapted for the control of any desired equipment.

Apparatus—All indicating meters are type S, seven inches in diameter, of highest grade, highly damped, accurate, and with long open scales, with either white or black dials, as desired.

No field switch is included with the standard panels, as with Westinghouse self-starting synchronous motors none are required, the motor being started with the field circuit closed through the field rheostat and the armature of its individual exciter.

The starting equipment consists of a double-throw starter operated from two handles, non-automatic for starting and automatic with overload inverse-time-limit and low-voltage release for running. The handles are mechanically interlocked so that only one side of the starter can be closed at a time and so that the starting side must be closed first. For the smaller equipments the type QF auto-starter is used, which is a special four-pole double-throw oil circuit-breaker with special movable and stationary contact arrangement. For the large capacities a combination of oil circuit-breakers mechanically interlocked and operated essentially as a double-throw switch are used.

Oil circuit-breaker equipment is furnished for both panel-mounting and remote-pipe-frame mounting.

A wiring diagram showing complete connections is supplied with each switchboard.

Further information will be furnished on request.

GENERATOR VOLTAGE REGULATORS

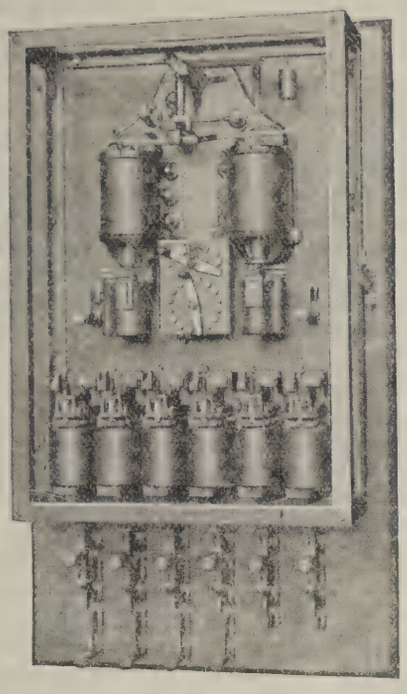


FIG. 1—TYPE AB-4
GENERATOR VOLTAGE REGULATOR

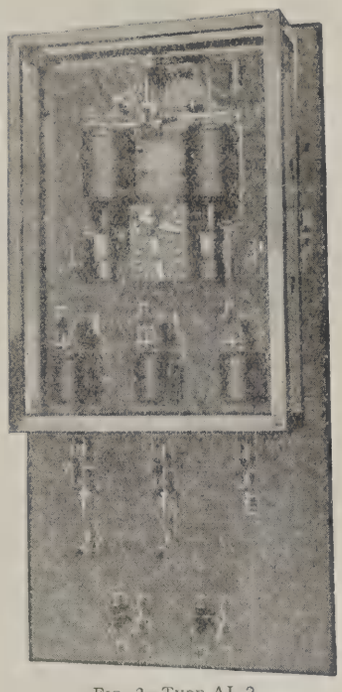


FIG. 2—TYPE AL-2
GENERATOR VOLTAGE REGULATOR

The problem of voltage regulation on constant-potential circuits is one of considerable importance, chiefly because of the necessity of giving satisfactory service to the customers of operating companies. Inadequate voltage regulation reduces the quality of the service and, consequently, its commercial value.

The operating company is no longer purely a lighting company, but largely power and lighting, hence, the regulation of generator voltage has become more difficult. The necessity of using an automatic voltage regulator is increased by the fact that the present design of alternating-current generators, for reasons of economy, gives poor inherent regulation. The voltage regulator automatically maintains the system voltage at a value that results in a steady voltage at the required point, a result that is obviously impossible of accomplishment by hand.

USES OF VOLTAGE REGULATORS

Alternating-Current Regulators—The various uses to which alternating-current voltage regulators are best adapted fall into the following divisions: (a) the maintenance of constant voltage at generator, bus, or some predetermined center of distribution; (b) the maintenance of constant voltage at the end of transmission lines by the control of synchronous condensers or synchronous boosters; (c) the control of booster-type rotaries; (d) the control by special regulators of synchronous condensers applied to local network or distributing systems for voltage regulation and power factor correction; and (e) the maintenance of constant current instead of constant voltage.

Direct-Current Regulators—The application of direct-current voltage regulators is very much limited and should be made with the greatest of care. It is confined to the maintenance of constant voltage on direct-current generators where the plant is used for power purposes only, and to the maintenance of constant current.

Where a direct-current plant is too large for the limited capacity of the D. C. regulator, a D.C. regulator made similar to the alternating-current type may be used to control one or more exciters for the plant. This application is suitable for a mixed power-and-lighting service.

A modified type of the D.C. regulator can be applied to flywheel motor sets, and thereby limit the maximum current drawn from the supply source to a predetermined value.

GENERATOR VOLTAGE REGULATORS—Continued

CONSTRUCTION

Westinghouse voltage regulators, arranged in a suitable case, are constructed for bracket, panel, or pedestal mounting, as required by installation conditions. Bracket-mounted regulators are provided with a standard black-marine slate base; or, if desired, with a blue Vermont marble base, at an increase in list price.

The regulator parts are arranged in the case with the control system located in the upper part supported on a small cast base, and with the rheostat-shunting relays arranged in horizontal rows at the bottom. The control element and relays are self-contained units and either may be removed from the base without disturbing its adjustment.

Any size regulator can be designed to be mounted on a 16-inch panel. Where the number of rheostat-shunting relays exceeds ten, a second case containing relays only is supplied.

The control system for alternating-current and separately-excited direct-current generators consists of the main-control magnet and the vibrating magnet, with the main contacts between them. The magnets are of the solenoid type, and are very sensitive. They are provided with adjustable dashpots to permit adjustment of regulation to suit the characteristics of the system.

One of the relays, called the vibrating-magnet relay, is used to govern the operation of the vibrating magnet. On the larger size regulators, one or more master relays are used to control a group of rheostat-shunting relays, thus relieving the main contacts of handling control currents beyond their capacity.

The use of the master relay is made possible by the alternating-current control and permits of the construction of regulators with as many as 60 rheostat-shunting relays. The master relay introduces no time lag in the response of the regulator, nor in the voltage regulation, since the vibrating-magnet relay and the rheostat-shunting relays operate simultaneously.

The control system of regulators for self-excited direct-current generators consists of a single solenoid actuating the main contacts, no vibrator being required. The rheostat-shunting relays are located in horizontal rows in the lower part of the regulator case.

The general appearance and finish of all regulators is in harmony with the highest class switchboard practice.

Disconnecting switches and transfer switches of improved design are located below the case.

OPERATION

Westinghouse voltage regulators for alternating-current generators regulate the generator voltage indirectly by varying the exciter voltage.

Referring to Fig. 3, the main control magnet has its core attracted upward. Its core stem is connected to the floating lever, which is pivoted to the bell-crank lever of the vibrating magnet. A counterweight is used to assist the pull of the main control magnet, and to bring the lever and core to a balanced position at the normal voltage to be regulated. The vibrating magnet also has its core attracted upward. Its core stem is connected to one end of the bellcrank lever which is pivoted to the base, and its opposite end carries the floating lever of the main control magnet. The pull of this vibrating magnet is assisted by a single spring as shown. These two magnets are energized from the same voltage transformer, and actuate the movable main contact into and out of engagement with the fixed contact.

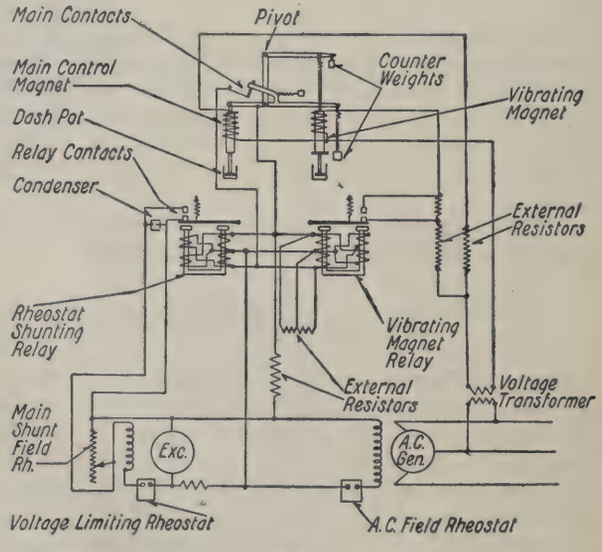


FIG 3—SCHEMATIC DIAGRAM OF TYPE AB-1 REGULATOR

An inspection of schematic diagram, Fig. 3, shows that the closure of the main contacts causes all relay contacts to close. One of the relays, called the vibrating relay, is connected so that the closure of its contacts shunts a small portion of the resistance in series with the vibrating magnet, thus increasing its pull and opening the main contacts. The opening of the main contacts opens all relay contacts and inserts the full resistance in the vibrating magnet circuit, weakening the pull and closing the main contacts again.

From the above cycle, it is seen that for any given position of the floating lever, a condition of continuous vibration results. A necessary condition to the continuous vibration of the system is that the weight

of the vibrating magnet core and lever must be exactly balanced by the tension of the control spring and average pull of the magnet. Any change in the tension of the control spring results in an equal change in the average magnet pull. For a given line voltage there is a definite magnet pull when the contacts are closed, and a definite pull of less value when the contacts are opened. The average magnet pull must be a function of the time of the contact engagement. For any given position of the floating lever, there is a corresponding position of the bell crank lever and tension of the control spring. However, on account of the balanced condition there must be a corresponding average magnet pull and time of contact engagement.

The rheostat-shunting relay contacts open and close across the shunt field rheostat of the exciter, and the effective resistance of the rheostat is determined by the time of contact engagement. For any effective resistance, there is a corresponding exciter voltage, and, therefore, A.C. voltage.

The time of contact engagement, as used here, means the ratio of the time the contacts are closed to the total time for opening and closing.

As the control element is energized from the A. C. generator the main control magnet will assume a position such that a time of contact engagement is maintained sufficient to develop an exciter voltage and therefore an A.C. voltage capable of balancing the core weight. Any variation in line voltage changes the position of the floating lever in such a manner as to vary the excitation and restore the balance.

In the standard range regulator, the rheostat-shunting relays are energized from the exciter circuit.

For the broad range regulator, the operation is similar to that of the standard range regulator, except that rheostat-shunting, vibrating, and master relays are energized from an independent source of direct current.

For self-excited direct-current generators, the rheostat-shunting relays operate directly on the generator-field rheostats, the control system being actuated from the direct-current mains through a suitable resistance.

For direct-current machines having a separate exciter, the rheostat-shunting relays operate on the exciter rheostat the same as in the alternating-current regulators.

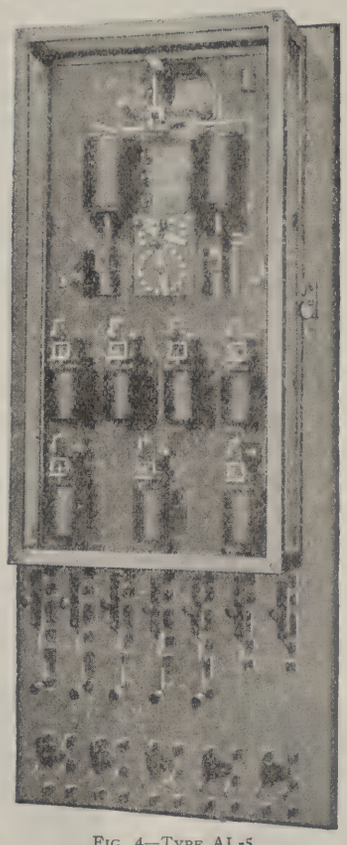


FIG. 4—TYPE AL-5
GENERATOR VOLTAGE REGULATOR

APPLICATION

The successful application of voltage regulators depends on several factors entirely independent of the size and design of the regulator itself. It is not only necessary that the regulator be properly designed, but it is also essential that the exciters, generators, and prime movers possess characteristics that will harmonize with each other and will assist in keeping the voltage at the desired value under rapidly changing load conditions. In general, the following conditions should be approached as nearly as possible in order to obtain satisfactory results:

1. Prime movers must be provided with proper automatic governors that will respond instantly to changes in load and keep the speed reasonably constant (within 3 per cent to 4 per cent from no-load to full-load).

2. Alternating-current generators should have as nearly as possible the same percentage range of excitation from no-load to full-load.

3. Exciters must be capable of delivering sufficient voltage to take care of the alternating-current generator fields under full-load conditions, 80 per cent power factor, plus a certain additional voltage. This additional voltage above the steady exciter voltage required to maintain constant bus voltage under full-load conditions, is necessary in order that the regulator will continue to vibrate and thereby have control of the exciter.

4. Exciters (where more than one are to be considered) must be adjusted to operate in parallel under all loads and at any point on the saturation curve.

5. Exciters for 125-volt service should be able to build their voltage up or down between the limits of 30 and 125 volts in 5 seconds or less under load consisting of generator field circuits. The time-constant should be the same for exciters of other rated voltages over proportional ranges. Exciters with greater time-constants than this may not permit the regulator to maintain constant voltage with rapidly fluctuating load.

6. 125-volt interpole exciters must be able to develop at least 135 volts with the series winding disconnected, and should be so operated. The series winding must be cut out of circuit in order to secure a satisfactory time constant. In general, the exciter must be capable of developing a voltage 10 to 15 per cent in excess of that required by the A.C. generator at full load, 80 per cent power factor, the A.C. generator-field rheostat being adjusted so that with 60 volts on a 125-volt exciter the A.C. generator develops normal voltage at no load.

The question of the application of these regulators to generating stations required to operate in parallel should be referred to the Works, giving complete data on the existing or proposed system as indicated in the paragraph under Line Drop Compensation.

On small systems, supplying a mixed lighting-and-power load, where induction motors are sometimes thrown directly on the line without starting devices, the momentary current required may be of such a value as to affect the feeder system and cause a noticeable flicker in the lights. Automatic regulating devices in the generating station cannot be made sensitive enough to prevent this effect under such conditions.

FIG. 5—TYPE AC-8 VOLTAGE REGULATOR EXCITERS IN PARALLEL

FIG. 6—SPECIAL 40-RELAY REGULATOR FOR LAURENTIDE POWER CO.

Standard Range System—The standard alternating-current generator-voltage regulator is adapted for voltage regulation of alternating-current generators requiring a nominal excitation range of 60 to 125 volts.

Where exciters permit, however, full automatic voltage regulation can be obtained by means of the standard regulator within the range of 1 to 2½, or 60 to 150 volts for 125-volt exciters and 120 to 300 or 250-volt exciters.

Broad Range System—With the broad range system of regulation, full-automatic voltage regulation can be obtained for all ranges of excitation. The standard regulator can be made broad range by energizing the relays from a separate source of direct current, such as a small motor-generator set or a storage battery.

The broad range system of regulation is directly applicable to synchronous condensers for maintaining voltage at the receiving end of a transmission line by adjusting the wattless load of the synchronous condenser, either lagging or leading, as required.

Voltage Adjusting Rheostats—Taps are always provided on the external resistor whereby the voltage regulated can be varied from 104 volts secondary to 116, in steps of 6 volts.

Where, for any reason it is desired to vary the

operating voltage of the system from time to time, a voltage adjusting rheostat should be used in the control-element circuits for the fine adjustment of voltage, instead of varying the counterweight. This rheostat has a sufficient resistance to give an adjustment of about 6 volts either way from the normal voltage when properly applied. The use of this rheostat is recommended in all applications, as it is a much more convenient and satisfactory method of adjusting the voltage while the regulator is in operation.

For the larger systems a rheostat having a range of 15 volts either way from normal can be supplied on special order.

Single Operation of Exciters and Parallel Operation of Generators—By the use of a control element energized entirely from the A.C. system the operation of alternating-current generators in parallel with the exciters operating singly, has been made possible. The regulators for such service are equipped with special transfer switches so that the D.C. circuit for energizing the relays may be transferred to any exciter that may be in operation.

Relays—The number of relays for any given exciter may be approximated very closely where the speed (r.p.m.) and the kilowatt capacity is known.

For standard 125-volt, 1200-r.p.m. or higher speed exciters, one relay for every 25 kilowatts of exciter capacity is required. One condenser section per relay is required.

For standard 125-volt, 900-r.p.m. exciters, one relay for every 18 kilowatts of exciter capacity and one condenser section per relay is required.

For standard 125-volt, 600-r.p.m. exciters, one relay for every 12 kilowatts of exciter capacity, and one condenser section per relay is required.

For slower speed exciters or for exciters of other than 125 volts, refer to Works with form 1046-G completely filled out.

In addition to condensers for relays, note that one condenser section is required for every master relay used in connection with the larger size of regulators.

A closer check on the number of relays for a given exciter may be determined approximately as follows: With no load on the exciter, turn its field rheostat all out, thus giving a maximum armature voltage. Measure field amperes at this maximum voltage and allow 5 amperes per relay with one condenser section per relay. If field current exceeds 16 amperes maximum at 30 per cent above normal voltage, the case should be referred to the Works.

LINE DROP COMPENSATION

For complete line drop compensation it is necessary to consider two factors, namely, inductive drop and ohmic drop in the line and transformers between the generator bus and the distributing center. The inductive component of line drop is at right angles to the load current and is compensated for by introducing into the potential circuits of the regulator a voltage in phase with and proportional to the actual inductive drop. An **external compensator**, energized from series transformers, properly connected, accomplishes this purpose. This compensator is provided with adjustable dials by means of which the voltage introduced in the regulator circuits, for a given ampere load, may be varied, thus permitting adjustment for the percentage inductive load.

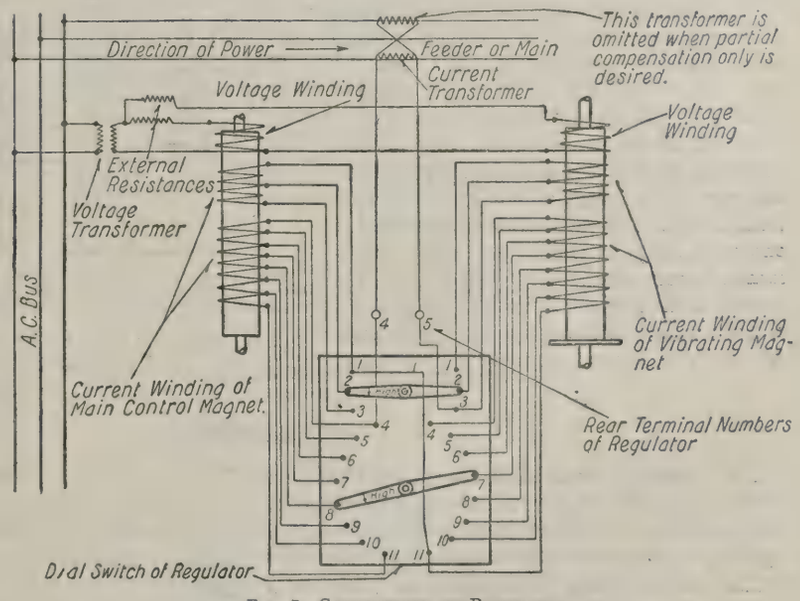

This transformer is omitted when partial compensation only is desired.
Direction of Power
Feeder or Main Current Transformer
Voltage Winding
Voltage Winding
External Resistances
Voltage Transformer
A.C. Bus
Current Winding of Vibrating Magnet
Current Winding of Main Control Magnet.
Rear Terminal Numbers of Regulator
Dial Switch of Regulator

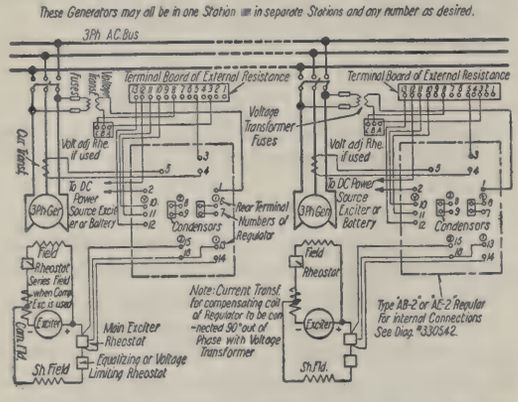
FIG. 7—CONNECTIONS OF REGULATOR FOR OHMIC COMPENSATION ON 3-PHASE SYSTEMS

The ohmic component of line drop is in phase with the load current and is compensated for by energizing the current windings of the regulator coils from series transformers properly connected. The regulator control magnets are then affected by a magnetizing force which is in phase with the load current. The current windings on the regulator coils are divided into sections and connected to an adjustable dial. This provides a ready means of obtaining the proper percentage of ohmic compensation.

Figure 9 shows the connections to three-phase systems for this method.

GENERATOR VOLTAGE REGULATORS—Continued

To obtain complete line drop compensation it is necessary to adjust both the compensating devices to agree with the line characteristics. Where ohmic line drop compensation only is desired no external compensator is necessary. The current windings on the regulator coils, when properly energized from


These Generators may all be in one Station or in separate Stations and any number as desired.
3Ph A.C.Bus
Terminal Board of External Resistance
Terminal Board of External Resistance
Voltage Transformer Fuses
Volt adj Rhe. if used
Volt adj Rhe. if used
To D.C. Power Source Exciter or Battery
To D.C. Power Source Exciter or Battery
3Ph Gen
3Ph Gen
Condensers
Condensers
Rear Terminal Numbers of Regulator
Field Rheostat Series Field when Comp'd Exc. is used
Field Rheostat
Exciter
Exciter
Main Exciter Rheostat
Equalizing or Voltage Limiting Rheostat
Sh. Field
Sh. Fld.
Note: Current Transf. for compensating coil of Regulator to be connected 90° out of Phase with Voltage Transformer
Type 'AB-2' or 'AE-2' Regulator for internal Connections See Diag. #330542.

Where reactance between points regulated exceeds 8 per cent cross current, current transformers may be omitted.

FIG. 8—PARALLEL OPERATION OF GENERATOR—VOLTAGE REGULATORS

series transformers, accomplish this result. For three-phase systems, two current transformers in vector parallel are required for complete compensation. The connections are shown in figure 7. The transformers must be in the same legs of the circuit as those to which the voltage transformer is connected in order that the resultant current will be in phase with the voltage at 100 per cent power factor.

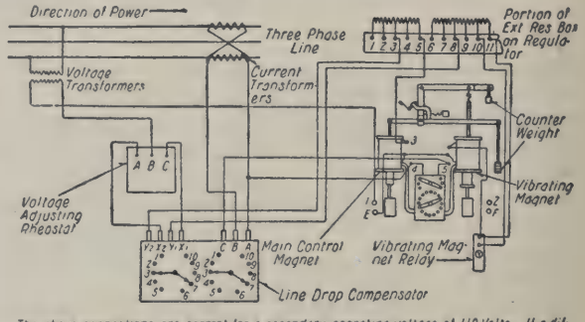
Partial ohmic compensation may be obtained on three-phase systems by energizing the current windings of the regulator coils from a single current transformer connected in one of the legs to which the voltage transformer is connected. With this method, the current from the current transformer is 30° out of phase with the voltage and will therefore not give as accurate results as when two current transformers are used. This method is also indicated in fig. 7.

In single or two-phase systems, ohmic compensation is obtained by energizing the current windings of the regulator coils from one current transformer connected in one of the legs to which the voltage transformer is connected.

When it is desired to correct for line-drop or power-factor changes by means of a separate line drop compensator in conjunction with the regulator outfit, information as to the equipment necessary should be secured from the Company.

When information is sent to the Company regarding line drop compensation, the following should be given: The approximate regulation of transmission line, at its rated capacity and zero power factor; length of transmission line, and capacity and number of stations; number of regulators to be applied and total capacity of transformer bank at each station that operates on the line.

Where stations operate in parallel, and each is controlled by a voltage regulator, it is possible to compensate for the ohmic drop only, as inductive compensation destroys the stability of the system. The point in the system at which it is desired to maintain constant voltage should be specified in order to obtain proper compensation.



The above connections are correct for a secondary operating voltage of 110 Volts. If a different operating voltage is required, refer to the diagram of connections furnished with the Voltage Adjusting Rheostat for the proper connections to the external resistor.

FIG. 9—CONNECTIONS OF REGULATOR AND EXTERNAL COMPENSATOR FOR 3-PHASE SYSTEMS

ACCESSORIES

Condensers are required for connection across the rheostat-shunting relays, to minimize the contact wear occasioned by the sparking incident to the opening of the shunt across the exciter field rheostat.

However, the state of the art is such that it is sometimes impossible to anticipate the proper number of condenser sections to apply for exciters of certain inherent characteristics.

Exciter Rheostats—When a regulator equipment is being added to a plant in operation, the existing exciter rheostats should be checked to determine whether they have sufficient resistance to permit of adjusting the exciter for the proper time constant. If not, new exciter rheostats must be provided. If the shunt-field rheostat of the exciter used for hand control is unsuitable for use with the regulator, it can in many cases be used as the voltage-limiting rheostat.

Auxiliary Exciter Rheostats—Where two or more exciters, operating either singly or in parallel, are controlled from a regulator, the use of an auxiliary rheostat is required in the field circuits of each exciter, to adjust the time constants and maximum voltage of all the exciters to the same values in order that they will carry their proper share of load.

GENERATOR VOLTAGE REGULATORS—Continued

Where only one exciter is controlled by a regulator the use of an auxiliary rheostat is not required unless too high a maximum voltage and, consequently, too large a field current, is obtained when the main exciter rheostat is short-circuited by the relay contacts.

Voltage Transformers of 400-volt-ampere capacity with fuse blocks and fuses are required for all alternating-current voltage regulators. For price, outline dimensions, etc., refer to section on "Westinghouse Instruments and Relays."

Current Transformers are required only when compensation for line drop in some particular circuit is desired, or when two or more regulators are operating in parallel. One current transformer is required for partial compensation or two for full compensation, and one transformer is necessary for each regulator where two or more regulators operate in parallel. No current transformer is necessary when it is desired to maintain constant bus voltage. For prices, outline dimensions, etc., refer to section on "Westinghouse Instruments and Relays."

EXCESS VOLTAGE PROTECTION

With the ordinary type of generator voltage regulator, when a short circuit on a system is cleared away, a dangerous voltage rise is inevitable. On the occurrence of a short circuit on a system without some protective device, the main contacts of the regulator close, causing the relay contacts to close and the exciter voltage to build up to the maximum value. When the short is cleared away, a high voltage results, due to the high exciter voltage and consequent high generator field current, which lasts until the regulator has had time to again become operative.

This condition of excessive voltage can be prevented by means of the **excess voltage protective device,** which can be applied to any Westinghouse A.C. regulator. A diagrammatic view of this device is shown in Fig. 9. It consists of an undervoltage relay in combination with a direct-current control element connected in the main-contact circuit of the alternating-current voltage regulator. The contacts of the D.C. element and the relay are connected in parallel, the pair being in series with the main contacts of the regulator. The D.C. element is energized from the exciter bus, and the relay from the potential transformer supplying the A.C. regulator.

A short circuit coming on a system equipped with this protective device immediately causes the main contacts of the regulator to close and the A.C. relay contacts to open, on account of the drop in the A.C. voltage. As soon as the exciter voltage builds up to the point for which the D.C. element is adjusted, the contacts of this element begin to operate and to regulate the exciter voltage in the same manner that the regulator contacts normally do, so that the exciter voltage can never rise above the predetermined point, which is usually a little above the no-load excitation value required by the A.C. generators. When the short circuit is relieved, therefore, no excessive field current exists to produce a dangerous rise in A.C. voltage. The moment the A.C. voltage rises above the setting of the undervoltage relay, the contacts of the relay close and put the A.C. voltage regulator back into serivce.

This protective device is not included in the style number of the regulator, but can be obtained on special order, price on application. When ordering, give the type of regulator, voltage of the exciter system, frequency of the A.C. system, the excitation required by A.C. generators to give normal voltage at no-load, and the secondary operating voltage.

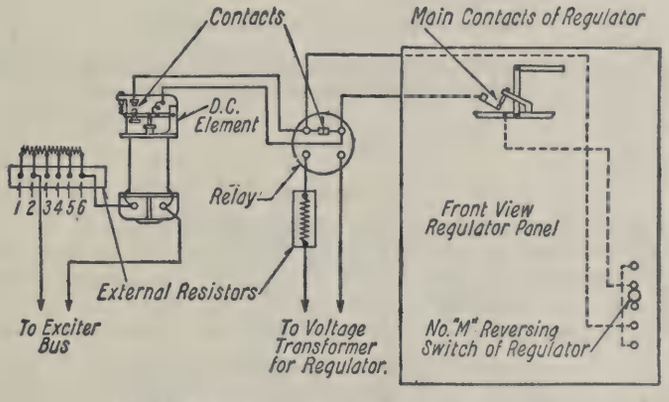


FIG. 10—DIAGRAMMATIC VIEW OF EXCESS VOLTAGE PROTECTIVE DEVICE

INSTRUCTIONS FOR ORDERING

Style number and list price include regulator with slate base and external resistor.

Condensers and brackets must be ordered separately and are listed below under "accessories." Fuse blocks and fuses, and voltage transformers, when required, must be ordered from their respective catalogues. For information regarding rheostats, refer to separate paragraph on "Rheostats."

Each inquiry for quotation must be accompanied by form 1045 for direct-current regulators and form 1046 for alternating-current regulators. Complete information given at the time of ordering prevents unnecessary correspondence and delay in shipment.

Fac-similes of forms 1045 and 1046 are shown on following pages.

PRICES

Alternating-Current Regulators

Prices given are for regulators for 125-volt exciters; regulators for 250-volt exciters will be furnished at same price. Prices for other voltages upon application.

Bracket-Mounted

Style number and price include regulator, mounted on black marine finished slate base, 1¼ inches thick. For blue Vermont marble or Natural Black Slate base, increase list price $27.00. For White Italian and Pink Tennessee Marble base, increase list price $35.00.

Style No. 25 and 60 Cycles	Type	Number of Master Relays	Size of Base Width	Size of Base Height	Approx. Shipping Wt., Lbs.	List Price
	For Alternating-Current Generators with 125-Volt Exciters in Parallel Range of Excitation 60 to 150 Volts					
243766	AB-1	0	16	27⅝	280	$1600 00
243767	AB-2	0	16	27⅝	290	2030 00
243768	AB-3	0	16	27⅝	300	2390 00
243769	AB-4	1	16	27⅝	305	2705 00
243770	AC-5	1	16	33	320	2915 00
243771	AC-6	1	16	33	325	3090 00
243772	AC-7	1	16	33	330	3250 00
243773	AC-8	1	16	33	335	3450 00
243774	AC-9	1	16	33	340	3505 00
243775	AC-10	1	16	33	345	3620 00
	For Alternating-Current Generators with 125-Volt Exciters not in Parallel Range of Excitation 60 to 150 Volts					
243864	AL-2	0	16	33	305	2100 00
243865	AL-3	0	16	33	310	2490 00
243866	AL-4	1	16	33	315	2825 00
243867	AM-5	1	16	38½	320	3190 00

Panel-Mounted

Style number and list price include regulator, suitable for mounting on switchboard panel 2 inches thick. Price includes mounting of regulator on panel at Works and includes standard 90-inch black marine slate panel of suitable width, with ½-inch bevels. For blue Vermont marble or Natural Black Slate panel increase list price $40.00. For White Italian and Pink Tennessee Marble, increase list price $50.00. Where purchaser furnishes panel the list price may be reduced $130.00.

Style 25 and 60 Cycles	Type	Number of Master Relays	Panel Width Inches	Dimensions of Regulator Width Inches	Dimensions of Regulator Height Inches	Approx. Shipping Wt., Lbs.	List Price
	For Alternating-Current Generators with 125-Volt Exciters in Parallel Range of Excitation 60 to 150 Volts						
243812	AE-1	0	16	16	28	880	1700 00
243813	AE-2	0	16	16	28	890	2160 00
243814	AE-3	0	16	16	28	900	2515 00
243815	AE-4	1	16	16	28	905	2810 00
243816	AF-5	1	16	16	33	910	3055 00
243817	AF-6	1	16	16	33	925	3220 00
243818	AF-7	1	16	16	33	930	3300 00
243819	AF-8	1	16	16	33	935	3515 00
243820	AF-9	1	16	16	33	940	3635 00
243821	AF-10	1	16	16	33	945	3755 00
243822	AG-11	2	16	16	50	1050	3900 00
243823	AG-12	2	16	16	50	1055	4015 00
243824	AG-14	2	16	16	50	1060	4715 00
243825	AH-16	2	16	16	60	1065	5020 00
243826	AH-18	2	16	16	60	1070	5300 00
243827	AH-20	2	16	16	60	1075	5555 00
	For Alternating-Current Generators with 125-Volt Exciters not in Parallel Range of Excitation 60 to 150 Volts						
243872	AN-2	0	16	16	33	905	2245 00
243873	AN-3	0	16	16	33	910	2625 00
243874	AN-4	1	16	16	33	915	2920 00
243875	AO-5	1	16	16	38½	920	3175 00

Order by Style Number

GENERATOR VOLTAGE REGULATORS—Continued

Direct-Current Regulators

Prices given are for 125-volt and 250-volt regulators. 550-volt regulators will be furnished without change in price.

Bracket-Mounted Regulators for Self-Excited D. C. Generators

Style number and list price include regulator mounted on black marine finished slate base, 1¼ inches thick. For blue Vermont marble or Natural Black Slate base, increase the price $27.00. For White Italian and Pink Tennessee Marble base, increase list price $35.00.

Style No. 125 Volts	Style No. 250 Volts	Type	Number of Master Relays	Size of Base Width Inches	Size of Base Height Inches	Approximate Shipping Weight, Lbs.	List Price
243876	243886	DA-1	0	8⅞	15¼	140	$ 965 00
243877	243887	DB-2	0	12½	25	150	1375 00
243878	243888	DB-3	0	12½	25	155	1560 00
243879	243889	DB-4	0	12½	25	160	1665 00
243880	243890	DB-5	0	12½	25	165	1790 00
243881	243891	DB-6	0	12½	25	170	1905 00
243882	243892	DB-7	0	12½	25	175	2035 00
243883	243893	DB-8	0	12½	25	180	2120 00
243884	243894	DB-9	0	12½	25	190	2225 00
243885	243895	DB-10	0	12½	25	200	2335 00

Prices for panel-mounted direct-current regulators type DC-1 and DD-2 to DD-10 are $98.00 higher than above list prices.

Regulators for Separately-Excited D. C. Generators

Style No. 125 Volts	Style No. 250 Volts	Type	Mounting	Dimensions of Regulator Width Inches	Dimensions of Regulator Height Inches	Approx. Shipping Weight, Lbs.	List Price
243916	243918	DK-1	Bracket	16	27⅝	210	$1545 00
243917	243919	DN-1	Panel	16	28	810	1645 00

The direct-current regulators listed above do not include provision for line drop compensation, but this feature can be supplied upon special order.

Pedestal-Mounted Regulators

For regulators used with alternating-current generators with 125-volt exciters in parallel, and for direct-current regulators, regulator mounted on suitable pedestal can be furnished at an incease of $500.00 over list price of panel-mounted regulator.

Accessories

Excess Voltage Protective Device

Style No.	Description	List Price
289655	s For 125-Volt Exciters	$750 00
289656	s For 250-Volt Exciters	750 00

Style number includes necessary resistor.

Condensers

Style No.	Description		List Price
276225	Condenser section, one micro-farad capacity	Each	$37 50
*257236	Frame Mounting for condensers, two required per set of condensers,	Per Set of Two	5 00

Approximate shipping weight of each condenser section, 5 pounds.

Voltage Adjusting Rheostat

Style No.	Description	List Price
254200	Range of Adjustment of secondary voltage, 6 volts either way from normal	$250 00

Order by Style Number

Brackets

For Supporting A. C. Regulators at Either End of Switchboard

Two brackets required per regulator.

Style No.	Type of Regulator	Type of Frame	List Price Per Set of Two
*214514	AB, AC, AL, and AM	Angle iron	$15 50
*214518	AB, AC, AL, and AM	Pipe	15 50

Approximate shipping weight of one set of brackets, 15 pounds.

For Supporting D. C. Regulators at Either End of Switchboard

Two brackets required per regulator.

Style No.	Type of Regulator	Type of Frame	List Price, Per Set of Two
*214515	DA	Angle iron	$15 50
*214519	DA	Pipe	15 50
*214516	DB	Angle iron	15 50
*214520	DB	Pipe	15 50
*214514	DK	Angle iron	15 50
*214518	DK	Pipe	15 50

Approximate shipping weight of one set of brackets, 15 pounds.

Spare Parts

Style No.	Description	List Price Per Set
249093	Main contacts for alternating-current regulators.	$44 00
205316	Contacts for rheostat-shunting relays for alternating-current regulators.	7 50
205318	Contacts for vibrating and master relays.	38 75
219341	Main contacts for direct-current regulators, types DA, DB, DC, and DD.	44 00
249093	Main contacts for direct-current regulators, DK and DN.	44 00
205316	Contacts for rheostat-shunting relays for direct-current regulators.	7 50
280541	Pivots and bearings for relays.	7 50

*Style No. covers one only, two required.

Order by Style Number

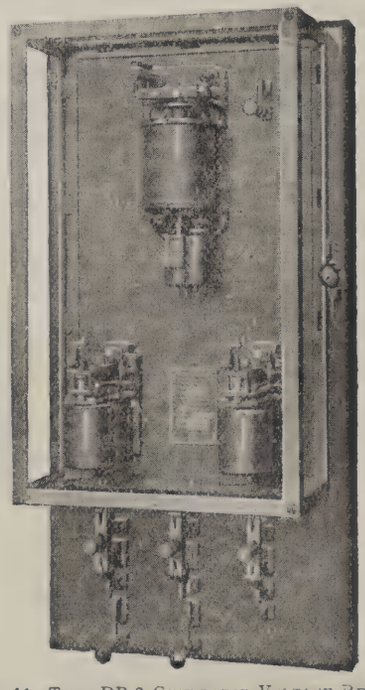


FIG. 11—TYPE DB-2 GENERATOR VOLTAGE REGULATOR

Form 1046-G
(2 Sheets) Sheet 1

Westinghouse Electric & Manufacturing Company
East Pittsburgh, Pa.

.....
(Purchaser's Name)

Station..... Negotiation No..... Date.....191.....

DATA SHEET FOR VOLTAGE REGULATORS FOR ALTERNATING-CURRENT GENERATORS
or for *separately excited* D. C. generators

In order to secure correct regulator application, it is desirable that complete data, as requested below, be given.

EXCITER INFORMATION:

Exciter	No. 1	No. 2	No. 3	No. 4	No. 5
1. Kw. capacity					
2. Rated voltage					
3. Rated speed					
4. Number of poles					
5. Serial No.					
6. Type					
7. Manufacturer's name					
8. Shunt or compound-wound					
9. Interpole or non-interpole					
10. Laminated or solid main field poles					
11. Exciter shunt field current at no load and rated voltage					
12. Exciter shunt field current and armature volts at no load, 10 per cent above rated voltage — Amps.					
12. Exciter shunt field current and armature volts at no load, 10 per cent above rated voltage — Volts					
13. Exciter shunt field current and armature volts at no load and full field (rheostat all out) — Amps.					
13. Exciter shunt field current and armature volts at no load and full field (rheostat all out) — Volts					
14. Give name plate reading of rheostat — Amps.					
14. Give name plate reading of rheostat — Ohms					
14. Give name plate reading of rheostat — No. of steps					
In what time will the shunt field rheostat lower the voltage from normal to ⅓ normal with generator field load on exciter					
NOTE—For complete information see reverse side of this sheet 15. How are exciters driven?					
16. Speed regulation of prime mover; if water wheels do they have automatic governors?					

17. Is regulator to be suitable for single operation or parallel operation of exciters?.....

NOTE—Unless paralleling the exciters is required by station operating conditions, Westinghouse voltage regulators can be supplied suitable for single operation of exciters with parallel operation of generators.

GENERATOR VOLTAGE REGULATORS—Continued

Form 1046-G
(6 Sheets) Sheet 2

A.C. GENERATOR, SYNCHRONOUS CONDENSER OR SYNCHRONOUS MOTOR INFORMATION:

A.C. Generators in Parallel	No. 1	No. 2	No. 3	No. 4	No. 5
18. Kva. capacity					
19. Rated voltage					
20. Normal operating voltage at no load					
21. Operating voltage at maximum load					
22. Rated speed					
23. Manufacturer's name					
24. Serial number					
25. Voltage directly across field at no load and normal operating voltage					
26. Voltage drop directly across field under maximum operating conditions. (Give Kva. load) — Volts					
26. Voltage drop directly across field under maximum operating conditions. (Give Kva. load) — Kva.					
26A. For syn. cond. only, give voltage drop across field under max. lagging zero per cent P. F. conditions — Volts					
26A. For syn. cond. only, give voltage drop across field under max. lagging zero per cent P. F. conditions — Kva.					
27. How are generators driven?					
28. Speed regulation of prime movers					

29. Is system single-phase, two-phase or three-phase?..... Frequency in cycles per second.....

30. Give leading or lagging P. F. which syn. cond. or motor must meet under operating conditions.

31. Is compensation for line drop desired.....If so, is this to be obtained by means of a current transformer and the regulator compensating winding or by means of an external compensator and two current transformers?.....

The latter method is necessary only when exact compensation, independent of power factor variations, is required.

32. State percentage of line drop in feeder in which compensation is desired.....

33. State current in feeder in which compensation is desired.....

For large step-up transmission systems, it is desirable that a pencil sketch showing single line diagram of system be furnished.

34. Indicate nature of load, giving percentage of each:—Lighting.....% Motor.....% Elevator Motor.....%. Note character of any load causing serious voltage fluctuations.

REGULATOR INFORMATION:

35. General finish of metal parts on switchboard.....Standard is dull black.

36. Material and finish of regulator base.....Standard is black marine finished slate.

37. If regulator is to be bracket mounted state whether switchboard framework is angle iron or pipe.....

38. If regulator is panel mounted, state height, thickness, bevel and number of sections of panel, and type of switchboard frame.....

.....

Additional Information.....

.....

.....

Signed.....

TIME CONSTANTS OF EXCITERS

Explanation of question No. 14

The quality of regulation depends largely on the response of the exciter to the regulator. It is, therefore, important to know the time constants of the exciters and to make the necessary alterations if these are unsatisfactory, to secure the best results.

The time constants of an exciter should be taken under load. The load used should be the field or fields of the A.C. Generators it is intended to supply.

If the plant is in continuous service, the test can be most conveniently made by running temporary leads directly from the exciter main switch to the generator field switch. The leads can be run either in front or rear of the switchboard. The exciter and generator field switches must be left open during the test to keep clear of the rest of the system. Care should be taken to see that the field discharge resistance is out of circuit during the test as it may become overheated.

If the plant is not in continuous service, or if an extra set of bus-bars is available, the exciter and generator switches may be closed as when operating.

GENERATOR:

The A.C. Generator Rheostat should be set so that when running at normal speed 60 volts on the exciter gives normal voltage on the generator at no load, if 125-volt exciters are used. Proportional values should be taken for other exciter voltages.

The A.C. Generator is preferably shut down during the test. If this can not be done, care should be taken not to allow the generator to carry excessive voltages except momentarily. If the A.C. voltage is above 6600, the generator rheostats should be set so that with 125 volts on the exciter the A.C. voltage does not rise more than 25 per cent above normal.

EXCITER:

A single-pole switch should be connected across the exciter rheostat so that when the switch is closed, the rheostat is short-circuited. The rheostat should be entirely cut in. The switch should be located convenient to the exciter voltmeter.

With all connections made, the switch should be closed and the time taken for the exciter to build up from 30 to 125 volts. The switch should be opened at 125 volts, and the time taken for the exciter to fall from 125 to 30 volts.

These measurements of time should be made with a stop watch. If this is not available, the second hand of an ordinary watch may be used, but the results are not accurate and two persons are necessary to make the test.

The time to build up or down should be 4 seconds or less for the best results.

Form 1045-D
(2 Sheets) Sheet I

Westinghouse Electric & Manufacturing Company

Works East Pittsburgh, Pa.

.....
(Purchaser's Name)

Station..... Negotiation No..... Date.....191....

DATA SHEET FOR VOLTAGE REGULATORS FOR SELF-EXCITED DIRECT-CURRENT GENERATORS

For separately excited D. C. Generators, Data Sheet for A. C. Generators Form 1046-D should be used.

In order to insure correct regulator application it is desirable that complete data, as requested below, be given, and that particular attention be given question 20.

GENERATOR INFORMATION:

Generators in Parallel.....	No. 1	No. 2	No. 3	No 4	No. 5	No. 6
1. Kw. capacity.....						
2. Rated voltage.....						
3. Rated speed.....						
4. Number of poles.....						
5. Serial No.....						
6. Type.....						
7. Manufacturer's name.						
8. Shunt or compound.....						
9. Interpole or non-interpole.....						
10. Laminated or solid main field poles.....						
11. Shunt field current at no load and rated voltage.....						
12. Shunt field current at no load and full field. (Rheostat all out).....						
13. Armature volts at no load and full field. (Rheostat all out).....						
14. State resistance of field rheostat.....						

Fac-Simile of Data Sheet, Form 1045, Sheet I

1555-18

GENERATOR VOLTAGE REGULATOR—Continued

Form 1045-D
(2 Sheets) Sheet 2

15. How are generators driven?.....

16. Speed regulation of prime movers.....

17. Are pressure wires brought back from center of distribution?.....

If not, is compensation for line drop desired?.....

18. State percentage of line drop in circuit for which compensation is desired.....

19. State current in circuit for which compensation is desired.....

20. Indicate nature of load, giving percentage of each:

Lighting.....%
Motor.....%
Elevator.....%
Miscellaneous.....%

REGULATOR INFORMATION :

21. General finish of metal parts on switchboard.....

Standard is dull black.

22. Material and finish of regulator base.....

Standard is black marine finished slate

23. If regulator is bracket mounted, state whether switchboard frame work is angle iron or pipe.....

.....

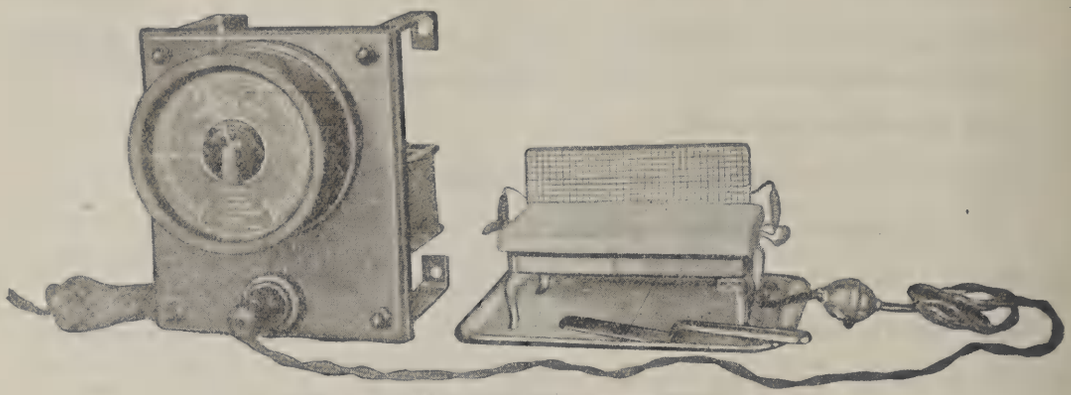
24. If regulator is panel mounted, state height, thickness, bevel and number of sections of panel, and type of switchboard frame.....

Additional information.....

.....

Fac-Simile of Data Sheet, Form 1045, Sheet 2

CENTS-PER-HOUR METER PANEL



CENTS-PER-HOUR METER PANEL WITH TOASTER STOVE CONNECTED

Application—The cents-per-hour meter demonstrates to the prospective heating appliance purchaser, at a glance and in **non-technical terms**, the cost of operating any heating appliance that is connected to it. It talks in dollars and cents,—a language that any purchaser understands. It gives him exactly the answer he wants to know and no further explanation is necessary.

Description—It consists of a single-phase indicating wattmeter, calibrated in "cents-per-hour," the full-scale reading being the kw-hr rate applying in the particular locality where the cents-per-hour meter panel is to be installed. It is of attractive appearance, neatly mounted on a dull black slate panel 12 inches high and 10 inches wide, provided with brackets for supporting it from the wall. By means of the ordinary lamp receptacle and plug, any form of electrical appliance can be connected to the meter.

Style number and list price include the wattmeter with black dial, panel with wall supports and plug receptacle. It does not cover the wattmeter scale marking, (the full-scale reading being the local charge per K. W. H. for electric service) nor the frequency, which must be specified on each order. A white dial can be furnished instead of the black dial wattmeter at the same price.

Style No.	Gross Shipping Weight	List Price
268587	50	$160 00

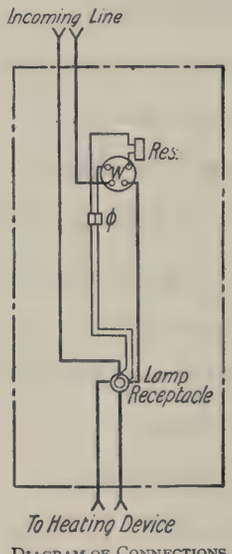
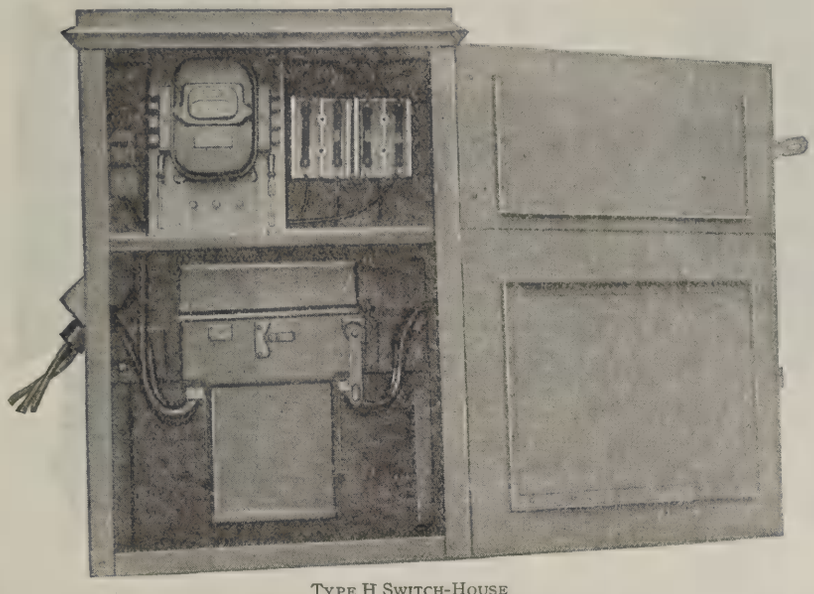


DIAGRAM OF CONNECTIONS

Order by Style Number

OUTDOOR SWITCHING AND METERING EQUIPMENTS

TYPES H, F AND G SWITCH-HOUSES



TYPE H SWITCH-HOUSE

Application—Types H, F and G switch-houses include both **circuit-breaker and watthour meter equipments** properly housed and protected for mounting in exposed locations. They are used for the control of outdoor distributing substations which supply power to small towns, farming communities, manufacturing plants, mines, quarries, and numerous similar installations where the connected load is not large enough to warrant the expense of a substation building with indoor apparatus. The service switch provided is suitable for a medium-capacity station.

Capacity—These equipments are listed single-phase and three-phase, in capacities up to 500 amperes at 7500 volts or 600 amperes at 2500 volts. The scope of each particular type of house with limiting standard ratings are given in the tables.

Equipments for three-phase service in capacities other than those listed and for two-phase service, as well as for various combinations of meters, will be furnished on special order.

Construction—The weatherproof house, in which the equipment is enclosed, is built of heavy-gauge sheet steel supported on a structural steel frame. All apparatus inside is rigidly supported from the web of the frame, the incoming and outgoing leads being located in such a manner as to prevent accidental contact. A large two-section door, hinged and provided with a hasp and padlock, gives access from the front to all apparatus inside.

The door being divided into two sections horizontally permits the reading of the watthour meter by simply opening the upper section.

Type H houses are suitable for pole, wall, or tower mounting, provision being made for hanger irons so that they can be mounted in the same manner as distributing transformers. These houses have a removable bottom, to permit lowering the oil circuit-breaker tank for inspection of contacts and refilling.

The type F switch-house is a new design, paralleling the type H house in current and voltage ratings. It is applicable where a less expensive equipment than the type G is wanted for ground mounting to control a relatively small capacity. It is smaller in size but of the same general construction as the type G house.

The type G switch-house is designed to stand on its own base, and is of sufficient height to prevent accidental contact with the incoming and outgoing leads. The back side of the house is removable, permitting free access from the rear to all apparatus inside.

In the type G design the oil circuit-breaker is pipe-frame mounted. This construction has the advantage of being easily accessible for inspection of wiring, removal of oil circuit-breaker tank, inspection of contacts, and replacement of fuses protecting the potential transformers—all very desirable features not possessed by switch-houses employing panel-mounted oil circuit-breakers.

Finish—The inside and outside of the switch-house are finished with best quality weather-proof paint.

OUTDOOR SWITCHING AND METERING EQUIPMENTS—Continued

TYPE F SWITCH-HOUSE

TYPE G SWITCH-HOUSE

The outside finish is a "battleship grey," which harmonizes with the standard finish on large outdoor power transformers, electrolytic arresters, and oil circuit-breakers. The finish of all details mounted within the house is dull black.

Apparatus—The standard **three-phase equipment** consists of:

One three-pole, single-throw, automatic oil circuit-breaker.
One type OA polyphase watthour meter.
Two current transformers* of suitable ratio.
For equipments above 440 volts, two voltage transformers with primary fuse blocks and fuses.
One set of calibrating and testing terminals.
All necessary wiring.

The standard **single-phase equipment** consists of:

One two-pole, single-throw, automatic oil circuit-breaker.
One type OA single-phase watthour meter.
One current transformer of suitable ratio.
For equipments above 440 volts, one voltage transformer with primary fuse block and fuses.
One set of calibrating and testing terminals.
All necessary wiring.

In the type H and F switch-houses, which are applicable for 200 amperes and below, the oil circuit-breakers used are of the self-contained wall-mounted type, full-automatic, series-trip, with or without self-contained inverse-time-limit feature.

Type H breakers are used up to 100 amperes, 2500 volts, and type F-1 above 100 amperes up to 200 amperes, 4500 volts.

In the type G design (above 200 amperes capacity), the oil circuit-breaker is full-automatic current-transformer trip of pipe-frame-mounted type.

The circuit-breakers furnished with type G switch-houses are equipped with the well-known Westinghouse type F wedge contacts of the self-aligning type, having separate butt arcing tips, which prevent any possibility of roughening the main contacts.

A standard type OA watthour meter is furnished mounted on a slate panel together with calibrating and testing terminals. The voltage terminals are of the binding-post type and the current terminals of the knife-switch type. The latter permits the connecting and inserting of the current coils of the test meter in series with the current coils of the service meter without interruption of service to the customer or danger to the meterman.

Wiring and Connections—All wire is of National Electrical Code standard, insulated to provide a high factor of safety. The switch-house is shipped completely wired and assembled, including inlet and outlet bushings, so that it is only necessary to connect it to the lines and to put the oil in the switch tanks.

List Price includes the weatherproof switch-house and standard switching and metering equipment with the necessary wiring ready to connect to power circuit.

*One additional current transformer is included for 3-phase 4-wire grounded neutral equipments.

OUTDOOR SWITCHING AND METERING EQUIPMENTS—Continued

If desired, either a type RO or type RA demand meter may be substituted in place of the type OA (either single-phase Style No. 183960 or polyphase Style No. 224369) watthour meter included in the standard equipment, omitting the watthour meter and adding the demand meter at the prices listed in section 3-A, **plus a charge of $30.00 list** added to the demand meter price.

Intermediate capacities will be furnished at the price of the next higher capacity listed. Other single and three-phase capacities, all two-phase capacities, and various combinations of meters can be supplied on special order, prices upon application. In ordering always give complete data, including frequency, voltage, and maximum current capacity of circuit controlled.

STANDARD OUTDOOR SWITCHING AND METERING EQUIPMENTS

TYPE H (POLE MOUNTING)

Single-Phase

Voltage	Amperes	Approx. Height Inches	Approx. Depth Inches	Approx. Width Inches	Approx. Net Wt., Lbs.*	List Price 60-Cycle	List Price 25-Cycle
440	100	48	30	30	575	$ 555 00	$ 560 00
440	200	48	30	30	670	695 00	700 00
2500	100	48	30	30	610	700 00	705 00
2500	200	48	30	30	705	760 00	780 00

Three-Phase

440	100	48	30	30	650	660 00	665 00
440	200	48	30	30	700	815 00	825 00
2500	100	48	30	30	665	835 00	875 00
2500	200	48	30	30	765	995 00	1040 00
4500†	100	48	30	30	800	905 00	945 00
4500†	200	48	30	30	810	1080 00	1120 00

TYPE F (GROUND MOUNTING—SMALL CAPACITY)

Single-Phase

Voltage	Amperes	Approx. Height Inches	Approx. Depth Inches	Approx. Width Inches	Approx. Net Wt., Lbs.*	List Price 60-Cycle	List Price 25-Cycle
440	100	72	24	24	650	$ 775 00	$ 780 00
440	200	72	24	24	700	875 00	880 00
2500	100	72	24	24	725	880 00	885 00
2500	200	72	24	24	775	945 00	965 00

Three-Phase

440	100	72	24	24	675	880 00	885 00
440	200	72	24	24	725	1000 00	1010 00
2500	100	72	24	24	750	1020 00	1060 00
2500	200	72	24	24	800	1180 00	1220 00
4500†	100	72	24	24	850	1110 00	1150 00
4500†	200	72	24	24	875	1280 00	1330 00

TYPE G (GROUND MOUNTING—HEAVY CAPACITY)

Single-Phase

7500	300	96	36	30	900	1400 00	1410 00

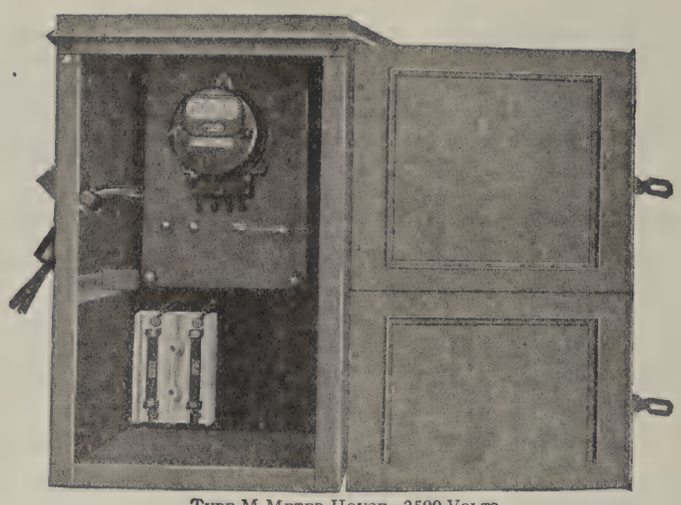
Three-Phase

440	300	96	36	30	825	1060 00	1070 00
440	500	96	36	30	875	1360 00	1365 00
440	600	96	36	30	925	1470 00	1480 00
2500	300	96	36	30	900	1380 00	1420 00
2500	500	96	36	30	950	1480 00	1510 00
2500	600	96	36	30	1000	1590 00	1650 00
4500†	300	96	36	30	1100	1530 00	1570 00
4500†	500	96	36	30	1150	1660 00	1760 00
4500†	600	96	36	30	1200	1780 00	1820 00
7500	300	96	36	30	1285	1600 00	1650 00
7500	500	96	36	30	1285	1700 00	1750 00

*Gross shipping weight is the same as net weight.
†For 3-phase, 4-wire grounded neutral circuits.

Order by Style Number

TYPE M METER-HOUSES



TYPE M METER-HOUSE—2500 VOLTS

Application—Type M meter-houses have the same general application as the types H, F and G switch-houses except that they are used where **outdoor watthour metering equipments only** are required. They are designed for pole, wall, or tower mounting and without any service switch.

Capacity—These metering equipments have been developed for single-phase and polyphase, 25- and 60-cycle service, for current ratings not exceeding 800 amperes, and for voltage ratings up to 7500 volts. (For outdoor metering equipments for higher voltages see Section 3-B of this catalogue.)

Construction—The weatherproof house is well constructed for mounting in exposed locations, affording the necessary protection for the watthour meter and instrument transformers. The large hinged door in front gives ready access for reading or calibrating the meter.

The door is divided into two sections horizontally so as to permit reading the watthour meter when the upper half of the door is open,—the lower half in the closed position serves as a barrier over the potential transformers.

No live parts are exposed and the arrangement of incoming and outgoing leads guards against accidental contact.

The standard polyphase equipment consists of a standard type OA polyphase watthour meter, with a complete set of calibrating and testing terminals mounted on a slate base; and two current transformers. (One additional current transformer is included for 3-phase 4-wire grounded neutral equipments.) Above 440 volts two voltage transformers with fuse blocks and fuses are furnished.

Finish—The inside and outside of the meter-house are finished with high grade black weatherproof paint. The outside finish is a "battleship grey" which harmonizes with the standard finish on outdoor power transformers, electrolytic arresters and oil circuit-breakers. All details mounted within are of dull black finish.

Wiring and Connections—The meter-house is completely wired from inlet to outlet bushings with wire of National Electrical Code standard of proper insulation. Connections are simple. To put the equipment in operation requires only the external connections to the power lines.

OUTDOOR SWITCHING AND METERING EQUIPMENTS—Continued

List Price includes the weatherproof meter-house and standard metering equipment with necessary wiring ready to connect to power circuit.

If desired, either a type RO or type RA demand meter may be substituted in place of the type OA (either single phase Style No. 183960 or polyphase Style No. 224369) watthour meter included in the standard equipment, omitting the watthour meter and adding the demand meter at the prices listed in Section 3-A, **plus a charge of $30.00 list** added to the demand meter price.

Intermediate capacities will be furnished at the price of the next higher capacity listed. Other capacities for single-phase and polyphase service and various combinations of meters can be supplied on special order, prices upon application. In ordering always give complete data, including frequency, voltage, and maximum current capacity of circuit controlled.

STANDARD TYPE M OUTDOOR METERING EQUIPMENTS

Single-phase

Voltage	Amperes	Approx. Height Inches	Approx. Depth Inches	Approx. Width Inches	Approx. Net Wt., Lbs.*	List Price 60-Cycle	List Price 25-Cycle
440	100	32	20	18	275	$355 00	$360 00
or	300	32	20	18	280	370 00	372 50
less	500	32	20	18	300	385 00	390 00
2500	100	32	20	18	31'	420 00	440 00
2500	300	32	20	18	325	430 00	450 00
2500	500	32	20	18	335	445 00	465 00

Polyphase

440	100	32	20	18	310	425 00	430 00
or	300	32	20	18	315	440 00	447 50
less	500	32	20	18	320	455 00	460 00
2500	100	32	20	18	370	540 00	580 00
2500	300	32	20	18	375	555 00	595 00
2500	500	32	20	18	385	595 00	610 00
2500†	800	48	30	30	650	830 00	870 00
4500‡	100	48	30	30	500	745 00	780 00
4500‡	300	48	30	30	515	795 00	835 00
4500‡	500	48	30	30	525	830 00	865 00
4500‡	800	48	30	30	550	935 00	970 00
7500†	100	48	30	30	675	815 00	855 00
7500†	300	48	30	30	685	855 00	890 00
7500†	500	48	30	30	700	900 00	935 00
7500†	800	48	30	30	725	965 00	1000 00

*Gross shipping weight is the same as net weight.
†For these equipments the type H housing is used.
‡For 3-phase, 4-wire grounded neutral service; the type H housing is furnished with these equipments.

Order by Style Number

CONTROL PEDESTALS

STYLE NO. 190669

STYLE NO. 190668

CONTROL PEDESTAL WITH CONTROL EQUIPMENT

These control pedestals are installed in connection with instrument posts for the control of generator or feeder circuits. Generator and feeder switches, motor-operated rheostats, and motor-operated engine governors are controlled by means of drum-type control switches, and their condition is indicated by lamp indicators, which are mounted on the control pedestal.

Control pedestals installed in connection with instrument posts allow the switchboard operator a clear view of the station and operating machinery. When each pedestal controls a generating unit, there is less liability of an operator getting confused and manipulating the circuits of the wrong generator than where the apparatus for all the generators is assembled on a single switchboard.

Electrically operated circuit-breakers are operated by direct current of low voltage. The circuit-breaker mechanism is provided with a small switch which makes connections to the control circuit and to red and green lamp indicators which show whether the breaker is open or closed. These indicators are mounted on the control pedestal.

The conditions in different power stations are so varied that it is impossible to list a control pedestal with equipment suitable for one generator, so a list is given of the pedestals only and a size should be selected to contain the control switches and indicators required. Dimensions of the pedestals are given on the following page and dimensions of control switches and indicators are given in this section of the catalogue. Plugs and receptacles are mounted on the pedestals when one instrument serves several generators and for synchronizing.

Connecting wires are run through the floor inside the pedestal, a door in the back giving access to the connections.

Pedestal frames are finished in dull black and trimmings are in black marine. Black marine finished slate top and panels are considered standard, but blue Vermont or white Italian marble can be supplied if desired.

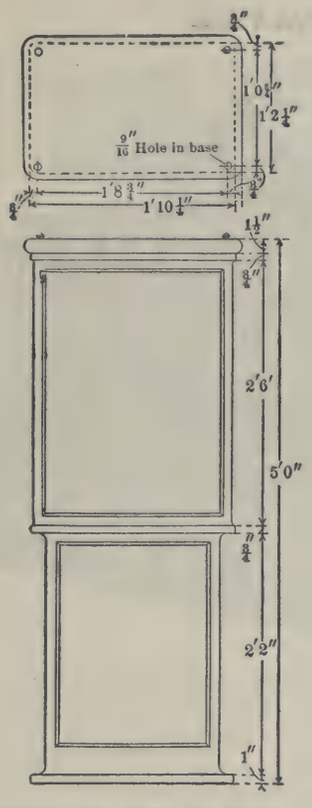
Style number and list price include pedestal with panels and top but without instruments.

Size	Panels and Top	Approx. Wt., Lbs. Net	Approx. Wt., Lbs. Boxed	Style No.	List Price
Large	Slate, black marine finish	450	500	190668	$560 00
Small	Slate, black marine finish	350	400	190669	365 00
Large	Blue Vermont marble	450	500	91703	620 00
Small	Blue Vermont marble	350	400	91704	440 00
Large	White Italian marble	450	500	190670	830 00
Small	White Italian marble	350	400	190671	500 00

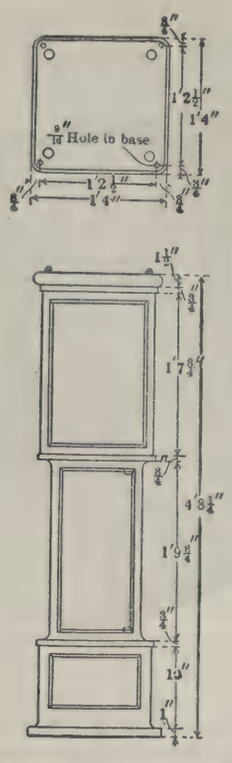
Order by Style Number

CONTROL PEDESTALS—Continued

OUTLINE DIMENSIONS



Style Nos. 91703, 190668 and 190670



Style Nos. 91704, 190669 and 190671

The available space for mounting apparatus on pedestal, Style Nos. 91703, 190668 and 190670 is 2 feet 3½ inches by 1 foot 7¼ inches on the upper panel and 1 foot 10¼ inches by 1 foot 4½ inches on the lower panel; also, approximately 1 foot 9¾ inches by 1 foot 1¾ inches on top horizontal panel.

The available space for mounting apparatus on pedestal, Style Nos. 91704, 190669 and 190671 is 1 foot 5¼ inches by 11¼ inches on the upper panel, and 1 foot 7¼ inches by 8½ inches on the lower panel; also, approximately 1 foot 1¾ inches by 1 foot 1¾ inches on top horizontal panel.

CONTROL DESKS

SECTIONAL TYPES

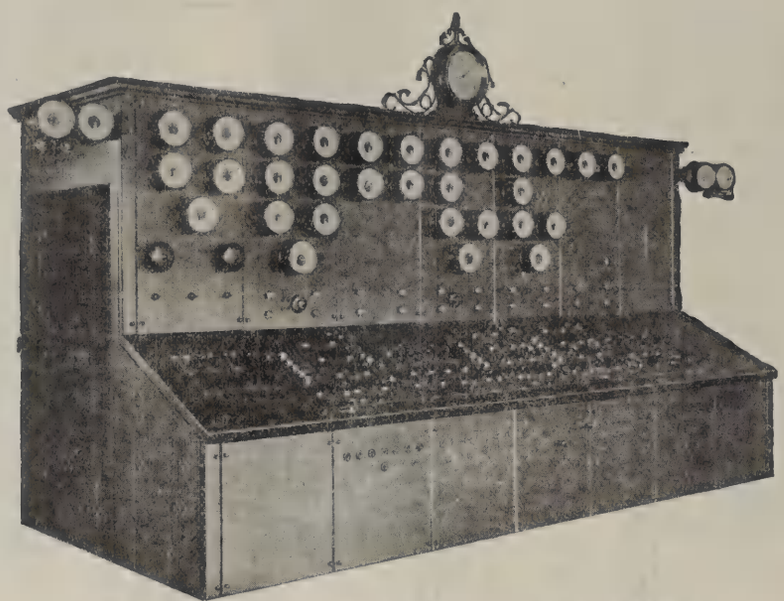


FIG. 1—TYPE D-3 CONTROL DESK WITH SPECIAL ENCLOSURE OF REAR

Under conditions where space economy is an important consideration, a control desk may often be used to advantage for the mounting of control apparatus. Standard control desks are sectional in form, each section being a unit in itself corresponding to the panels of a switchboard.

The desks are built up on a pipe framework having a channel-iron base. The design is such that sections can be easily added to an existing desk by moving one or both end sections and without disturbing apparatus already installed. The top sections are of slate and the sides of steel. Black marine finish is standard for both top and sides to correspond with standard finish of controlling devices and indicators. Access to the desk for wiring is afforded either from the rear or sides by means of cover plates which are easily removable.

These desks can be supplied in three standard types to suit varying conditions. The three types are as follows:

Type D-1—This is a plain desk having no provision for instruments. The desk may be located at any convenient place in the station and still permit of an uninterrupted view. Instruments are generally mounted on a supplementary panel switchboard or on instrument posts or frames to suit local conditions.

Type D-2—The second type of desk includes an instrument frame mounted on posts as shown in Figs. 2, 6, and 7. The frame is supported at such a height as to permit of a view of the station floor. The instrument frame is also of pipe construction with slate panel sections of width to correspond with

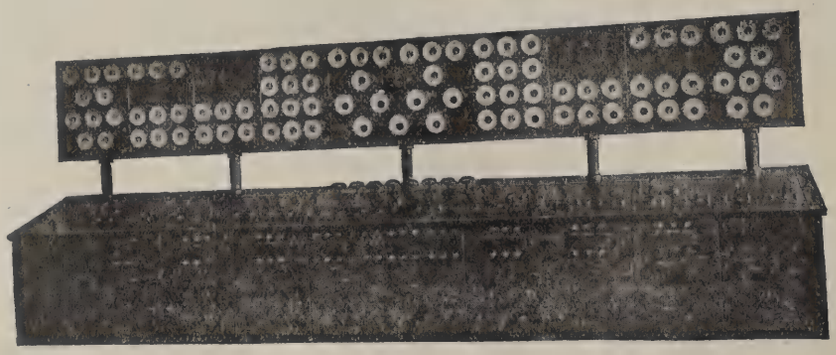


FIG. 2—TYPE D-2 CONTROL DESK

CONTROL DESKS—Continued

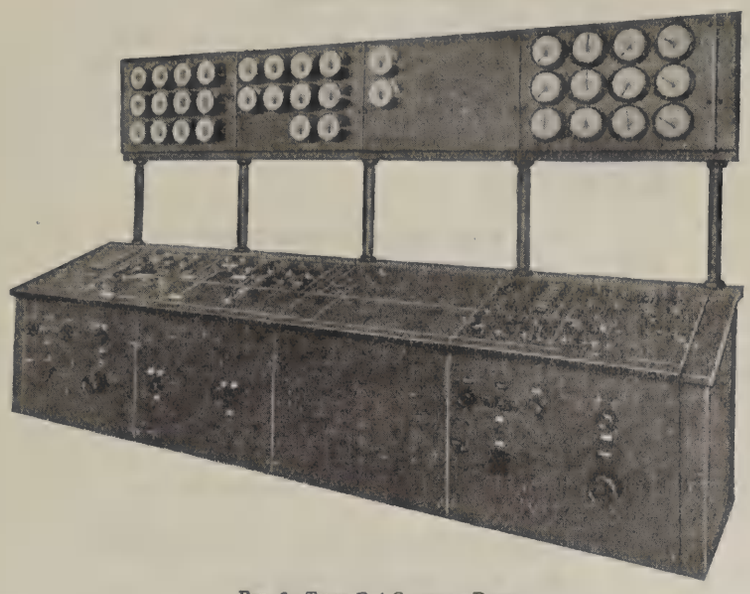


FIG. 3—TYPE D-4 CONTROL DESK

those of the desk top. The posts supporting the frame are hollow, instrument leads being brought up through them from the desk below. Section of desk includes section of instrument frame.

Type D-3— The third type of desk has an instrument section extending upwards from the rear edge of desk top, without intervening space. Section of desk includes corresponding instrument section. This type of desk is commonly combined with a panel switchboard which is indicated by the dotted outline in Fig. 8. The panel switchboard is special and is not included with the desk.

The standard sizes of sections listed below will be found to meet most conditions. No controlling devices or instruments have been listed with the desk sections, as the combinations used are widely different.

Type D-4— This desk is a special form of the type D-2 desk preferred by some purchasers and can be supplied when desired. The price is slightly higher than for the type D-2.

Prices on desks to suit special conditions will be furnished on application.

Packing—Desks are packed in sections 4 to 6 feet in length, except for export shipment, in which case desks are shipped knocked down. For approximate shipping weight for export add four times the allowance for packing material given below.

FIG. 3A—TYPE D-1 CONTROL DESK

PRICES

Type D-1 Desks

Style number and list price include complete section, with channel-iron base.

Style No.	Description	Approx. Weight Net * Lb.	List Price
	Desk With Top 20 Inches Deep		
191010	Set of right and left-hand ends	70	$490 00
191011	Section 16 inches long	120	315 00
191012	Section 20 inches long	140	325 00
191013	Section 24 inches long	170	340 00
191014	Section 32 inches long	220	365 00
	Desk With Top 32 Inches Deep		
191015	Set of right and left hand ends	90	515 00
191016	Section 16 inches long	160	340 00
191017	Section 20 inches long	200	360 00
191018	Section 24 inches long	240	375 00
191019	Section 32 inches long	310	410 00

***Approximate shipping weight**—Add 75 pounds per foot length to net weight.

Type D-2 Desks

Style number and list price include complete section with channel-iron base of desk, and channel iron, top iron, and frame for instruments.

Style No.	Description	Approx. Weight Net * Lb.	List Price
	Desk With Top 28 Inches Deep		
191020	Set of right and left-hand ends	135	$685 00
191021	Section 16 inches long with post	290	530 00
191022	Section 20 inches long with post	340	555 00
191023	Section 24 inches long with post	410	580 00
191024	Section 32 inches long with post	520	630 00
191025	Section 16 inches long plain	250	435 00
191026	Section 20 inches long plain	300	465 00
191027	Section 24 inches long plain	370	490 00
191028	Section 32 inches long plain	480	540 00
	Desk With Top 40 Inches Deep		
191029	Set of right and left-hand ends	165	700 00
191030	Section 16 inches long with post	330	555 00
191031	Section 20 inches long with post	400	590 00
191032	Section 24 inches long with post	470	625 00
191033	Section 32 inches long with post	600	695 00
191034	Section 16 inches long plain	290	470 00
191035	Section 20 inches long plain	360	505 00
191036	Section 24 inches long plain	430	530 00
191037	Section 32 inches long plain	560	595 00

***Approximate shipping weight**—Add 125 pounds per foot length to net weight.

For number of plain sections and numbers of sections with post required to make up a desk, consult outline drawing on following pages.

Type D-3 Desks

Style number and list price include complete section with channel-iron base, instrument section, and top iron.

Style No.	Description	Approx. Weight Net * Lb.	List Price
	Desk With Top 20 Inches Deep		
191038	Set of right and left-hand ends	150	$750 00
191039	Section 16 inches long	320	490 00
191040	Section 20 inches long	400	545 00
191041	Section 24 inches long	480	590 00
191042	Section 32 inches long	630	660 00
	Desk With Top 32 Inches Deep		
191043	Set of right and left-hand ends	190	775 00
191044	Section 16 inches long	370	540 00
191045	Section 20 inches long	460	500 00
191046	Section 24 inches long	550	640 00
191047	Section 32 inches long	715	705 00

***Approximate shipping weight**—Add 125 pounds per foot length to net weight.

Order by Style Number

CONTROL DESKS—Continued

Type D-4 Desk

Style number and list price include complete section with channel-iron base of desk, and channel iron, top iron, and frame for instruments.

Style No.	Description	Approx. Weight Net* Lbs.	List Price
	Desk, With Top 32 Inches Deep		
292443	Set of right and left-hand ends	150	$740 00
292444	Section 16 inches long with post	320	600 00
292445	Section 20 inches long with post	370	640 00
292446	Section 24 inches long with post	450	680 00
292447	Section 32 inches long with post	570	720 00
292448	Section 16 inches long plain	275	525 00
292449	Section 20 inches long plain	330	565 00
292450	Section 24 inches long plain	400	605 00
292451	Section 32 inches long plain	530	650 00

***Approximate shipping weight**—Add 125 pounds per foot lengths to net weight.

Order by Style Number

OUTLINE DIMENSIONS
Type D-1 Desks

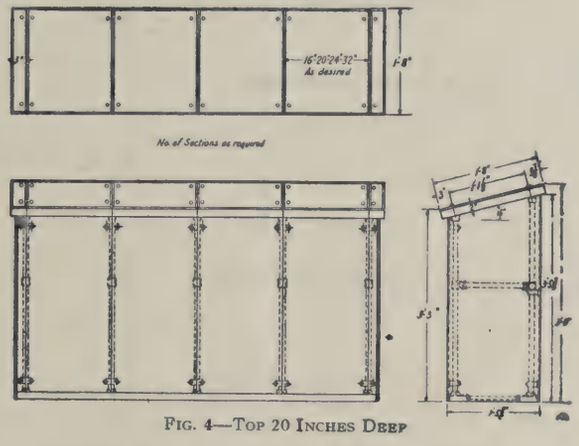


FIG. 4—TOP 20 INCHES DEEP

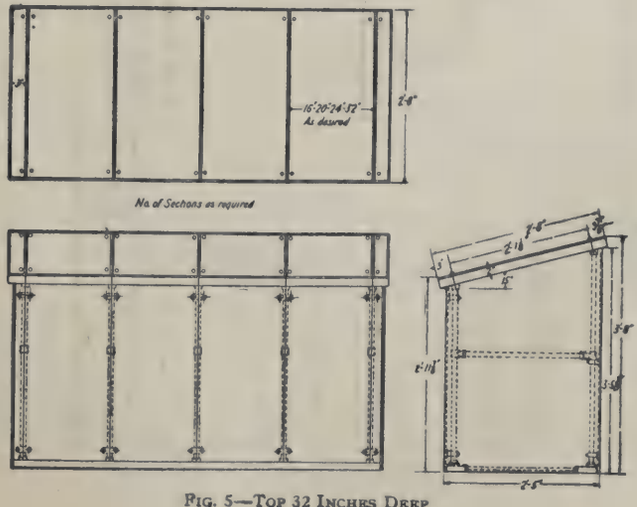


FIG. 5—TOP 32 INCHES DEEP

CONTROL DESKS—Continued

OUTLINE DIMENSIONS
Type D-2 Desks

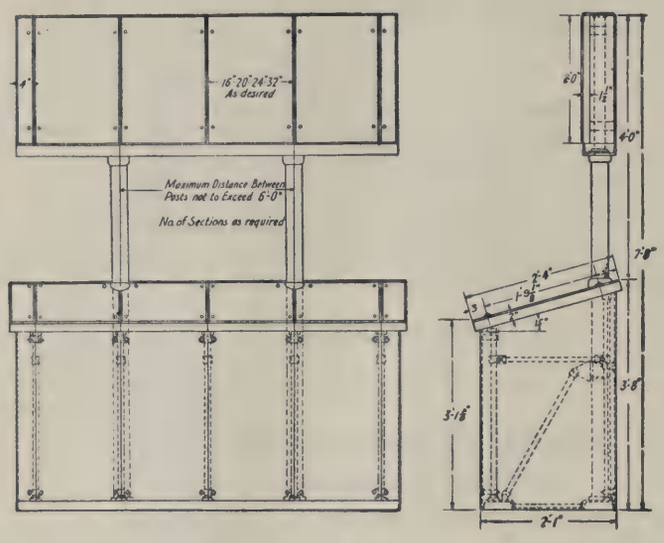


FIG. 5—TOP 28 INCHES DEEP

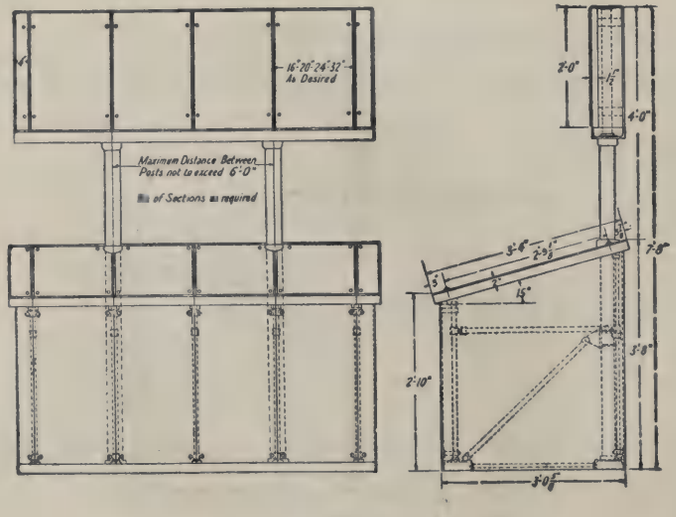


FIG. 7—TOP 40 INCHES DEEP

OUTLINE DIMENSIONS

Type D-3 Desks

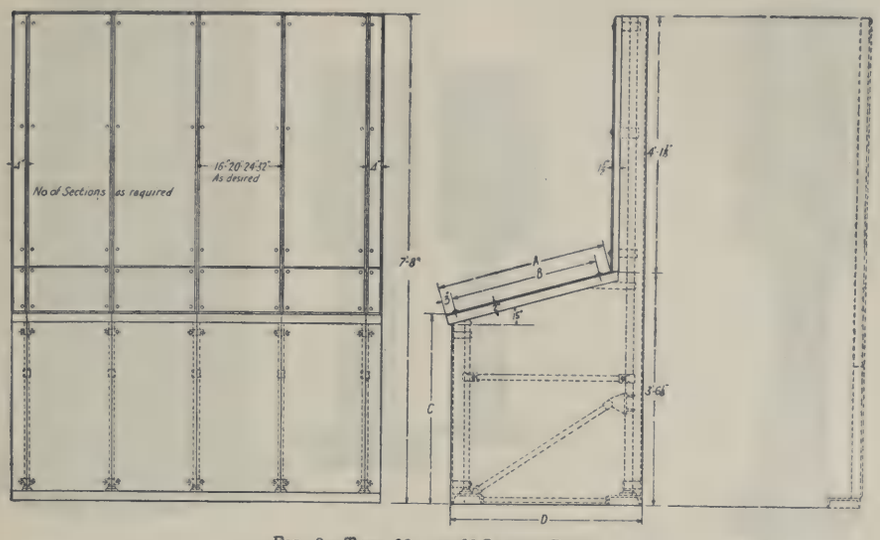


FIG. 8—TOPS 20 AND 32 INCHES DEEP

Type	Fig.	Dimensions in Inches			
		A	B	C	D
D-3	8	20	13½	37⅛	25
D-3	8	32	25 6/16	33 12/16	36½

Type D-4 Desks

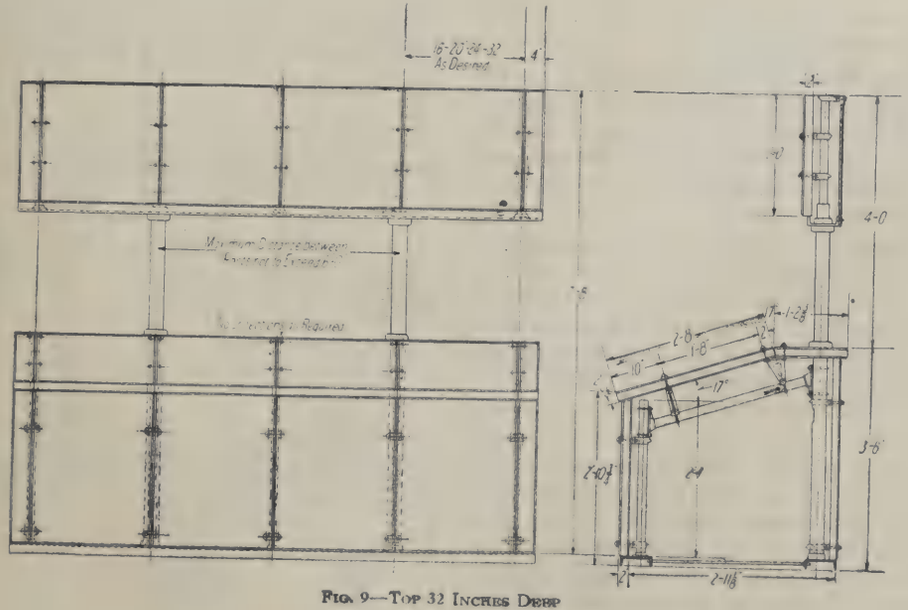


FIG. 9—TOP 32 INCHES DEEP

EQUALIZER PEDESTALS

EQUALIZER PEDESTAL WITH SWITCH

STYLE NOS. 7249-B, 7250-B AND 15185-B EQUALIZER PEDESTAL

These pedestals are designed to support equalizer switches for compound-wound direct-current generators, or synchronous converters. They permit the installation of the switch close to the machine thus saving the expense of long heavy cables to the switchboard.

The type A rear connected, single-pole, single or double-throw, knife switches without quick break attachment or fuse connections are suitable for equalizer switches.

Double-throw switches are required only where there is a double set of bus-bars.

The capacity of the equalizer **switch** is usually chosen approximately one half of the capacity of the main generator or synchronous converter switches, but the relative capacity of the main and equalizer **cables** is dependent upon the conditions of installation.

It is imperative that the equalizer connection be of low resistance in order to be effective in balancing the load between the machines. By installing equalizer pedestals, the reduction in length of cable to the switchborad results not only in saving the cost of the cable, but also gives a low resistance connection with consequent effective results in equalizing the load.

Fuses and automatic circuit-breakers are omitted from equalizer leads. They are not necessary for protecting the machine since any current that reaches the switchboard bus-bars flows through some protective device connected in a positive or negative generator or synchronous converter lead. In case a fuse or circuit-breaker is connected in the equalizer circuit and it opens the circuit, the generators or converters must necessarily operate with unbalanced fields, one machine taking all the load, which eventually results in shutting down the entire station. These equalizer pedestals, therefore, are designed for mounting the equalizer switch only.

Dimensions of pedestals are given on the following page. The switch required for the generator or converter capacity is first selected and a pedestal with panel of proper size for mounting this switch will be found in the list on this page. Pedestals differ in size of the opening for the cable; this dimension is shown in the illustrations on the following page.

The style number and list price include the pedestal and marble base without switch. The finish of the entire pedestal is black marine.

Style No.	Size of Throat Inches	Size of Marble Inches	Approx. Wt., Lbs. Net	Boxed	List Price
7249-B	4½ diam.	7x19	130	350	$154 00
7250-B	6¼ diam.	7x19	175	400	156 00
92790-B	8¼x16¼	10x22	410	700	275 00
15185-B	12 x19	15x26	565	750	345 00

Slate, finished in black marine, will be supplied at the following allowances from list price:

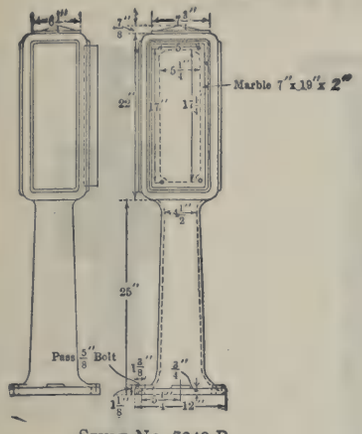
Size of Marble, Inches	Allowances
7x19	$16 00
10x22	13 00
15x26	20 00

Polished White Italian or Blue Vermont marble will be supplied at the following additions to list price:

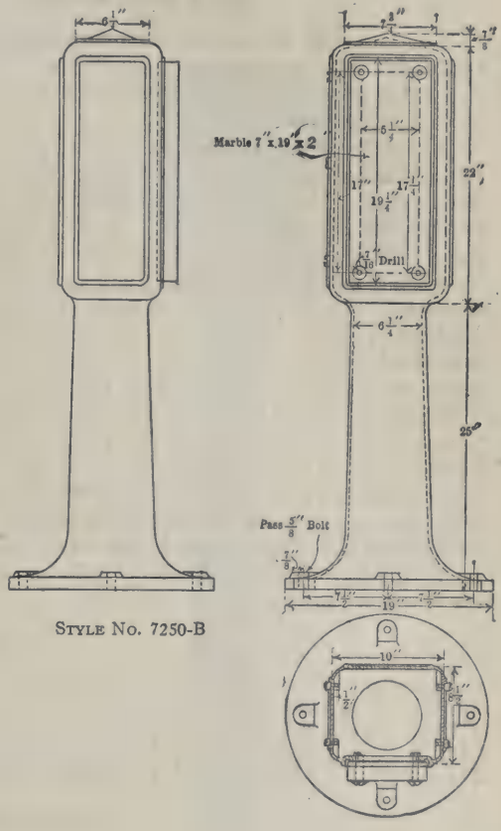
Size of Marble, Inches	White Italian	Blue Vermont
7x19	$38 00	$ 8 00
10x22	59 00	11 00
15x26	87 00	17 00

EQUALIZER PEDESTALS—Continued

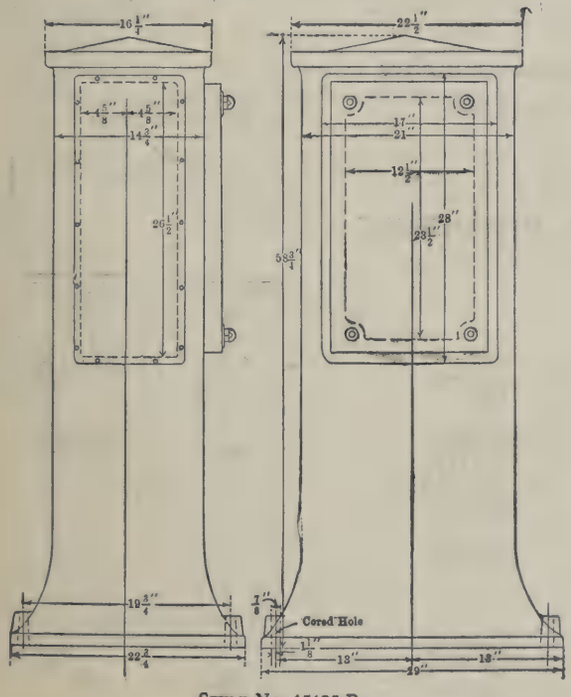
OUTLINE DIMENSIONS



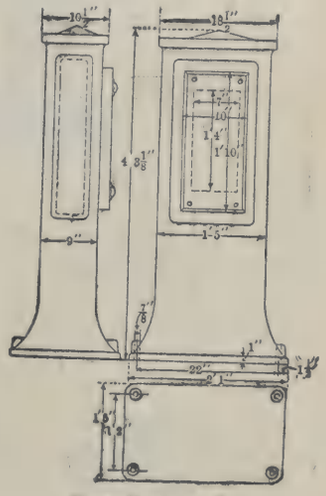
STYLE NO. 7249-B



STYLE NO. 7250-B



STYLE NO. 15185-B



STYLE NO. 92790-B

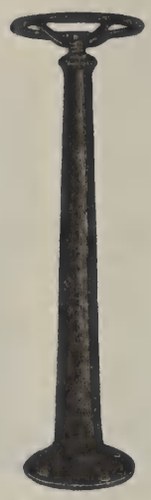
RHEOSTAT PEDESTALS

WITH AND WITHOUT BASE FOR FIELD SWITCH

These pedestals are used for mounting rheostat handwheels when the rheostats are too large to be mounted on the switchboard or when such mounting is not convenient.

Each of the styles listed consists of a single iron casting finished in dull black, and a handwheel in black marine. The standard styles having bases for switches are supplied with black marine-finished slate panels one and one-quarter inch thick. Polished blue Vermont marble bases can be substituted at an additional list price of $2.50 each. The style number and list price of each style include pedestal, handwheel, coupling, and shaft of length given below, but do not include drilling for any switch.

When the rheostat faceplates are to be mounted horizontally directly below the pedestal, no additional material is required. Frequently, however, it becomes necessary to operate the rheostat through bevel gearing, chain-and-sprocket mechanism, or a combination of the two, in which case sketch showing required arrangement should be submitted to the Works for price.



STYLE NO 24051

STYLE NO 215799

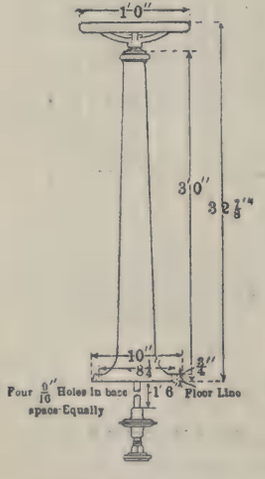
Prices

Style No	Description	List Price
24051	Pedestal with handwheel and shaft	$167 00
215799	Pedestal with handwheel and shaft and one 15⅞ × 10½ inch switch base	275 00
215800	Pedestal with handwheel and shaft and one 12¾ × 8⅞ inch switch base	265 00
215801	Pedestal with handwheel and shaft and one 8½ x 8⅛ inch switch base	250 00
215802	Pedestal with handwheel and shaft and two 8½ × 8⅞ inch switch bases	260 00

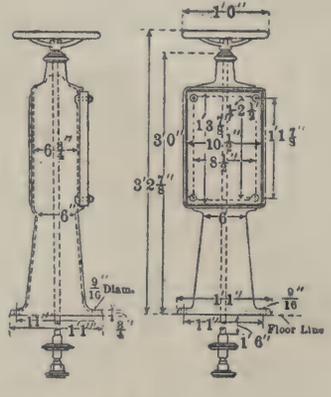
Dimensions in Inches

Style No	Size of Switch Base	Size of Opening in Switch Base Casting
215800	12¾ × 8⅞	7 x 12
215801	8½ x 8⅛	7 x 7¾
215802	8½ × 8⅞	7 x 7¾

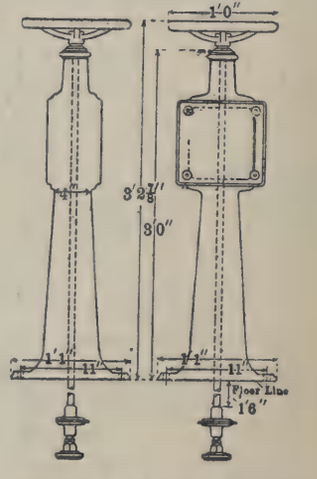
OUTLINE DIMENSIONS



STYLE NO. 24051



STYLE NO. 215799



STYLE NOS. 215800, 215801 215802

Order by Style Number

SIGNAL PEDESTALS AND SIGNAL SWITCHING SETS

Application—This equipment is designed to provide signal communication between switchboard operators and engine room operators.

Several methods of signaling are in use, but the common application requires two signal switching sets for each generator. One of these sets is mounted at the control desk or switchboard; the other in the signal pedestal and located convenient to the machine. In addition, one bell relay, one electrically operated gong or whistle and the necessary wiring must be provided for the station. In some cases the gong or whistle is paralleled with an illuminating signal set for the engine room.

The signal switching set includes a number of three-way push switches with their indicating lamps and plates. It is suitable for mounting in the pedestal, as shown in the figure, or on a control desk or switchboard.

The signal pedestal includes a pedestal complete with a signal set, but unwired.

Wiring, relays, or alarm bells are not included in the style number.

Pedestal With Signal Switching Set

Style No.	No. of Switches and Indicating Plates	List Price
292469	6	370 00
292470	8	420 00

Signal Switching Set

Style No.	No. of Switches and Indicating Plates	
292471	6	240 00
292472	8	300 00

PEDESTAL WITH SIGNAL SWITCHING SET

INSTRUMENT POSTS

FOR ELECTRICALLY-OPERATED CONTROL OUTFITS

STYLE NO. 93510

STATIONARY TYPE INSTRUMENT POST WITH ORNAMENTAL BASE

STYLE NO. 108991

SWIVEL TYPE INSTRUMENT POST WITH PANELLED BASE

STYLE NO. 93531

STATIONARY TYPE INSTRUMENT POST WITH PANELLED BASE

STYLE NO. 292452

INSTRUMENT PANEL POST WITH PLAIN BASE

Application—These instrument posts are used whenever a device is required upon which to mount instruments in a power station in place of using an instrument switchboard. The wiring is concealed in the interior of the posts.

They permit of a very convenient and ornamental mounting for instruments and enable locating the instruments so that they can be readily observed without obstructing the general view of the operator.

The instrument panel posts provide a convenient method for mounting station instruments.

Arrangement—The usual arrangement is to place these posts so as to form a support for the railing of an operating gallery, each post being placed in front of its respective controlling apparatus, which is usually located on a suitable controlling pedestal.

Erection—The posts may be secured to the floor either by bolting the shank to the side of channel iron beams located under the floor, or by using a bolted flange collar, secured to the post and provided with holes for holding-down bolts. When a concrete floor is provided, a socket can be supplied which may be set into the floor, and which is arranged for bolting to the flange collar. It is necessary in ordering these posts to specify which style is required, otherwise the standard post will be supplied provided with the flange collar.

It is also necessary to specify if provision is to be made for a hand railing. The standard ornamental posts as listed have plates provided at the places where hand railing is usually attached, but when required hand rail bosses may be substituted without additional cost. These bosses are drilled to take a standard 2-inch pipe, 2⅜ inches outside diameter. They will not be supplied unless specially ordered. Posts with panel bases cannot be arranged for hand railing.

Pedestals—Two styles of pedestals are listed: those with ornamental bases and those with panelled bases suitable for mounting control apparatus. Each of these styles is also listed with stationary top and with swivel top which can be turned about by means of a handwheel just above the base.

Finish—The posts as listed by style numbers are finished in dead black. The posts having panelled bases are supplied with panels of slate with black marine finish.

The style number and list price do not include instruments or drilling for instruments, and if the posts are to be drilled a sketch should be supplied with the order specifying the drilling required. The posts will be drilled without charge if sufficient information for the purpose is received with the order.

The posts for 7 and 9-inch instruments are identical except that the style numbers for posts for 7-inch instruments include adapter plates to permit mounting the smaller instruments.

INSTRUMENT POSTS—Continued

PRICES

Number of Round Meters	Additional Meters	Posts for 7-inch Meters Style No.	List Price	Posts for 9-inch Meters Style No.	List Price
		Ornamental Base—Stationary Type			
5		192544	$575 00	92510	$540 00
6		192545	660 00	93511	635 00
7		192546	690 00	93512	655 00
8		192547	715 00	93513	675 00
9		192548	805 00	93514	760 00
4	One type GL or GM meter	192549	565 00	93515	545 00
5	One type GL or GM meter	192550	670 00	93516	640 00
		Ornamental Base—Swivel Type			
5		192552	$740 00	93518	$715 00
6		192553	840 00	93519	810 00
7		192554	865 00	93520	835 00
8		192555	890 00	93521	850 00
9		192556	960 00	93522	915 00
4	One type GL or GM meter	192557	735 00	93523	720 00
5	One type GL or GM meter	192558	855 00	93524	830 00
		Panelled Base—Stationary Type			
5		192559	$650 00	93527	$625 00
6		192560	745 00	93528	715 00
7		192561	775 00	93529	735 00
8		192562	800 00	93530	760 00
9		192563	890 00	93531	845 00
4	One type GL or GM meter	192564	645 00	93532	625 00
5	One type GL or GM meter	192565	755 00	93533	725 00
		Panelled Base—Swivel Type			
5		192567	$ 935 00	108989	$ 910 00
6		192568	1030 00	108990	1005 00
7		192569	1040 00	108991	1010 00
8		192570	1060 00	108992	1020 00
9		192571	1160 00	108993	1140 00
4	One type GL or GM meter	192572	535 00	108994	915 00
5	One type GL or GM meter	192573	635 00	108995	1010 00
		Instrument Panel Post			
5*		292452	550 00		

*For larger panels refer to the nearest district office for description and prices.

Floor Socket

Style No.	Description	List Price
93526	Floor socket for use in concrete floor	$34 00

DIMENSIONS AND WEIGHTS

Style Numbers: Posts for 7-inch Meters	Style Numbers: Posts for 9-inch Meters	Top Fig. No.	Base Fig. No.	Total Height	Approx. Wt. Boxed, Lbs.
192544	93510	1	8	8′10⅛″	760
192545	93511	3	8	8′10⅝″	810
192546	93512	5	8	9′ 0″	860
192547	93513	6	8	9′ 0¾″	910
192548	93514	7	8	8′11⅞″	960
192549	93515	2	8	9′ 0⅜″	775
192550	93516	4	8	9′ 0⅞″	825
192551	93517	3*	8	9′ 0½″	825
192552	93518	1	10	8′10⅛″	900
192553	93519	3	10	8′10⅝″	950
192554	93520	5	10	9′ 0″	1000
192555	93521	6	10	9′ 0¾″	1050
192556	93522	7	10	8′11⅞″	1100
192557	93523	2	10	9′ 0⅞″	915
192558	93524	4	10	9′ 0⅞″	965
192559	93527	1	11	8′10¼″	825
192560	93528	3	11	8′10¾″	875
192561	93529	5	11	9′ 0⅛″	925
192562	93530	6	11	9′ 0⅞″	975
192563	93531	7	11	9′ 0″	1025
192564	93532	2	11	9′ 0½″	840
192565	93533	4	11	9′ 1″	890
192566	93534	3*	11	9′ 0⅝″	890
192567	108989	1	12	8′10¼″	925
192568	108990	3	12	8′10¾″	975
192569	108991	5	12	9′ 0⅛″	1025
192570	108992	6	12	9′ 0⅞″	1075
192571	108993	7	12	9′ 0″	1125
192572	108994	2	12	9′ 0½″	940
192573	108995	4	12	9′ 1″	990
192574	108996	3*	12	9′ 0⅝″	990
292452	.....	13	13	7′ 6″	1000

Style No. 93526—See Fig. 9—Total height, 9 inches, weight, boxed, 150 pounds.
*Type C meter at top. Height of top, 3 feet, 5⅛ inches.

Dimensions given are for reference only. For official dimensions apply to the nearest district office.

Order by Style Number

INSTRUMENT POSTS—Continued

OUTLINE DIMENSIONS

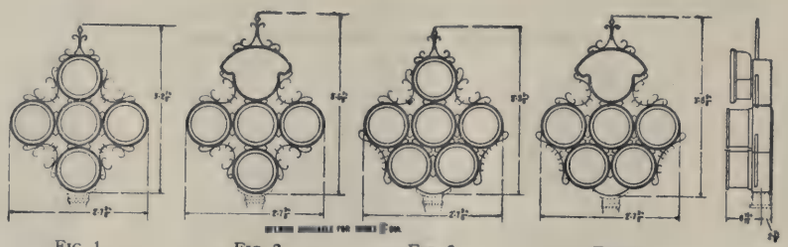


FIG. 1 FIG. 2 FIG. 3 FIG. 4

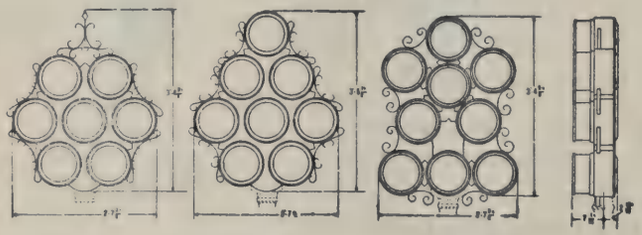


FIG. 5 FIG. 6 FIG. 7

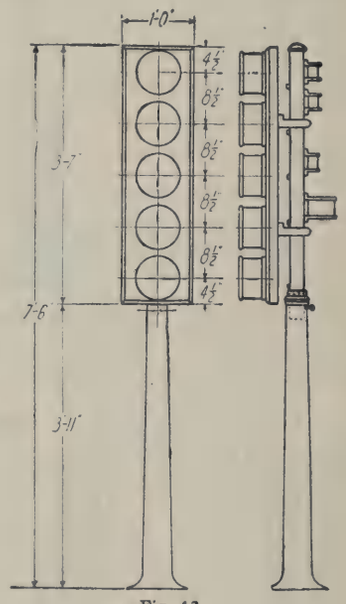


Fig. 13

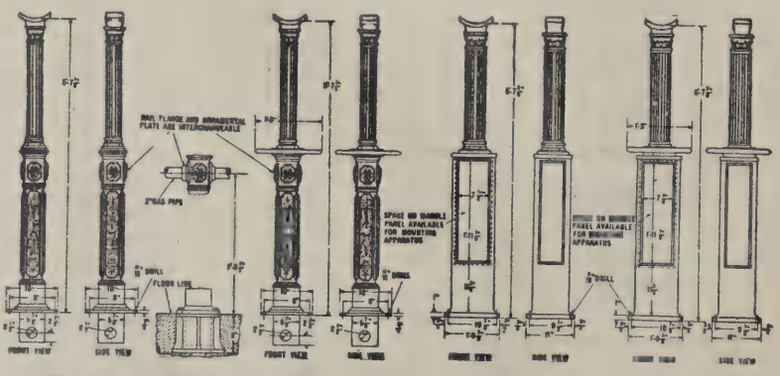


FIG. 8 FIG. 9 FIG. 10 FIG. 11 FIG. 12

TYPE CS CONTROL SWITCHES FOR MOTOR AND CIRCUIT-BREAKER CONTROL

COMPLETE — SEGMENT OF HOUSING REMOVED FOR INSPECTION

FIG. 1—TYPE CS CONTROL SWITCH

Application

Type CS control switches have been designed for the control of circuits governing the operation of solenoid-operated switches and circuit-breakers or their control relays, solenoid-operated rheostats, motor-operated rheostats, motor-operated engine and turbine governors, and motor-operated feeder-potential regulators. The type CS control switch is built along modern and latest practise in controller design, having an insulated square shaft for carrying the moving contact segments with special view to securing space economy while having due regard for proper insulation.

The adaptability of the type CS control switch to a variety of special requirements insures a neat and uniform appearance of equipment on the front of the switchboard. As an aid in selection for the switchboard operator, type CS control switches for circuit-breakers are provided with handles of a different shape than the other control switches.

Ratings

Due to the inductive nature of the circuits usually controlled, these ratings represent, in general, the current interrupting limits rather than the current conducting limits of the controllers.

Control Voltage	Ultimate Interrupting Capacity, Amperes
125 volts, D.C. or A.C.	30
250 volts, D.C. or A.C.	20
600 volts, D.C. or A.C.	5

It will be noted from the table above that the type CS control switches will successfully handle current values of considerable magnitude. However, where the current demands, of closing solenoids in particular, are in excess of these values, a control relay should be interposed between the controller contacts and the solenoid. In general, control relays are not usually required in the trip-coil circuit of Westinghouse breakers. For specific data covering the application and prices of control relays refer to "Control Relays" in this section.

Construction

Ruggedness and compactness are salient features of the type CS control switches. Advantage has been taken in their design of the years of successful operation and experience on railway controller contacts. Rugged stamped contact fingers of the same type as employed on railway controllers are used; the advantages of the horn-gap construction inherent in this design are well known.

Movable contact members mounted on a square insulated shaft engage with stationary spring-contact fingers as the shaft is rotated to the right or left. The switching element is housed in a substantial bakelite-micarta tube, which provides a simple rigid insulating structure. A segment of the housing is easily removable for inspection and adjustment.

The switches with their indicating lamps can be mounted 3½ inches between vertical center lines and 7 inches between horizontal center lines, or 7 inches between vertical center lines and 3½ inches between horizontal center lines. Two switches with their indicating lamps may be mounted on even less rectangular space than is required for one 7-inch Westinghouse indicating instrument, the switches being located in either of the above arrangements. This feature is in keeping with modern requirements of space economy for switchboards.

All control switches for circuit-breakers are provided with a mechanical indicating device that shows the last manual operation of the control switch. When the handle is released, the switch automatically returns to the neutral (central) position.

Several designs of switches for the control of solenoid-operated breakers, embodying a signal

lamp cut-out, are listed. The oval handle on these switches may be turned past the trip position to a lamp-cut-out position, which is 90 degrees from the neutral (central) position and there latched in place; this therefore, closes the circuit to trip the breaker, and then opens both the trip circuit and the indicating-lamp circuit, with the breaker "locked" in the open position. On double-bus or relay-bus systems, this permits cutting out of all breakers and lamps on the bus not used; the horizontal position of the control handles when set this way is very readily observed by the operator.

Finish—The operating handle is of black molded material with a polished black finish; the dial-plate markings are polished copper on the raised parts with a black mat background; and the housing is finished in dull black.

Prices

Style number and list price include switch complete as described. With the switches "With Lamp Indicators" are included: two lamp receptacles, one lens holder with red lens, one lens holder with green lens, and two lamps; the switches "With Lamp Indicators" are for 2-inch panels, for 1½-inch panels shorter mounting screws are required, which can be supplied on special order.

Application	Maximum Voltage of Circuit	Schematic Diagram Fig. Reference	Dimension *A* Fig. 2-Inches	Style No.	List Price
For Miscellaneous Control—Without Lamp Indicators					
Motor-operated engine governors	250*	3	8¼	271785	$33 00
Solenoid-operated rheostats	600	4	5¼	271786	25 00
Motor-operated rheostats	250*	5	8¼	271787	40 00
Motor-operated feeder-potential regulators	250*	6	8¼	271788	42 00
For Circuit-Breaker Control—Without Lamp Indicators					
Solenoid-operated circuit-breakers	600	7	5¼	290439†	23 00
Solenoid-operated circuit-breakers	600	8	6¼	290440†	28 00
Solenoid-operated circuit-breakers	600	9	7¼	290441†	30 00
Solenoid-operated circuit-breakers	600	10	8¼	290442†	33 00
Solenoid-operated circuit-breakers	600	11	8¼	290443†	34 00
For Circuit-Breaker Control—With Lamp Indicators					
Solenoid-operated circuit-breakers	600	7	5¼	290444‡	30 00
Solenoid-operated circuit-breakers	600	8	6¼	290445§	38 00
Solenoid-operated circuit-breakers	600	7	5¼	290446‡‡	40 00
Solenoid-operated circuit-breakers	600	8	6¼	290447§§	42 00

*Switches for 600-volt circuits will be made on special order; prices on request.

†Style No. 290439 is essentially a single-pole double-throw switch. Style No. 290440 is essentially a single-pole double-throw switch with additional lamp-circuit contacts; these will permit of opening the green-lamp circuit when desired. Style No. 290441 is the same as Style No. 290439 with two additional contacts that enable the automatic-trip circuit for a two-breaker double-bus system to be paralleled through the control switch. Style No. 290442 is the same as Style No. 290441 with another additional contact for the low-voltage release on rotary-converter high-voltage breaker outfits. Style No. 290443 is the same as Style No. 290441 with additional lamp-circuit contacts.

‡Includes switch Style No. 290439, lamps are for 125 volts.

§Includes switch Style No. 290440, lamps are for 125 volts.

‡‡Includes switch Style No. 290439, lamps are for 140 volts.

§§Includes switch Style No. 290440, lamps are for 140 volts.

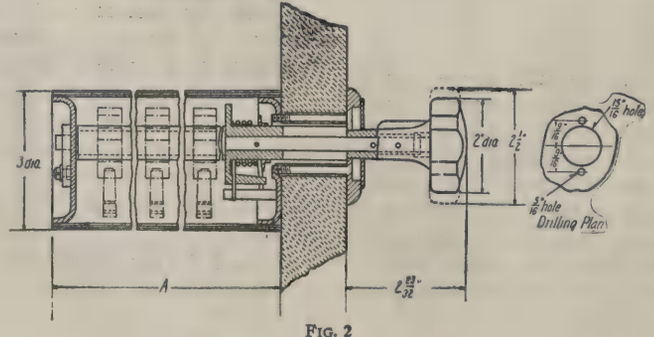


FIG. 2

These dimensions are for reference only. For official dimensions apply to the nearest district office.

Schematic Diagrams Using Type CS Control Switches

(Shown Looking Down on Switch—Handle End at Top of Diagram)

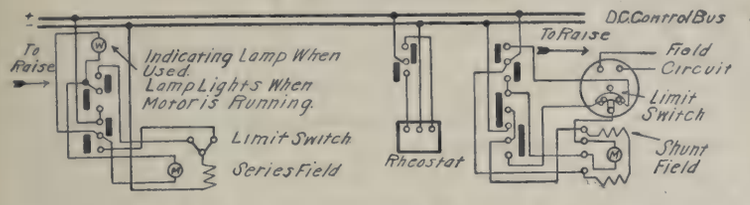


FIG. 3
STYLE NO. 271785

FIG. 4
STYLE NO. 271786

FIG. 5
STYLE NO. 271787

FIG. 6
STYLE NO. 271788

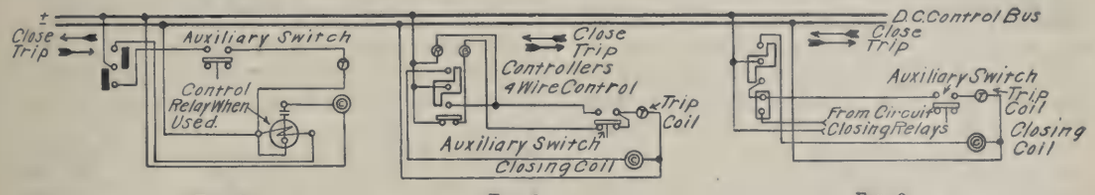


FIG. 7
STYLE NO. 290439

FIG. 8
STYLE NO. 290440

FIG. 9
STYLE NO. 290441

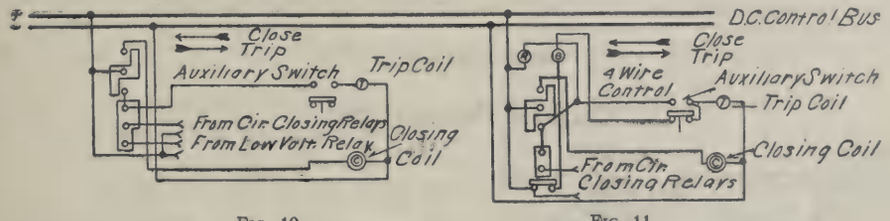


FIG. 10
STYLE NO. 290442

FIG. 11
STYLE NO. 290443

LAMP INDICATORS

Lamp indicators are connected in the control circuit of electrically-operated circuit-breakers to indicate whether the breaker is open or closed.

For diagrams of typical connections, see Figs. 3, 8 and 11, and similar diagrams on pages on "Oil Circuit-Breakers—General Information."

Operation—The lamps are so connected with the signal switch on the breaker that when the breaker is closed the red indicator will be lighted and when the breaker is open the green indicator is lighted.

Construction—Each indicator consists of a receptable projecting through the switchboard for holding a candelabra lamp, and a lens holder with a special prismatic lens. The lamp is removable from the front of the panel and the receptacle is provided with a glass tube fuse at the back of the board. The lens holder is pushed into the end of the receptacle from the front of the board and is held firmly by spring clips. A special feature of the lens is the prismatic projection extending across its face, which makes the indications visible from any position in front of the board.

These indicators are arranged for mounting on 2-inch panels, but can be used on 1¼-inch and 1½-inch boards by the addition of an adapter listed.

Style number and list price of receptacle include receptacle complete with panel ring and rods and tubular fuse but without adapter, lens holder, lens, or lamp. Style number and list price of **lens holder and lens** include the complete part but without receptacle or lamp.

A 125 or 140-volt candelabra screw-base lamp should be used. For control voltages over 140, the 140-volt lamp should be used with suitable resistor (see following table); style number and list price of lamp do not include resistor. Resistor Style No. 186465 consists of a single tube, one resistor being required for each pair of lamps. Resistor Style No. 186473 consists of two tubes, requiring one resistor for each pair of lamps.

Description	Volts	Watts	Style No.	List Price
Lamp receptacle for 2-inch panel	...	..	286649	$1 70
Adapter for using receptacle Style No. 286649 on 1¼ or 1½-inch panels	...	..	156145	65
Lens holder with red lens	...	..	154255	2 45
Lens holder with green lens	...	..	154256	2 10
Lens holder with white lens	...	..	154257	3 00
Extra glass-tube fuse	...	..	156096	§
Lamp (Candelabra screw-base T-6 Bulb Type E)	125	30	195973	1 90
	140	30	195974	2 25
Resistor used with Style No. 195974	250	(Single Tube)	186465	50
	600	(Double Tube)	186473	9 00

§For prices see Section 1-B.

These dimensions are for reference only. For official dimensions apply to the nearest district office.

Order by Style No.

Outline Dimensions

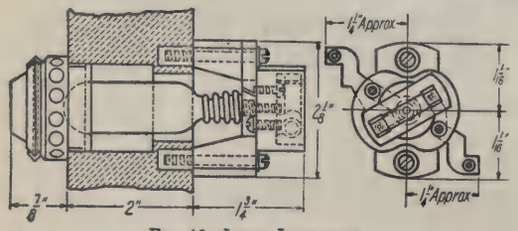


FIG. 12—LAMP INDICATOR

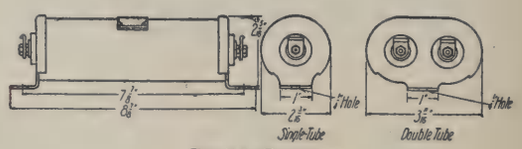


FIG. 13—RESISTOR

CONTROL RELAYS

FOR OPERATION ON DIRECT CURRENT

General Application—Control relays are interposed between the contacts of a main relay or the contacts of a control switch and the apparatus to be controlled, when the current required to operate the apparatus exceeds the current-carrying or interrupting capacity of the main relay or control switch contacts.

Control relays are thus frequently required for the closing-coil circuits of electrically-operated carbon and oil circuit-breakers. In general, the tripping-coil circuits of Westinghouse circuit-breakers do not require sufficient current to make necessary the use of control relays.

Operation—The operating coil for the control relay is connected directly across the control circuit by the closing of the control switch, causing the control relay to close, connecting the circuit-breaker closing coil across the line.

The control relays listed are given a maximum current and voltage rating based on intermittent operation. They will give satisfactory service for intermittent duty, namely, with power impressed thereon for not more than ten seconds out of every sixty; this is the condition found under usual operating requirements.

Construction—These control relays are an adaption of the well known "contactor type" of switch used most extensively for industrial motor control.

The contacts, which have ample overload capacity, are pressed firmly together with a self-cleaning action.

Flexible copper shunts carry the current from the moving contact to the lower terminal of the relay. No current passes through pins, springs, or bearing surfaces. The top contact is stationary and therefore, requires no shunt.

Blowout coils are used on all control relays. The blowout coils and arcing horns are very efficient in operation, the blowout coils being of special design to handle the highly inductive control circuit. The arc is distributed over a relatively large area as soon as formed and is quickly extinguished. Hence it has practically no destructive action.

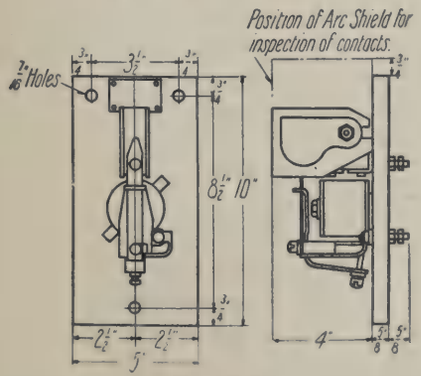
Arc shields made of compressed asbestos compound are used on all control relays.

The operating coil is wound upon a spool of insulating material that will withstand a temperature of 125 degrees Centigrade. The coil is impregnated so that it forms a homogeneous mass that is unaffected by moisture or high temperature. The winding is so arranged that both terminals are brought out at the surface and at no point is there high voltage between turns.

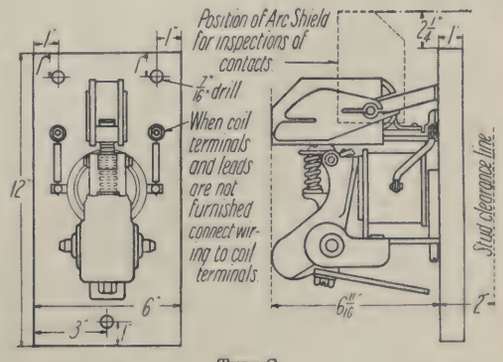
125-Ampere Type C Relay With Blow-out

The bearing pin on which the movable arm turns is of large diameter, so that its life is very long. It, as well as all screws, nuts, bolts, etc., has a sherardized non-corrosive finish.

Bases—The type 20-C control relay is mounted on a slate base 5/8 inch thick, and the type C on a similar base 1 inch thick. When the control relays are to be mounted by the purchaser on a switchboard or other panel, order by specifying: "Control relay similar to Style No....., except on wood base and to be provided with mounting bolts and terminals for.....inch panel." They can be furnished for any panel thickness up to 2 inches without additional charge, and for thicker panels on special order at reasonable additional expense. Attention is called to the fact that no terminal studs are furnished for the operating coil on the type 20-C control relay, but the base is drilled so that the purchaser's leads can be run direct to the coil terminals.



Type 20-C


Position of Arc Shield for inspections of contacts
drill
When coil terminals and leads are not furnished connect wiring to coil terminals
12"
6"
Stud clearance line

Type C

273-1A

CONTROL RELAYS—Continued

Specific Application Data

For Control Relays When Used With Type CS Control Switches

Type of Oil Circuit-Breaker	Type of Control Relay Required
F-2, 300-ampere common frame with unit mechanism	None
F-2, 500–600-ampere common frame with unit mechanism	20-C
F-2, Multiple single-pole	20-C
F-3, Common frame with unit mechanism	None
*F-3, With separate mechanism	20-C
F-3, Multiple multipole	20-C
Ba, With separate mechanism	20-C
B-2, Except 2000-ampere	20-C
B-2, 2000-ampere amd multiple multipole	C
B-3 and B-13, 300 and 600-ampere	20-C
B-3 and B-13, 1200 and 2000-ampere	C
E-8 and E-9, 300 and 600 amperes	20-C
E-8 and E-9, above 600 amperes	C
†E-6 and E-7	None
†O-1 and O-2	None
†CO-1 and CO-2	None
CG and C-2	C
G-1, G-11, GA and G-2	C

*Not listed in breaker catalogue.

†These have a special control relay (called a "cut-off switch") furnished as an integral part of the operating mechanism.

Type of Carbon Circuit-Breaker	Type of Control Relay Required
CD, Field Switch	None
CA, Field Switch 800 to 2000-ampere, 2-pole	None
CA, 3000 and 4000-ampere, single-pole	None
CA, All others not mentioned above	20-C

Prices

Style Number and List Price Include the Control Relay Complete as Described.

Type	Maximum Intermittent Rating Volts	Amperes	Style No.	List Price
20-C	125	75	204780	$36 00
20-C	250	40	204781	42 00
C	125	150	273019	58 00
C	250	75	273020	62 00
C	550	25	273021	64 00

Order by Style Number

CABLES FOR AUXILIARY CIRCUITS ON ELECTRICALLY-OPERATED SWITCHBOARDS

As the instruments and control switches for electrically-operated switchboards are usually located some distance from the meter transformers, circuit-breakers, rheostats and other accessories, it is necessary to use connecting leads of varying lengths. For this purpose, multiple-conductor cables, as listed herein, are used.

Size of Cable Required—The sizes of conductors generally used, where lengths do not exceed 500 feet, are as follows:

For current transformer circuits, each lead equivalent to 19,500 circular mils and for very short runs 10,000 circular mils. For potential transformer circuits, each lead equivalent to 10,000 or 6,000 circular mils.

For small solenoid-operated circuit-breakers, closing-coil leads equivalent to 19,500 circular mils; tripping-coil and indicator leads equivalent to 6,000 circular mils; return circuit being same size as closing-coil lead, either in same cable or separate.

For large oil circuit-breakers on control circuits of 125 volts or lower, it is sometimes considered advisable to use a heavier closing lead. In every case it is advisable to carefully check the drop in the closing circuit to insure proper operation of the breaker, as in some cases very heavy leads will be required. When a relay switch is used, the lead from the control switch is only large enough for the current in the relay switch, for which purpose 6,000-circular mil cable is usually adequate.

For engine governor control or electrically-operated rheostat control, each lead should be equivalent to 10,000 or 6,000 circular mils; three, four or six leads being used, as required.

Specifications—The cables listed in the following pages are manufactured according to Westinghouse Electric & Manufacturing Company specifications, and are particularly adapted to the diverse requirements of switchboard service.

Insulation—Each individual conductor is insulated for 600-volt service and is covered with braid with an identifying color. The insulated conductors are assembled and covered with a layer of tape and an outer braided covering or lead sheath. The outer covering of the cable selected depends upon the nature of the installation.

Colors of Leads—The colors used in identifying the individual conductors are as follows: First, Black; second, White; third, Red; fourth, Green; fifth, Yellow; sixth, Blue; seventh, Yellow and Green. For example, a four-conductor cable requires the use of the first four colors: black, white, red, and green.

When conductors of different sizes are used in a multiple-conductor cable, the sequence of colors given above is followed in the order of the capacities, the largest conductors having a black braid, the next largest a white braid, etc.

Prices—Owing to the wide fluctuations in the market price of the materials used in the manufacture of the cables, **prices will be quoted only upon application.**

RUBBER-INSULATED BRAID-COVERED WEATHER-PROOF AND FLAME-PROOF MULTIPLE-CONDUCTOR CABLES FOR AUXILIARY CIRCUITS

Number of Conductors	Stranding of Each Conductor	Circular Mils	Diameter—Inches: Bare Copper	Diameter—Inches: Over Outer Braid Maximum	Approx. Wt. Lbs. Per 1000 ft.
2	19 of .0179"	6000	.0895	.57	150
2	19 of .0226"	10000	.113	.62	195
2	19 of .032"	19500	.160	.78	325
3	19 of .0179"	6000	0895	.61	190
3*	19 of .0226"	10000	.113	.66	225
3*	19 of .032"	19500	.160	.84	430
3	One 19 of .032" Two 19 of .0179"	19500 6000	.160 .0895	.70	230
3	One 37 of .0359" Two 19 of .0179"	47500 6000	.251 .0895	.81	415
4	19 of .0179"	6000	0895	.66	210
4*	19 of .0226"	10000	.113	.72	300
4*	19 of .032"	19500	.160	.92	540

*These items are regularly carried in stock at East Pittsburgh.

(Continued on next page.)

CABLES FOR AUXILIARY APPARATUS—Continued

BRAID-COVERED CABLES (Continued)

Number of Conductors	Stranding of Each Conductor	Circular Mils	Diameter—Inches: Bare Copper	Diameter—Inches: Over Outer Braid Maximum	Approx. Wt. Lbs. Per 1000 ft.
4	One 19 of .032" / Three 19 of .0179"	19500 / 6000	.160 / .0895	.76	375
4*	Two 19 of .032" / Two 19 of .0179"	19500 / 6000	.160 / .0895	.76	375
5	19 of .0179"	6000	.0895	.75	260
5	19 of .0226"	10000	.113	.82	350
5	Two 19 of .032" / Three 19 of .0179 '	19500 / 6000	.160 / .0895	.86	450
6*	19 of .0179"	6000	.0895	.80	385
6*	19 of .0226"	10000	.113	.88	500
6*	19 of .032"	19500	.160	1.12	760
7	19 of .0179"	6000	.0895	.80	420
7	19 of .0226"	10000	.113	.88	540

*These items are regularly carried in stock at East Pittsburgh.

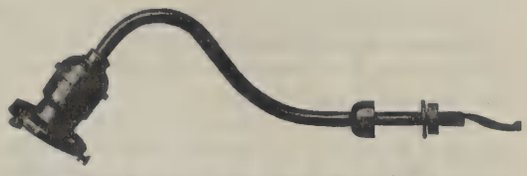
RUBBER-INSULATED LEAD-COVERED SINGLE AND MULTIPLE-CONDUCTOR CABLES FOR AUXILIARY CIRCUITS

Number of Conductors	Stranding of Each Conductor	Circular Mils	Diameter—Inches: Bare Copper	Diameter—Inches: Over Lead Maximum	Approx. Wt Lbs. Per 1000 ft.
1	19 of .0226"	10000	.113	.37	390
1	19 of .032"	19500	.160	.45	530
1	37 of .0285"	30000	.200	.49	600
1	37 of .0359"	47500	.251	.55	720
2	19 of .0179"	6000	.0895	.65	600
2	19 of .0226"	10000	.113	.69	735
2	19 of .032"	19500	.160	.88	930
3	19 of .0179"	6000	.0895	.68	715
3	19 of .0226"	10000	.113	.73	805
3	19 of .032"	19500	160	.94	1180
4	19 of .0179"	6000	0895	.73	800
4	19 of .0226"	10000	113	.79	915
4	19 of .032"	19500	160	1.02	1400
4	One 19 of .032" / Three 19 of .0179"	19500 / 6000	.160 / .0895	.86	1025
4	Two 19 of .032" / Two 19 of .0179"	19500 / 6000	.160 / .0895	.94	1200
5	19 of .0179"	6000	0895	.82	1200
5	19 of .0226"	10000	113	.92	1300
5	Two 19 of .032" / Three 19 of .0179"	19500 / 6000	160 / .0895	90	1400
6	19 of .0179"	6000	0895	.90	1040
6	19 of .0226"	10000	113	1.10	1200
6	19 of .032"	19500	160	1.25	1700
7	19 of .0179"	6000	.0895	.90	1075
7	19 of .0226"	10000	.113	1.10	1200

The above cables are not carried in East Pittsburgh stock. Delivery will be facilitated by ordering sizes corresponding to those in the preceding list of braid-covered cables as they are already available and may be provided with a lead covering.

LAMP SOCKETS, SHADES, AND BRACKETS

METAL SHADE STYLE NO. 27659



LAMP BRACKET, STYLE NO. 170664 (INCLUDES SOCKET AND SHADE HOLDER, STYLE NO. 144265)

PORCELAIN BASE SOCKET, STYLE NO. 9428

SWITCHBOARD SOCKET, STYLE NO. 238396

The brackets as listed and illustrated here are of the type furnished when required on standard panels for illuminating meters on the front of panels.

These brackets furnished in our standard black marine finish are of a neat and pleasing appearance, conforming to the finish of the board. They require only one hole in the switchboard panel, as they are held in place by the clamping action of the two nuts, one in front and the other in rear of panel. The sockets used are designed for Edison base lamps.

The shade holders, supplied only as part of the socket and shade holder, fit 2¼-inch shades.

The shades are designed so that the light is reflected downward, directing the illumination to the point desired.

The lamp sockets are of the National Electrical Code standard design and, except the porcelain base sockets, have our standard switchboard black marine finish.

Porcelain base socket Style No. 9428 is intended for mounting on the rear of the board only.

Keyless socket and shade holder, Style No. 144265, is used in the assembly of our standard lamp brackets.

Switchboard socket Style No. 238396 is intended for mounting on the front of board, and is arranged for rear connection. The two rear connection studs also hold the socket on the board, thus requiring only two holes to be drilled. The case is of moulded insulation, matching in appearance the standard black marine finish. This case can be easily fastened over the socket from the front of the board after all connections are made. This socket was especially developed for switchboard mounting, and is undoubtedly the most convenient ever produced for that purpose, and is especially neat in appearance.

Style No.	Description	Finish		Thickness of Panel, Inches	List Price
		Outside	Inside		
170664	Lamp Bracket*	Black Marine	.....	1¼ to 2	$5 00
215580	Lamp Bracket Complete†	Black Marine	.....	1¼ to 2	6 50
9428	Porcelain Base Wall Socket	.....	.....	.....	80
144265	Keyless Bracket Socket and Shade Holder	Black Marine	.....	.....	1 85
238396	Switchboard Socket	Black Marine	.....	1¼ to 2	1 85
27659	Metal Shade	Black Marine	White	.....	2 50
142080	Glass Shade	Green	White	.....	3 00

*Style number and list price include bracket, keyless socket, shade holder and lamp cord.

†Style number and list price include bracket, keyless socket, shade holder, lamp cord, metal shade and one 16-candlepower 110-volt incandescent lamp.

Order by Style Number

SWITCHBOARD FRAMES

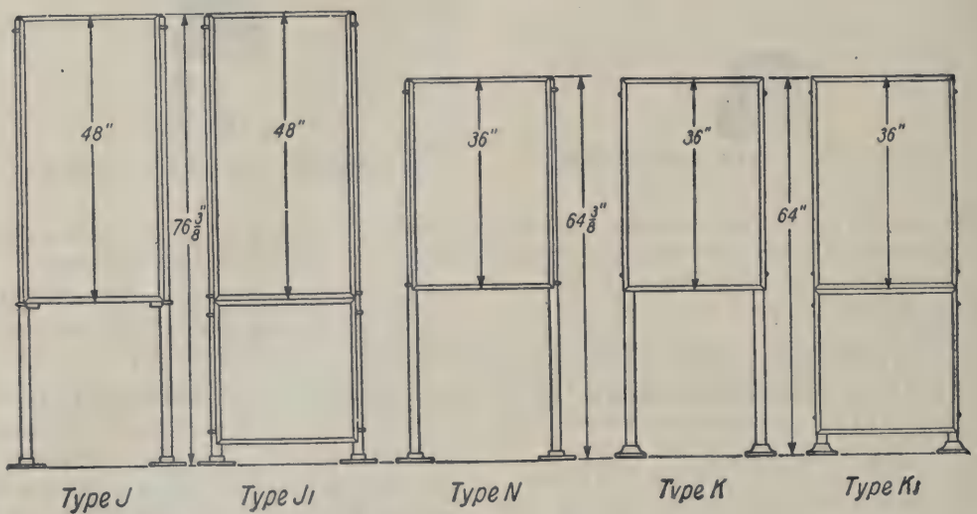
Westinghouse switchboard frames are of two general types: one made from structural steel angle and the other made from iron pipe.

The application of the tubular type of frames, in general, is limited to light panels and small switchboards. The angle types are better suited for heavy panels and large switchboards. Angle frames are cheaper and more convenient than tubular for shipping and erecting, as each panel may be shipped completely wired without dismantling.

Frames should be ordered according to the instructions given under the different types.

The descriptions are given looking at the front of the switchboard.

Panel mounting bolts are included in the style number.



NOTE:—The type does not specify width, thickness, or material of slabs.

Types J, J-1, and N Frames

The types J, J-I and N frames consist of 1¼-inch wrought-iron pipe uprights resting in floor flanges and with the necessary panel mounting brackets, top-iron brackets, and a flat top-iron, as listed on next page. The top-iron is included with switchboard frames of more than one panel and forms a continuous tie across the switchboard, provides a good alignment for the various panels, and also renders bracing each panel to the wall unnecessary, so that fewer wall braces are required. Channel bases and wall and floor braces are not regularly supplied with these frames.

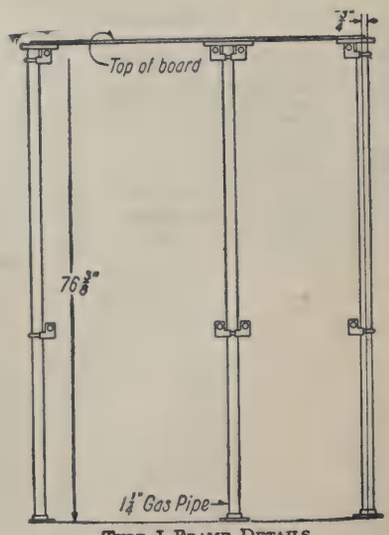
These frames are intended for the lighter line of panels and switchboards. They are designed particularly for individual panel mounting about the station, and for multi-panel switchboards used with smaller equipments.

The type J frame is designed for a one-section switchboard panel 48 inches high, supported 28⅜ inches above the floor. This space will permit the addition of a sub-panel not exceeding 25 inches in height.

The type J-1 frame is designed for a two-section switchboard panel; the upper slab is 48 inches, and the lower slab 25 inches in height.

As listed on next page, types J and J-1 frames, when used for single panels only, will be furnished without top-iron brackets.

The type N frame is designed for a one-section switchboard panel 36 inches high of more than 1 inch in thickness, supported 28⅜ inches above the floor. This space will permit the addition of a sub-panel 25 inches high. The type N frame is regularly furnished without top-iron brackets.

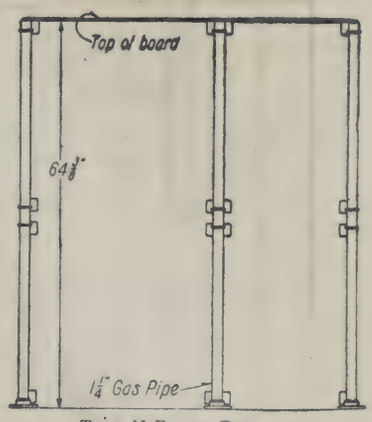


TYPE J FRAME DETAILS

Prices—Types J, J-1, and N Frames

In ordering complete frames, specify the type letter, quantity and style numbers of the frame uprights required, and in addition for switchboards of more than one panel, specify the number of panels constituting the switchboard, width, and consecutive order of panels. Detail parts ordered separately should be specified by style number.

List Price and Style Numbers of uprights include 1¼-inch pipe, floor flange, panel brackets, and panel mounting bolts for 1½-inch thick panel, and also top-iron brackets with frames for multi-panel use only. They do not include floor or wall braces. One left-hand and one right-hand upright are required for each separate switchboard, and as many intermediate uprights as there are panels in the switchboard, less one. Approximate net weight per panel 40 pounds.



TYPE N FRAME DETAILS

For wall or floor braces and description of panel-mounting brackets, see part of this catalogue on "Switchboard Details."

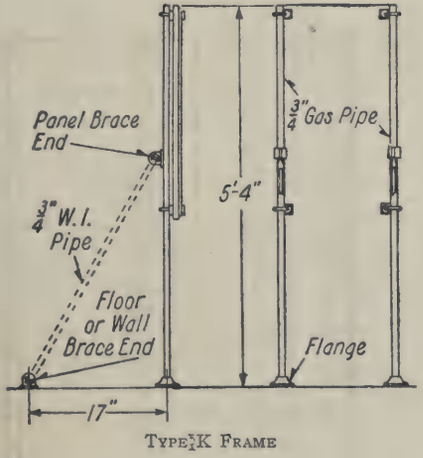
Detail Parts

Types J, J-1, and N Frames

Type of Frame	Description	Left-Hand Upright Style No.	Left-Hand Upright List Price	Intermediate Upright Style No.	Intermediate Upright List Price	Right-Hand Upright Style No.	Right-Hand Upright List Price
J	For one panel-swbd.	254300	$7 00	.....	.....	254301	$7 00
J	For more than one-panel swbd.	223667	8 00	223668	$8 50	223669	8 00
J-1	For one-panel swbd.	254302	8 50	.....	.....	254303	8 50
J-1	For more than one-panel swbd.	223670	9 50	223671	10 50	223672	9 50
N	For one-panel swbd.	254304	6 50	.....	.....	254305	6 50

Top-iron, length equal to length of board, for frames types J and J-1, list price $1.10 per foot. Maximum length of top-iron in one piece, 12 feet. Joints in top-iron to be made at center line of pipe, without lap.

TYPES K AND K-1 FRAMES



TYPE K FRAME

Construction—The type K frame consists of two ¾-inch iron pipe uprights resting in floor flanges, and complete with panel mounting brackets. The total height of the frame is 64 inches.

The application of the type K frame is limited to individual panels for light mounting.

The type K frame is designed for a one-section panel, 1 inch in thickness.

The type K-1 frame is designed for a two-section panel, 1 inch in thickness.

Prices

Types K and K-1 Frames

List price and style number of the type K frames include the frame complete with panel mounting, brackets and mounting bolts, but without wall or floor braces. Approximate net weight complete frame—30 pounds.

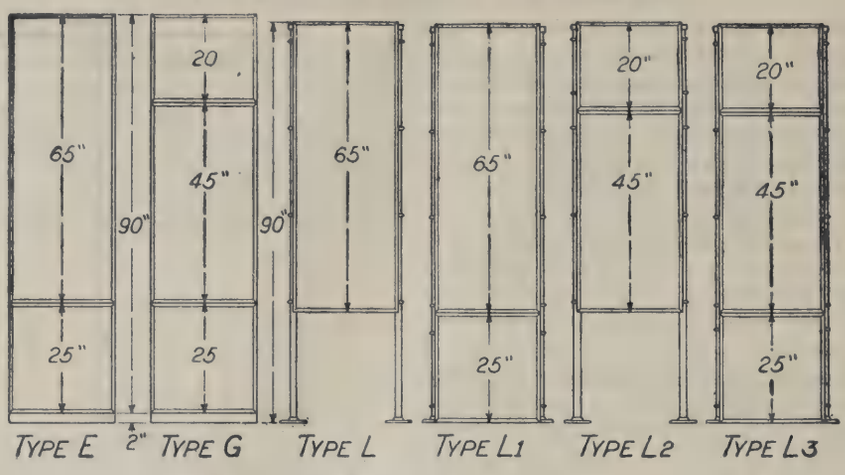
Style No.	Type Frame	List Price
212029	K	$ 9 75
212030	K-1	12 25

Wall and Floor Braces

Style No.	Description	List Price Each
215795	Wall Braces or Floor Braces, complete (2 required per panel)	$4 75
216515	Panel End of brace (2 required per panel)	2 00
216516	Floor or Wall End (2 required per panel)	1 50

Order by Style Number

TYPES E AND G FRAMES



NOTE—The type does not cover width, thickness, or material of slabs.

Construction—Types E and G frames consist of a channel base, angle uprights, top-iron, and the necessary corner angles. The base and top-iron form a continuous tie across the switchboard, provide a good alignment for the various panels, and render bracing each panel to the wall unnecessary. Wall braces are not included.

The type E frame is designed for a two-section switchboard panel; the bottom slab is 25 inches and the top slab 65 inches in height. The total height of the frame, including the base, is 92 inches.

The type G frame is designed for a three-section switchboard panel; the bottom slab is 20 inches, the middle slab 45 inches, and top slab 25 inches in height. The total height of the frame, including the base, is 92 inches.

Prices—Types E and G Frames

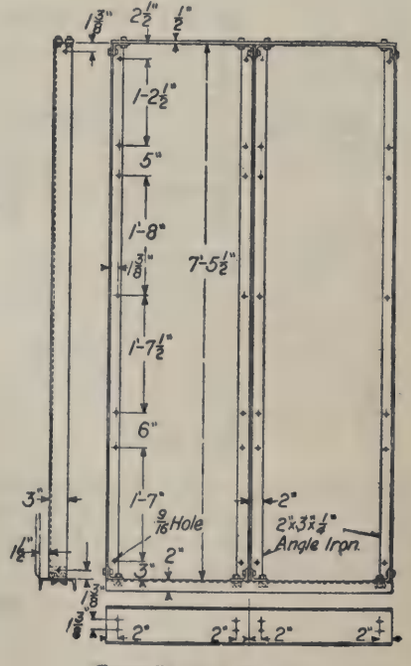
In ordering complete frame, specify type letter, quantity and style number of the frame uprights, number of panels constituting the switchboard width, and consecutive order of panels. Detail parts ordered separately should be specified by style number.

Style No.	Description	Net Wt. Lbs.	List Price
108078	Type E or G complete left-hand upright with corner angles; one required per panel	55	$13 00
108079	Type E or G complete right-hand upright with corner angles; one required per panel	55	13 00
	Channel base, length equal to length of board per foot of switchboard length	8	5 50
	Top-iron, length equal to length of board per foot of switchboard length	4	1 10

Length of one section of channel iron or top-iron will not exceed 12 feet. Joints will be made between panels without lap.

Frame style number includes angle-iron side, corner angles, and panel mounting-bolts for 2-inch thick panel. Longer bolts will be supplied on request.

For Wall and Floor Braces, see Switchboard Details in another part of this catalogue.



TYPES E AND G FRAMES

Order by Style Number

TYPES L, L-1, L-2, AND L-3 FRAMES

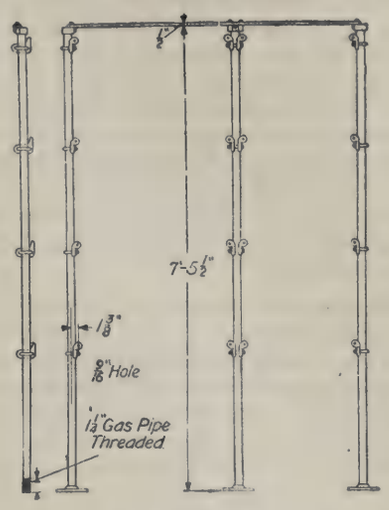
Construction—Type L frames consist of 1¼-inch iron pipe uprights resting in floor flanges and with the necessary panel-mounting brackets, panel-mounting bolts for 2-inch thick panel, top-iron brackets, and top-iron. The top-iron forms a continuous tie across the switchboard, provides a good alignment for the various panels, and renders bracing each panel to the wall unnecessary. Channel bases are not regularly supplied with this frame. The total height of the type L frame is 90 inches.

The type L frame is designed for a one-section switchboard panel, 65 inches in height, supported 25 inches above the floor. This space will allow the addition of a standard 25-inch sub-panel.

The type L-1 frame is designed for a two-section switchboard panel. The bottom slab is 25 inches, the top slab 65 inches in height.

The type L-2 frame is designed for a two-section switchboard panel; the lower slab is 45 inches, and the top slab 20 inches in height, the lower slab being supported 25 inches above the floor. This space will permit the addition of a standard 25-inch sub-panel.

The type L-3 frame is designed for a three-section switchboard panel; the bottom slab is 25 inches, the middle section 45 inches, and the top section 20 inches in height.



TYPE L FRAME

Prices—Types L, L-1, L-2, and L-3 Frames

In ordering complete frames, specify type letter, quantity and style number of frame uprights, number of panels constituting the switchboard, width, and consecutive order of panels. Detail parts ordered separately should be specified by style number.

Detail Frame Parts

List price and style number of uprights include a 1¼-inch pipe, floor flange, panel and top-iron brackets, and panel mounting-bolts for 2-inch thick panel. They do not include floor or wall braces. One left-hand and one right-hand upright are required for each separate switchboard, and as many intermediates as there are panels less one. Approximate net weight per panel—50 pounds.

Type Frame	Style No.	List Price
	LEFT-HAND UPRIGHT	
L	254306	$10 00
L-1	223586	11 50
L-2	254309	11 00
L-3	223582	12 25
	INTERMEDIATE UPRIGHT	
L	254307	10 75
L-1	223587	12 00
L-2	254310	11 50
L-3	223583	12 00
	RIGHT-HAND UPRIGHT	
L	254308	10 00
L-1	223588	11 50
L-2	254311	11 00
L-3	223584	12 25

Top-iron, length equal to length of board, per foot of switchboard length for frames L, L-1, L-2, L-3, list price, $1.10.

Maximum length of top-iron in one piece is 12 feet. Joints in top-iron to be made at center line of pipe, without lap.

BLANK PANELS DRILLED FOR MOUNTING BOLTS

The line of switchboard panels adopted as standard and listed with style numbers in the catalogue of "Westinghouse Switchboards," satisfactorily meets the majority of demands for switchboard panels. Conditions arise, however, where it is necessary to supply blank panels to be mounted and assembled at destination, to supply panels for remote control switchboard equipments, or to meet other special requirements. For these purposes the switchboard panels listed and described in the following pages, are intended.

Wherever possible, standard switchboards should be ordered, as templates are kept at the Works for drilling these panels and shipment can be made on same in considerably less time than if they require special drilling. The Works is very completely equipped for switchboard manufacture and is thus prepared to furnish a line of material built in a neat and workmanlike manner, such as would not be possible by local workmen with limited equipment and experience in such work. However, when a customer so desires, drilling plans for apparatus to be mounted on the panels will be supplied on application to the nearest district office.

The panels listed herein are made from the best quality of slate or marble of high insulating properties and free from metallic streaks or veins. They are not given style numbers on account of the great number of special orders for this material. The material, height, width, thickness, bevel and finish must be specified with order. Any drilling required must be definitely specified. The front and beveled edges are finished and the back is left plain. Several different finishes are offered. Care should be taken to order standard sizes as listed, as special sizes or special bevels will cause delay.

Marble should not be depended upon for insulating live contacts where voltage exceeds 3300.

Slate should not be depended upon for insulating live contacts for voltages above 750.

Black Marine Finished Marble—This marble has been adopted as standard by the Westinghouse Electric & Manufacturing Company where voltage in excess of 750 must be handled on face of panel, on account of the favor it has met with among central station men. It has been found that oil spots and stains cannot be avoided on natural colored marbles and some of them cannot be entirely removed. On account of this fact and the difficulty in matching the natural shades, black marine finished marble is recommended. The color is a dull soft black and can easily be restored if damaged. If the panels are likely to be spotted by oil, they may be given a treatment which will prevent the oil from showing, although it adds a slight luster to the appearance of the panel. This latter finish is known as "Oiled Black Marine."

Polished Blue Vermont Marble—When specially ordered, shades A, B, C, D, F and veined Blue Vermont marble with face and bevels highly polished can be supplied. This panel material is not regularly carried in stock, and usually has to be obtained from the quarries, with a consequent delay in shipment.

Descriptive leaflets 2254-55-56-57-58 and 2442 illustrate the variations in shades and veining that may be expected in the marble ordered. Great care is exercised in matching marble for individual boards in order to see that harmony in shading and veining is obtained. When a close match with existing panels is desired, the marking and shade to be followed should be indicated on the order by reference to the descriptive leaflet and figure number.

White Italian marble has a grayish white color with occasional faint dark gray veins running through it. It shows oil stains very plainly and is more expensive than the other marbles. This marble is not kept in stock.

Plain Slate—This is unfinished slate with the surface rubbed smooth.

Black Marine Slate—This material and finish has been adopted as standard in all cases where voltage limitations of slate are not exceeded. It is identical with that of black marine marble and the appearance of the finished panel is the same.

Black Enameled Slate—This finish is a bright glossy black. The enamel will not break or chip off and retains its luster, but will show scratches made on its surface. This finish does not show oil stains.

Natural Black Slate, Oil Finish—This is a black slate with an oil finish and is highly desirable where there is any liability of oil coming in contact with the panel, since oil marks do not show as plainly as on panels not finished in this manner.

Black Monson Slate is a variety of natural Black Slate. On account of the small demand for this material no attempt is made to carry a stock.

The list price includes panel with the finish given and drilled for mounting bolts as per table below.

Black marine finished marble is available for immediate shipment from stock. Shades A, B, C, D, F and veined marble require from six (6) to eight (8) weeks for shipment. White Italian requires from eight (8) to ten (10) weeks for shipment.

A stock of black marine slate panels is available for immediate shipment. Black enameled slate panels require ten (10) days and Natural Black slate panels from six (6) to eight (8) weeks.

When ordering blank panels, specify material, height, width, thickness and panel number, from table at top of next page.

DIMENSIONS

Panel No.	Panel Height Inches	Panel Thickness Inches	Panel Number of Holes	Dimensions in Inches—Fig. 1 A	B	C	D	E	F
1	12	1	2	1	6	6	....	..	⅜
2	12	1	4	1⅜	1⅜	1⅜	....	..	⅜
3	14	1	4	1	3½	3½	....	..	⅜
4	18	1	4	1⅜	1⅜	1⅜	....	..	⅜
5	24	1	4	1	6	6	....	..	⅜
6	24	1	4	1⅜	1⅜	1⅜	....	..	⅜
7	28	1	4	1	3½	3½	....	..	⅜
8	36	1	4	1⅜	1⅜	1⅜	....	..	⅜
9	36	1	4	1⅜	1⅜	1⅜	....	..	⅜
10	25	1¼	4	1⅜	1⅜	1⅜	....	..	⅜
11	36	1¼	4	1⅜	1⅜	1⅜	....	..	⅜
12	48	1¼	4	1⅜	1⅜	1⅜	....	..	⅜
13	25	1½	4	1⅜	1⅜	1⅜	....	..	⅜
14	48	1½	4	1⅜	1⅜	1⅜	....	..	⅜
15	20	2	4	1⅜	3	2½	....	..	⅜
16	25	2	4	1⅜	3	2½	....	..	⅜
17	25	2	4	1⅜	3	3	....	..	⅜
18	30	2	4	1⅜	3	2½	....	..	⅜
19	45	2	6	1⅜	2½	3	20	..	⅜
20	65	2	8	1⅜	3	3	19½	20	⅜
21	25	2½	4	1⅜	3	2½	....	..	⅜
22	30	2½	4	1⅜	3	2½	....	..	⅜
23	45	2½	6	1⅜	2½	3	20	..	⅜
24	65	2½	8	1⅜	3	3	19½	20	⅜

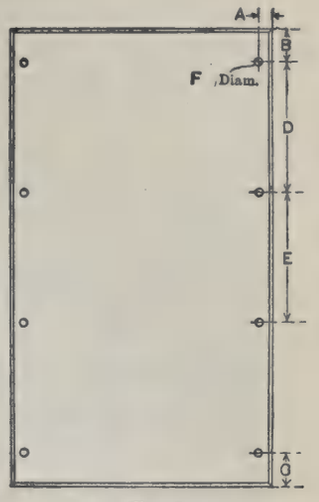


Fig. 1

PRICES

Marble Panels

Sizes in Inches Height	Width	Thickness	Bevel	List Prices for Various Finishes Black Marine	Shades A, B, C and D, and Veined Marble	Shade F	White Italian
12	16	1	¼	$ 9 35	$ 10 80	$ 12 00	$ 13 00
18	16	1	¼	13 90	16 00	16 40	18 90
24	16	1	¼	17 70	20 50	23 00	24 50
36	16	1	¼	27 50	32 00	35 50	37 75
36	16	1¼	¼	29 25	35 00	39 00	41 50
36	20	1¼	¼	35 75	43 00	48 00	50 00
36	24	1¼	¼	41 50	50 00	56 25	58 75
48	12	1¼	⅜	30 00	36 00	40 25	42 25
48	16	1¼	⅜	40 75	48 50	53 75	57 00
48	20	1¼	⅜	48 50	58 00	65 00	68 00
48	22	1¼	⅜	52 25	63 00	70 50	73 50
48	24	1¼	⅜	56 50	68 25	76 00	79 50
48	32	1¼	⅜	72 50	88 00	99 00	102 50
48	12	1½	⅜	35 00	42 00	47 00	50 50
48	16	1½	⅜	47 00	56 50	63 00	67 50
48	20	1½	⅜	55 75	67 50	75 75	80 50
48	22	1½	⅜	61 00	73 50	83 00	88 00
48	24	1½	⅜	66 00	79 50	88 00	95 50
48	32	1½	⅜	85 00	103 00	117 00	124 00
20	16	2	½	24 00	28 50	32 00	38 50
25	16	2	½	28 75	34 25	38 25	45 75
45	16	2	½	50 00	59 75	67 00	80 00
65	16	2	½	71 50	85 25	95 50	114 00
20	20	2	½	28 75	28 75	38 25	45 50
25	20	2	½	35 00	41 75	47 00	56 00
30	20	2	½	37 95	45 25	50 75	65 50
45	20	2	½	61 50	74 00	83 00	98 00
65	20	2	½	85 25	103 00	115 00	136 00
20	24	2	½	33 50	39 75	41 25	53 50
25	24	2	½	40 50	48 50	54 50	65 50
30	24	2	½	47 50	57 00	64 00	76 50
45	24	2	½	69 00	85 00	96 00	115 00
65	24	2	½	96 00	120 00	135 00	160 00
20	32	2	½	43 00	51 50	58 00	68 75
25	32	2	½	52 00	62 50	70 50	84 00
45	32	2	½	92 00	110 00	125 00	148 00
65	32	2	½	134 00	160 00	181 00	215 00
20	40	2	½	52 00	62 75	70 50	84 00
25	40	2	½	63 75	76 75	86 75	107 00
45	40	2	½	120 00	143 00	160 00	191 00
65	40	2	½	164 00	197 00	223 00	265 00
20	48	2	½	63 75	76 75	96 00	103 00
25	48	2	½	77 50	93 00	105 00	126 00
45	48	2	½	142 00	170 00	191 00	225 00
65	48	2	½	198 00	235 00	265 00	315 00

Order by Style Number

BLANK SWITCHBOARD PANELS—Continued

PRICES

Slate Panels

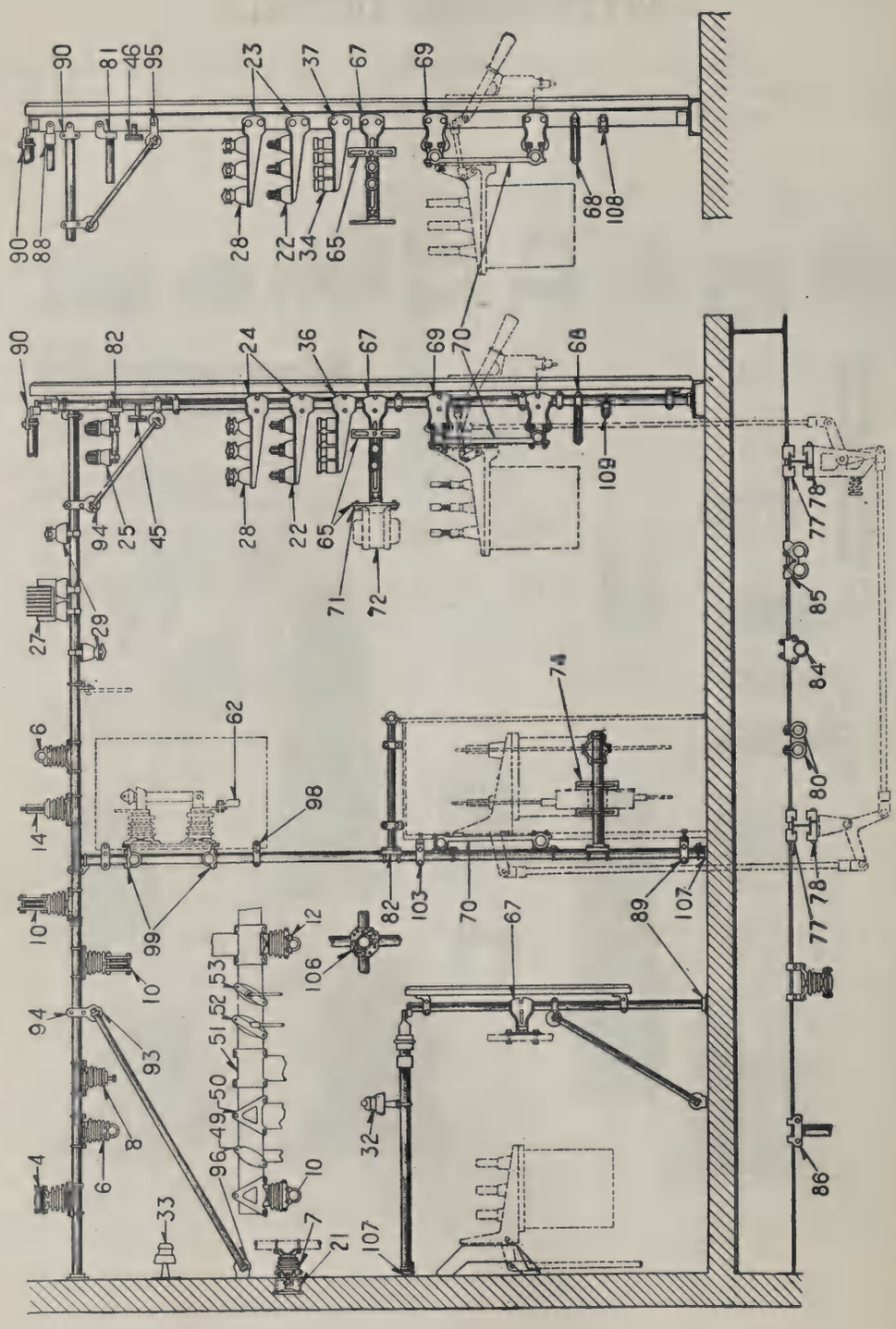
Sizes in Inches				List Prices for Various Finishes		
Height	Width	Thickness	Bevel	Black Marine	Black Enamel	Natural Black
12	16	1	¼	$ 7 90	$11 90	$ 9 00
12	20	1	¼	10 00	14 95	11 00
12	32	1	¼	14 75	22 50	16 50
14	24	1	¼	.....	.....	.....
18	16	1	¼	11 75	17 60	13 00
24	16	1	¼	15 00	15 40	16 80
24	20	1	¼	19 00	30 00	22 95
24	32	1	¼	28 50	44 25	34 00
28	24	1	¼	.....	.....	.....
36	16	1	¼	26 00	37 90	30 00
36	16	1¼	¼	28 50	40 50	35 00
36	20	1¼	¼	34 50	49 25	42 50
36	24	1¼	¼	40 00	58 00	49 50
48	12	1¼	⅜	28 75	40 75	36 00
48	16	1¼	⅜	40 00	49 25	49 50
48	20	1¼	⅜	47 25	67 00	58 50
48	24	1¼	⅜	57 50	81 00	76 50
48	32	1¼	⅜	69 25	100 00	98 50
48	12	1½	⅜	30 00	42 50	40 75
48	16	1½	⅜	42 00	58 00	55 50
48	20	1½	⅜	49 00	69 00	65 00
48	22	1½	⅜	53 75	75 75	71 50
48	24	1½	⅜	63 00	87 00	85 00
48	32	1½	⅜	90 00	113 00	110 00
20	16	2	½	21 00	27 75	27 75
25	16	2	½	24 50	32 50	32 75
45	16	2	½	44 50	59 50	63 00
65	16	2	½	63 00	85 00	90 00
20	20	2	½	24 50	32 50	32 75
25	20	2	½	31 00	41 00	43 75
30	20	2	½	35 75	48 25	51 50
45	20	2	½	54 50	73 00	87 00
65	20	2	½	78 50	105 00	115 00
20	24	2	½	29 00	39 00	41 75
25	24	2	½	35 50	42 25	51 25
30	24	2	½	41 00	45 50	59 75
45	24	2	½	63 50	86 00	90 50
65	24	2	½	91 50	124 00	135 00
20	32	2	½	37 00	50 50	53 75
25	32	2	½	45 50	62 00	65 75
45	32	2	½	85 00	115 00	126 00
65	32	2	½	130 00	173 00	197 00
20	40	2	½	45 50	62 00	65 75
25	40	2	½	55 50	76 00	80 00
45	40	2	½	118 50	155 00	175 00
65	40	2	½	170 00	225 00	260 00
20	48	2	½	56 50	76 00	80 00
25	48	2	½	71 75	96 50	106 00
45	48	2	½	148 50	192 00	225 00
65	48	2	½	220 00	285 00	335 00
25	20	2½	½x1	36 00	46 25	60 00
25	24	2½	½x1	41 00	53 50	70 00
45	20	2½	½x1	62 75	81 50	105 00
45	24	2½	½x1	73 75	96 00	125 00

Order by Style Number

SWITCHBOARD DETAILS

In the following pages there are listed various details developed and used by the Westinghouse Electric & Manufacturing Company in the design and building of switchboards for all classes of service. This detail apparatus meets every requirement of the National Board of Fire Underwriters.

SWITCHBOARD DETAILS—Continued



APPLICATION OF THE VARIOUS DETAIL PARTS LISTED

The numbers shown above refer to the "Index to Details" and also to the detail views on the following pages.

SWITCHBOARD DETAILS—Continued

INDEX TO DETAILS

(Refer to numbers on Fig. on preceding page and to detail views on following pages).

Description	Figure
Barrier brackets for pipe mounting	97–98
Beveled washers for front of panel	.....
Bolts, insulated and uninsulated	125–126
Bus supports with corrugated insulators	1 to 17
Bus-bar brackets	23–24–20A
Bus-bar clamps	49–50–51
Bus-bar copper	.....
Bus-bar supports rear connected, type P	19
Bus-bar terminals	52–53
Bus-rod brackets and supports	28–29–31–32–33 36–37
Bus-strap brackets	44
Bus-strap supports	22–25–26–27
Bus wire and insulated turnbuckles	47
Card holders	128
Clamps	84–85
Connectors, Tee	54–55
Connectors, of copper tubing	56–59
I-Beam clamps	77–78–79
Idler brackets with idlers	110–111
Insulators, corrugated porcelain	18–20
Insulators, plain porcelain	30–34–35
Metal caps for switchboards	124
Micarta cleats	48
Mounting brackets for condenser sections	75–76
Mounting brackets for current transformers	71–72
Mounting brackets for meters	115 to 119, 121–122
Mounting clamp brackets	99 to 104, 108–109
Nameplates	...
Nuts, fancy hexagon, special finish	127
Nuts for contact studs	64
Pipe braces and clamps	90–90A
Pipe end caps	112
Pipe brackets	81
Pipe conduit clamps	80
Pipe cross clamps	105–106
Pipe ends	88–89
Pipe end clamps	86
Pipe flanges	....
Pipe flange clamps	107
Pipe mounting brackets	73–74–83–91–92
Pipe saddle clamps	82
Shunt lead holder	113A
Shunt supporting brackets	114
Switchboard mountings for rheostats	113B
Terminals	61–64
Universal auxiliary brackets	65
Universal mounting brackets	66–67–68A-69
Universal mounting blocks	21
Universal mounting straps	68
Wall braces with angular adjustment	87, 93 to 96

MECHANICAL STRESSES ON BUS-BARS

Mechanical stresses due to short circuits on the bus-bars must be considered in selecting the type and size of support. These short-circuit stresses may depend on the maximum ampere load, under short-circuit conditions, the distance between center lines of bus-bars, and the relative location of the bus-bars.

The magnitude of these stresses with varying Kva. capacities, impedances, bus spacings etc., is graphically shown in the charts, Figs. 1A and 1B.

These are self-explanatory and with the examples worked out on each chart, should offer a ready means for taking care of problems of this nature.

Formulae for calculating the stresses are given below.

To find the maximum force exerted between bus-bars caused by a single-phase or three-phase short-circuit current on a three-phase system, the busses arranged in a plane:

Let F = maximum force exerted in lbs. per ft. of bus.

Kva. = normal rating of station, including all synchronous apparatus.

A = distance between busses in inches.

Z = impedance in per cent, expressed in decimals, to point of short-circuit.

V = line voltage.

$$\text{Then } F = \frac{.27 \times (\text{Kva.})^2}{A \times V^2 \times Z^2}$$

To find the kva. rating of a support for use on a system with an impedance different from that given in the table,

Let Kva. = rating given in table.

Z = per cent impedance used in table, expressed in decimals.

Kva.^{-1} = new Kva. rating.

Z^{-1} = new per cent impedance expressed in decimals.

$$\text{Then } \text{Kva.}^{-1} = \text{Kva.} \times \frac{Z^{-1}}{Z}.$$

SWITCHBOARD DETAILS—Continued

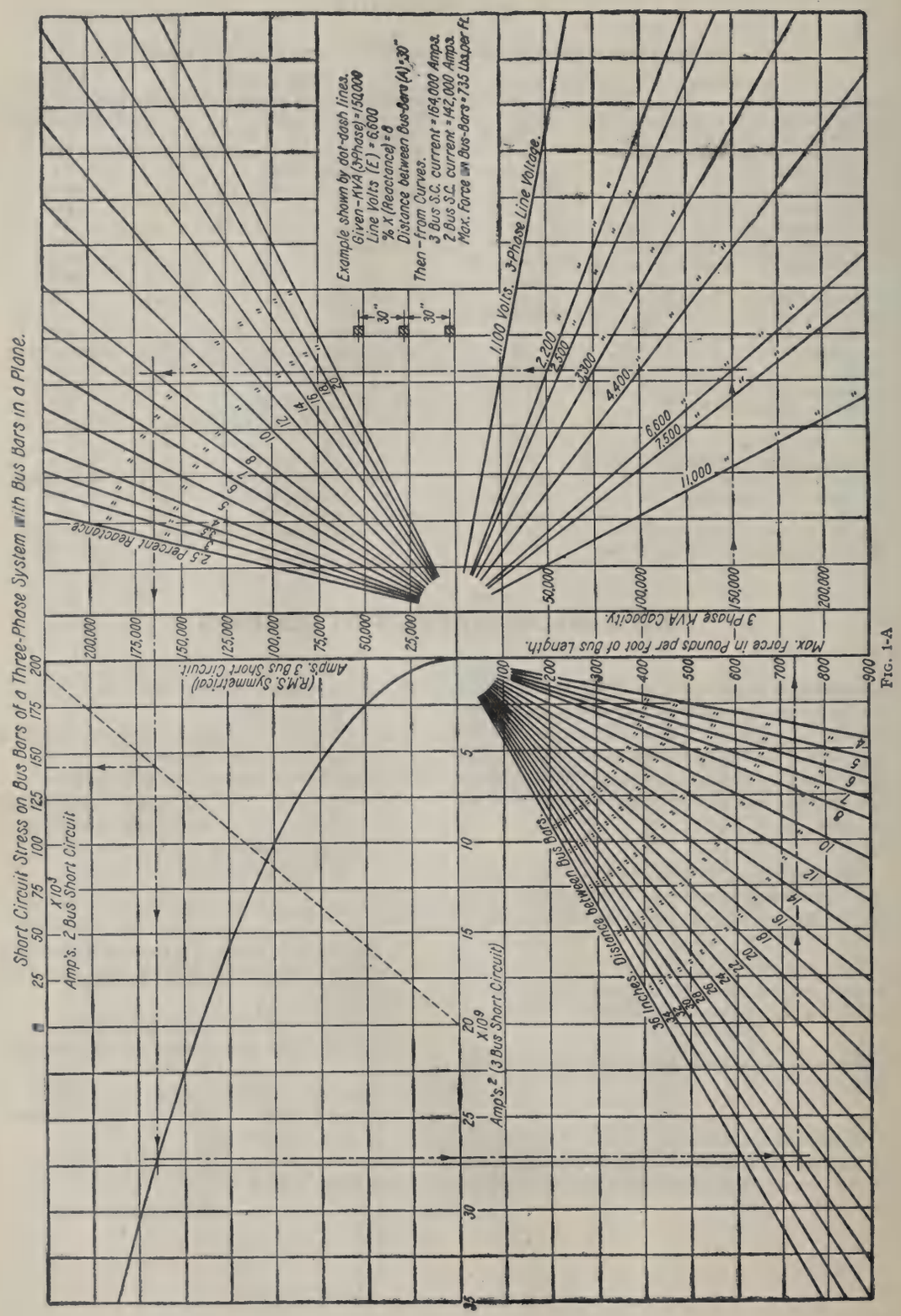

Short Circuit Stress on Bus Bars of a Three-Phase System with Bus Bars in a Plane.
Amp's. 2 Bus Short Circuit X 10³
Amp's.² (3 Bus Short Circuit) X 10⁹
Amps. 3 Bus Short Circuit (R.M.S. Symmetrical)
Distance between Bus Bars Inches.
Max. Force in Pounds per Foot of Bus Length.
3 Phase KVA Capacity.
2.5 Percent Reactance
Example shown by dot-dash lines.
Given—KVA (3 Phase) = 150,000
Line Volts (E) = 6,600
% X (Reactance) = 6
Distance between Bus-Bars (A) = 30"
Then—from Curves.
3 Bus S.C. current = 164,000 Amps.
2 Bus S.C. current = 142,000 Amps.
Max. Force on Bus-Bars = 735 Lbs. per Ft.
1,100 Volts. 3-Phase Line Voltage.
2,200
2,500
3,300
4,400
6,600
7,500
11,000

FIG. 1-A

SWITCHBOARD DETAILS—Continued

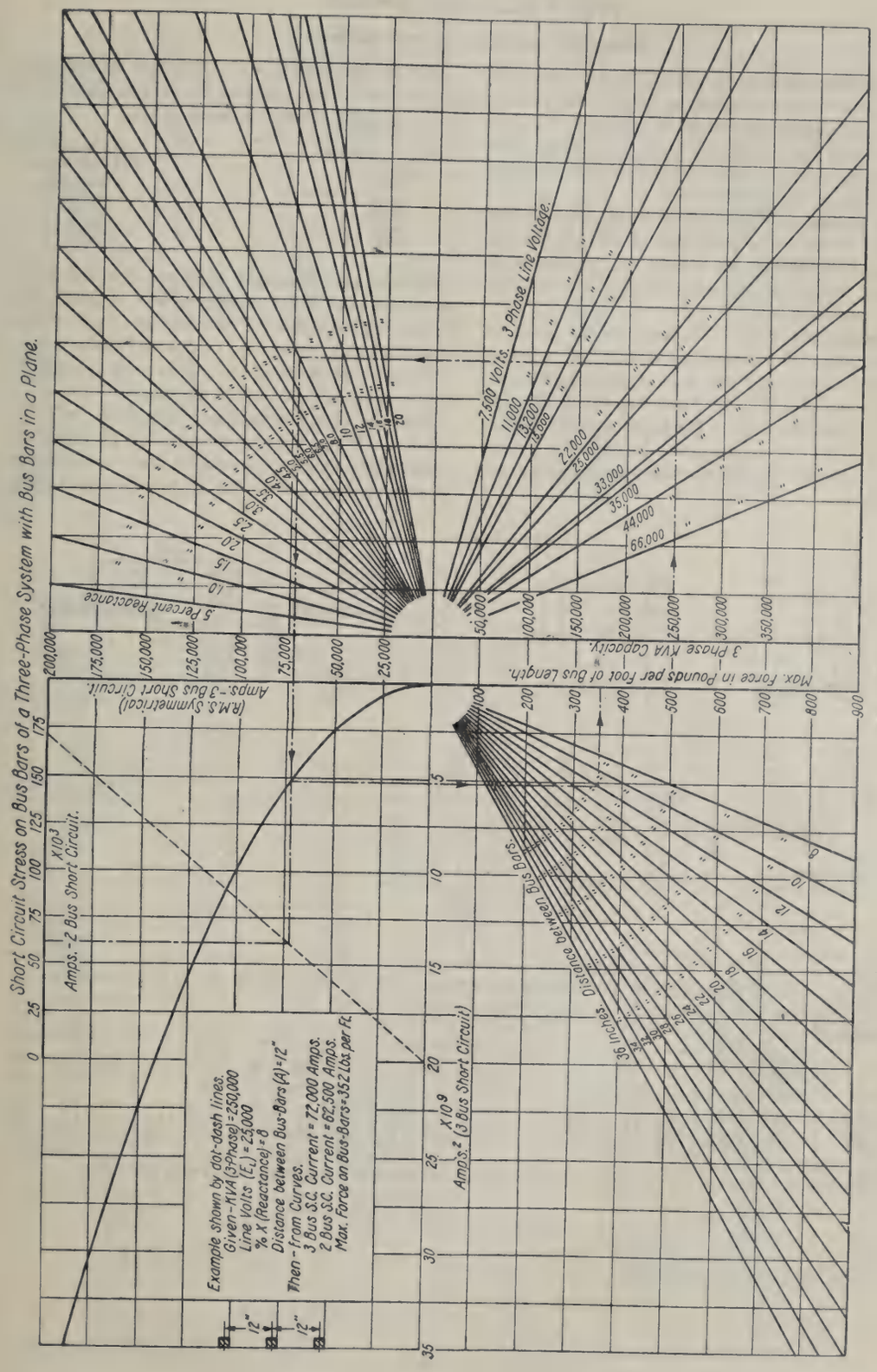

Short Circuit Stress on Bus Bars of a Three-Phase System with Bus Bars in a Plane.
Amps.-2 Bus Short Circuit. X10³
Amps.-3 Bus Short Circuit. (R.M.S. Symmetrical)
Amps.² (3 Bus Short Circuit) X10⁹
3 Percent Reactance
Distance between Bus Bars
36 Inches
7,500 Volts. 3 Phase Line Voltage.
11,000
13,200
22,000
33,000
44,000
66,000
3 Phase KVA Capacity.
Max. Force in Pounds per Foot of Bus Length.
Example shown by dot-dash lines.
Given-KVA (3-Phase) = 250,000
Line Volts (E_L) = 23,000
% X (Reactance) = 8
Distance between Bus-Bars (A) = 12"
Then - from Curves.
3 Bus S.C. Current = 72,000 Amps.
2 Bus S.C. Current = 62,500 Amps.
Max. Force on Bus-Bars = 352 Lbs. per Ft.
12"
12"

FIG. 1-B

SWITCHBOARD DETAILS—Continued

TYPE P BUS-BAR SUPPORTS

Standard Applications and Ratings

These supports consist essentially of an insulator with suitable bus and mounting fixtures clamped on.

The insulators are made of porcelain by wet process and have a brown mahogany glaze. The insulators are corrugated to insure ample creepage surface under service conditions.

The fittings are made of malleable iron or cast brass and have a high grade, dull black, baked finish.

Interchangeability of fittings on porcelains of different voltage but of same diameter of head or base is provided for.

Voltage tests with all fittings on are given in table below. These tests are ample for ordinary applications and are well within the requirements of the recommendations of the American Institute of Electrical Engineers. The large creepage surface provided by the corrugations insures the ability of the insulator to stand the same test under service conditions.

For exceptional installations where an insulator of a higher voltage test may be desired, select from the next higher maximum service class.

Maximum Service Voltage	One Minute Dry Test Volts
7500	20000
15000	40000
25000	65000
35000	90000
44000	115000

Applications—Standard supports are listed for mounting from a flat surface or from a pipe. Bus fittings are available for round busses and for rectangular straps, supported on flat surfaces or edges.

Fig. 1 shows some of the more common arrangements when mounted in cell structures.

Ratings—Standard ratings are given in the Table 1 below. When ratings required are in excess of those given, reference should be made to tables on succeeding pages, or to the nearest District Office.

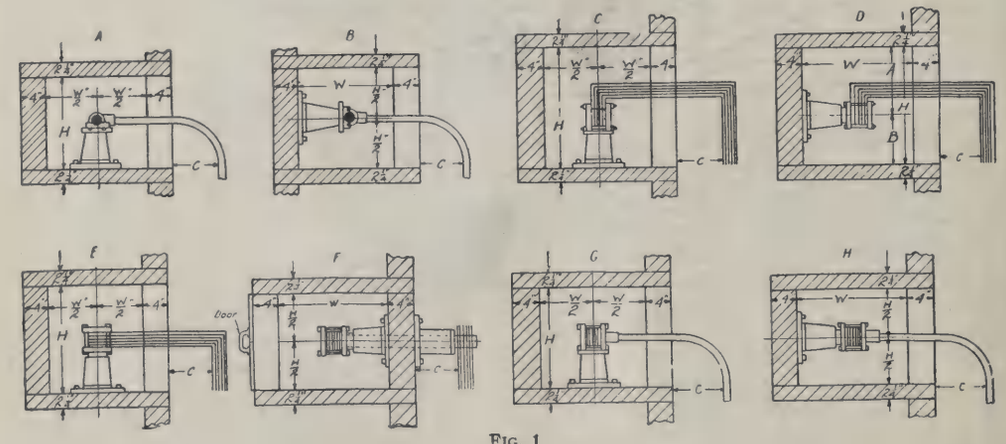


FIG. 1

Voltage	DIMENSIONS IN INCHES OF STANDARD ARRANGEMENTS OF BUS-BAR SUPPORTS																	
	All	A		B		C		D*		E		F		G		H	
	C-Min	H	W	H	W	H	W	H	W	H	W	H	W	H	W	H	W
2500	2	12	9	12	10¾	15½	10	12	13¾	13¼	9	12	13¼	12	9¾	12	13¼
7500	3¼	12¼	11½	12	12¼	17	13	14¼	14¾	14¾	11	12	14¾	13¼	12¾	12	14¾
15000	5½	15½	16¼	16¼	15½	20½	17½	18¾	18½	18½	15½	15½	18½	16¾	17¼	15½	18½

*Dimension A for 2500 volts = 7¾ inches and B = 4¼ inches; for 7500 volts A = 8¾ inches and B = 5½ inches.

SWITCHBOARD DETAILS—Continued

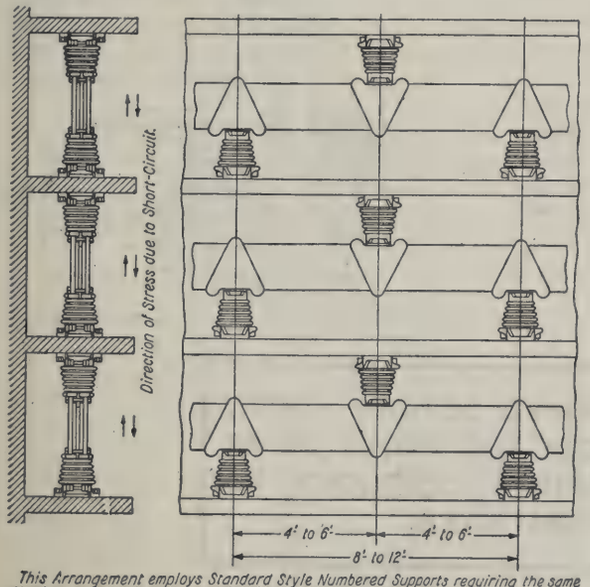
TYPE P BUS-BAR SUPPORTS

Post-Type—Kva. Rating

Line Service Voltage	Insulator Base, Inches Diameter	Minimum Spacing Between Busses, Inches	Maximum Spacing Between Supports, Feet	Kva. Rating of Support, Corresponding to Kva. Rating of Station, Assuming 10 Per Cent Impedance to Point of Short Circuit		
				Round or Flat Bus	Bus Mounted on Edge	
					3 to 4-inch Bus	5 to 6-inch Bus
			For Light Duty			
2500	2 7/8	6	3	10000	8000	.....
7500	2 7/8	[illegible]	3	35000	30000	.....
15000	2 7/8	10	3	60000	56000	.....
			For Medium Duty			
2500	3 7/8	[illegible]	4	15000	13000	11000
7500	3 7/8	8	4	47000	41000	34500
15000	3 7/8	10	4	90000	81000	.....
25000	3 7/8	16	4	172000	160000	155000
			For Heavy Duty			
2500	4 7/8	10	4	23000	21000	17000
2500	4 7/8	16	4	30000	26000	24500
2500	4 7/8	20	4	33000	29000	27500
2500	4 7/8	24	4	36000	32000	30000
7500	4 7/8	10	4	72000	64000	60000
7500	4 7/8	12	4	79000	70000	65000
7500	4 7/8	16	4	91500	81000	75000
7500	4 7/8	20	4	100000	91000	85000
7500	4 7/8	24	4	120000	100000	92000
15000	4 7/8	12	4	135000	125000	120000
15000	4 7/8	16	4	160000	145000	138000
15000	4 7/8	20	4	175000	160000	150000
15000	4 7/8	24	4	190000	175000	170000
25000	4 7/8	16	4	230000	220000	210000
25000	4 7/8	20	4	260000	247000	240000
25000	4 7/8	24	4	285000	270000	250000

For Extra Heavy Duty

Fig. 2 shows method of applying standard supports to increase ratings.



This Arrangement employs Standard Style Numbered Supports requiring the same Number as is ordinarily used for Single Supports, but so disposed that one half of the Porcelains are in Compression from Short-Circuit Stresses.

FIG. 2—EXTRA-HEAVY-DUTY BUS ARRANGEMENT, BUSSES VERTICALLY MOUNTED IN SAME VERTICAL PLANE WITH BARRIERS

EXAMPLE OF REQUIREMENTS
6-Inch Bus, 15000 Volts

Description	No. Required Approximately for each [illegible] to 12 ft. run of 3-Phase Bus
Main Support, similar to Style No. 237560	3
Brace Support, similar to Style No. 237560	3

Insulator supports for extra heavy busses will be supplied, when desired, with insulator braces between the bus-bars, as shown in Figure 3. The complete support and brace are made up of standard parts. This arrangement is equally adaptable for frame or cell mounting, as shown in Figures 3 and 3-A. Prices on application.

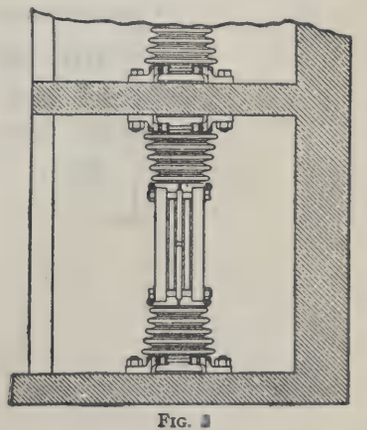


FIG. [illegible]

TYPE P BUS-BAR SUPPORTS

For Extra Heavy Duty

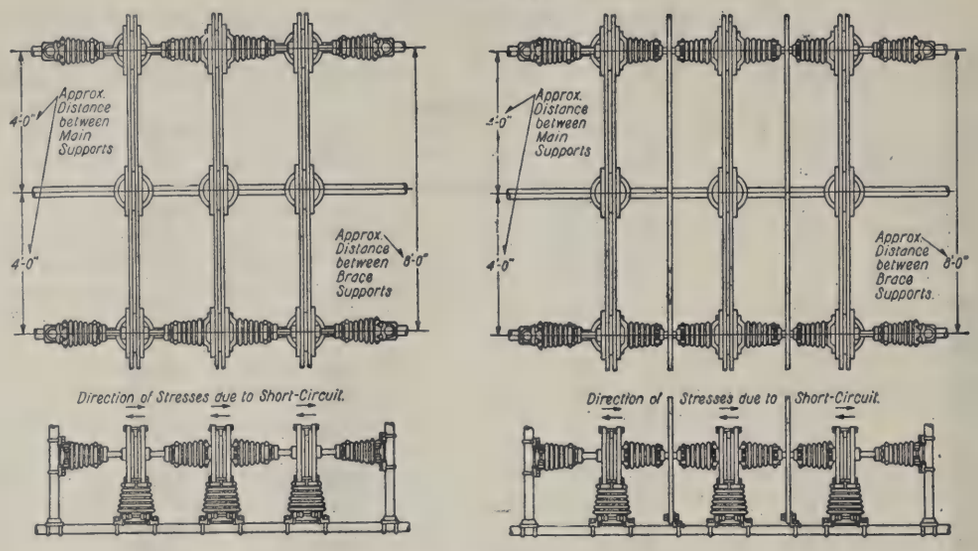


FIG. 3-A

STANDARD SUPPORTS

Type P bus supports with type R mounting and type F support—The bus clamp is of the two-bolt type and will accommodate bus straps of 2 inches to 5 inches wide, and connections of 1½ inches to 4½ inches. For 1¼ inch pipe mounting.

Style number includes bus-clamping bolts for 1 inch bus space and base for 1¼ inch pipe. Supports with greater bus space and with ¾ inch and 2 inch pipe base can be supplied when ordered, except that supports having 4⅞ inch diameter base require a pipe not less than 1¼ inch diameter.

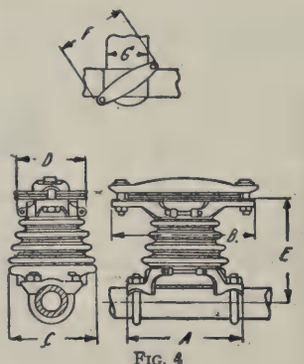


FIG. 4

THE SWITCHBOARD DETAILS LISTED IN THESE PAGES MAY PROVE TO BE OF THE GREATEST ASSISTANCE TO YOU. LOOK THEM OVER.

SWITCHBOARD DETAILS—Continued

Table for Fig. 4

Complete Support Style No.	Service Voltage	Width of Bus, Inches	Width of Connection, Inches	Diameter of Insulator Base, Inches	Approximate Dimensions in Inches							Approx. Shipping Weight, Lbs.
					A	B	C	D	E	F	G	
237792	7500	2	2	2 7/8	5	4 11/16	4 1/8	3 3/4	4 23/32	4 5/8	2	5
237792	7500	3	1	2 7/8	5	4 11/16	4 1/8	3 3/4	4 23/32	4 5/8	1	5
237793	7500	2	3	3 7/8	5 3/4	5 7/8	5 1/8	4 1/8	5 1/8	6 1/4	3	6
237793	7500	3	3	3 7/8	5 3/4	5 7/8	5 1/8	4 1/8	5 1/8	6 1/4	3	6
237793	7500	4	1 1/2	3 7/8	5 3/4	5 7/8	5 1/8	4 1/8	5 1/8	6 1/4	1 1/2	6
237794	7500	2	4 1/2	4 7/8	7 1/16	6 7/8	6 1/2	5	5 21/32	7 1/8	4 1/2	8
237794	7500	3	4	4 7/8	7 1/16	6 7/8	6 1/2	5	5 21/32	7 1/8	4	8
237794	7500	4	3	4 7/8	7 1/16	6 7/8	6 1/2	5	5 21/32	7 1/8	3	8
237794	7500	5	1 1/2	4 7/8	7 1/16	6 7/8	6 1/2	5	5 21/32	7 1/8	1 1/2	8
237795	15000	2	2	2 7/8	5	4 11/16	4 1/8	3 3/4	6 3/32	4 5/8	2	5
237795	15000	3	1	2 7/8	5	4 11/16	4 1/8	3 3/4	6 3/32	4 5/8	1	5
237796	15000	2	3	3 7/8	5 3/4	5 7/8	5 1/8	4 1/8	6 1/2	6 1/4	3	6
237796	15000	3	3	3 7/8	5 3/4	5 7/8	5 1/8	4 1/8	6 1/2	6 1/4	3	6
237796	15000	4	1 1/2	3 7/8	5 3/4	5 7/8	5 1/8	4 1/8	6 1/2	6 1/4	1 1/2	6
237797	15000	2	4 1/2	4 7/8	7 1/16	6 7/8	6 1/2	5	7 1/32	7 1/8	4 1/2	8
237797	15000	3	4	4 7/8	7 1/16	6 7/8	6 1/2	5	7 1/32	7 1/8	4	8
237797	15000	4	3	4 7/8	7 1/16	6 7/8	6 1/2	5	7 1/32	7 1/8	3	8
237797	15000	5	1 1/2	4 7/8	7 1/16	6 7/8	6 1/2	5	7 1/32	7 1/8	1 1/2	8
237798	25000	2	3	3 7/8	5 3/4	5 7/8	5 1/8	4 1/8	9 1/4	6 1/4	3	6
237798	25000	3	3	3 7/8	5 3/4	5 7/8	5 1/8	4 1/8	9 1/4	6 1/4	3	6
237798	25000	4	1 1/2	3 7/8	5 3/4	5 7/8	5 1/8	4 1/8	9 1/4	6 1/4	1 1/2	6
237799	25000	2	4 1/2	4 7/8	7 1/16	6 7/8	6 1/2	5	9 25/32	7 1/8	4 1/2	8
237799	25000	3	4	4 7/8	7 1/16	6 7/8	6 1/2	5	9 25/32	7 1/8	4	8
237799	25000	4	3	4 7/8	7 1/16	6 7/8	6 1/2	5	9 25/32	7 1/8	3	8
237799	25000	5	1 1/2	4 7/8	7 1/16	6 7/8	6 1/2	5	9 25/32	7 1/8	1 1/2	8
237800	35000	2	3	4 7/8	7 1/16	5 7/8	6 1/2	4 1/8	13 1/16	6 1/4	3	8
237800	35000	3	3	4 7/8	7 1/16	5 7/8	6 1/2	4 1/8	13 1/16	6 1/4	3	8
237800	35000	4	1 1/2	4 7/8	7 1/16	5 7/8	6 1/2	4 1/8	13 1/16	6 1/4	1 1/2	8
237801	45000	2	3	4 7/8	7 1/16	5 7/8	6 1/2	4 1/8	17 3/16	6 1/4	3	8
237801	45000	3	3	4 7/8	7 1/16	5 7/8	6 1/2	4 1/8	17 3/16	6 1/4	3	8
237801	45000	4	1 1/2	4 7/8	7 1/16	5 7/8	6 1/2	4 1/8	17 3/16	6 1/4	1 1/2	8

Type P bus supports with type F mounting and type F support—The bus clamp is of the two-bolt type and will accommodate bus straps of 2 inches to 5 inches wide, and connections of 1½ inches to 4½ inches.

Style number includes bus clamping bolts for 1-inch bus space. Supports with greater bus space can be supplied when ordered.

All insulator supports listed on this page with diameter of insulator base 2⅞ inches are for light duty, those having a diameter 3⅞ inches are for medium duty, and those of 4⅞ inches are for heavy duty.

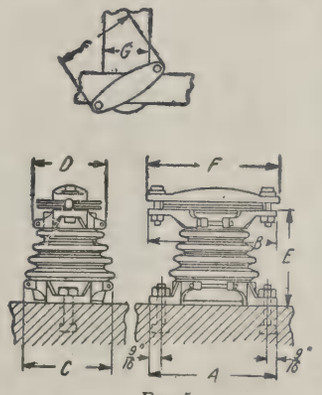


FIG. 5

Complete Support Style No.	Service Voltage	Width of Bus, Inches	Width of Connection, Inches	Diameter of Insulator Base, Inches	Approximate Dimensions in Inches							Approx. Shipping Weight, Lbs.
					A	B	C	D	E	F	G	
237482	7500	2	2	2 7/8	5 7/8	4 11/16	4 1/8	3 3/4	3 15/16	4 5/8	2	5
237482	7500	3	1	2 7/8	5 7/8	4 11/16	4 1/8	3 3/4	3 15/16	4 5/8	1	5
237483	7500	2	3	3 7/8	6 7/8	5 7/8	5	4 1/8	4 1/4	6 1/4	3	6
237483	7500	3	3	3 7/8	6 7/8	5 7/8	5	4 1/8	4 1/4	6 1/4	3	6
237483	7500	4	1 1/2	3 7/8	6 7/8	5 7/8	5	4 1/8	4 1/4	6 1/4	1 1/2	6
237484	7500	2	4 1/2	4 7/8	8 1/16	6 7/8	6 1/2	5	4 3/4	7 1/8	4 1/2	8
237484	7500	3	4	4 7/8	8 1/16	6 7/8	6 1/2	5	4 3/4	7 1/8	4	8
237484	7500	4	3	4 7/8	8 1/16	6 7/8	6 1/2	5	4 3/4	7 1/8	3	8
237484	7500	5	1 1/2	4 7/8	8 1/16	6 7/8	6 1/2	5	4 3/4	7 1/8	1 1/2	8
237485	15000	2	2	2 7/8	5 7/8	4 11/16	4 1/8	3 3/4	5 5/16	4 5/8	2	5
237485	15000	3	1	2 7/8	5 7/8	4 11/16	4 1/8	3 3/4	5 5/16	4 5/8	1	5
237486	15000	2	3	3 7/8	6 7/8	5 7/8	5	4 1/8	5 5/8	6 1/4	3	8
237486	15000	3	3	3 7/8	6 7/8	5 7/8	5	4 1/8	5 5/8	6 1/4	3	8
237486	15000	4	1 1/2	3 7/8	6 7/8	5 7/8	5	4 1/8	5 5/8	6 1/4	1 1/2	8
237487	15000	2	4 1/2	4 7/8	8 1/16	6 7/8	6 1/2	5	6 1/8	7 1/8	4 1/2	12
237487	15000	3	4	4 7/8	8 1/16	6 7/8	6 1/2	5	6 1/8	7 1/8	4	12
237487	15000	4	3	4 7/8	8 1/16	6 7/8	6 1/2	5	6 1/8	7 1/8	3	12
237487	15000	5	1 1/2	4 7/8	8 1/16	6 7/8	6 1/2	5	6 1/8	7 1/8	1 1/2	12
237488	25000	2	3	3 7/8	6 7/8	5 7/8	5	4 1/8	8 3/8	6 1/4	3	12
237488	25000	3	3	3 7/8	6 7/8	5 7/8	5	4 1/8	8 3/8	6 1/4	3	12
237488	25000	4	1 1/2	3 7/8	6 7/8	5 7/8	5	4 1/8	8 3/8	6 1/4	1 1/2	12
237489	25000	2	4 1/2	4 7/8	8 1/16	6 7/8	6 1/2	5	8 7/8	7 1/8	4 1/2	17
237489	25000	3	4	4 7/8	8 1/16	6 7/8	6 1/2	5	8 7/8	7 1/8	4	17
237489	25000	4	3	4 7/8	8 1/16	6 7/8	6 1/2	5	8 7/8	7 1/8	3	17
237489	25000	5	1 1/2	4 7/8	8 1/16	6 7/8	6 1/2	5	8 7/8	7 1/8	1 1/2	17
237490	35000	2	3	4 7/8	8 1/16	5 7/8	6 1/2	4 1/8	12 1/8	6 1/4	3	20
237490	35000	3	3	4 7/8	8 1/16	5 7/8	6 1/2	4 1/8	12 1/8	6 1/4	3	20
237490	35000	4	1 1/2	4 7/8	8 1/16	5 7/8	6 1/2	4 1/8	12 1/8	6 1/4	1 1/2	20
237491	44000	2	3	4 7/8	8 1/16	5 7/8	6 1/2	4 1/8	16 1/4	6 1/4	3	25
237491	44000	3	3	4 7/8	8 1/16	5 7/8	6 1/2	4 1/8	16 1/4	6 1/4	3	25
237491	44000	4	1 1/2	4 7/8	8 1/16	5 7/8	6 1/2	4 1/8	16 1/4	6 1/4	1 1/2	25

SWITCHBOARD DETAILS—Continued

Type P bus supports with type R mounting and type R support—For bus rods, bus cable or bus tubes, up to 2½ inches diameter. For 1¼-inch pipe mounting.

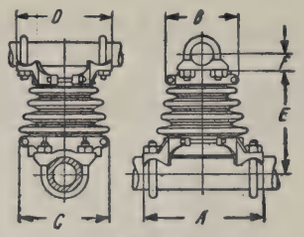


FIG. 6

Complete Support, Style No.	Service Voltage	Outside Diameter of Bus Inches	Diameter of Insulated Base Inches,	Approximate Dimensions in Inches						Approximate Shipping Weight, lbs.
				A	B	C	D	E	F	
238128	7500	Max. ¾	2⅞	4 11/32	3¾	4⅛	4 3/32	4 11/16	11/32	5
238129	7500	¾ to 1⅛	2⅞	4 11/32	3¾	4⅛	4 3/32	4 11/16	11/32	5
238130	7500	1⅛ to 1⅜	2⅞	4 11/32	3¾	4⅛	4 3/32	4 11/16	¾	5
238131	7500	1⅜ to 1¾	2⅞	4 11/32	3¾	4⅛	4 3/32	4 11/16	1	5
238132	7500	Max. ¾	3⅞	5 3/32	4⅛	5⅛	4 3/32	4⅞	5/16	6
238133	7500	¾ to 1⅛	3⅞	5 3/32	4⅛	5⅛	4 3/32	4⅞	11/32	6
238134	7500	1⅛ to 1⅜	3⅞	5 3/32	4⅛	5⅛	4 3/32	4⅞	11/32	6
238135	7500	1⅜ to 1¾	3⅞	5 3/32	4⅛	5⅛	4 3/32	4⅞	1 5/16	6
238136	7500	1⅛ to 1⅜	4⅞	7 5/16	5⅛	6½	5 21/32	5⅜	11/32	8
238137	7500	1⅜ to 1¾	4⅞	7 5/16	5⅛	6½	5 21/32	5⅜	1	8
238138	7500	1¾ to 2⅛	4⅞	7 5/16	5⅛	6½	5 21/32	5⅜	1 5/16	8
238139	7500	2⅛ to 2½	4⅞	7 5/16	5⅛	6½	5 21/32	5⅜	1 11/32	8
238140	15000	Max. ¾	2⅞	4 11/32	3¾	4⅛	4 3/32	6 1/16	11/32	5
238141	15000	¾ to 1⅛	2⅞	4 11/32	3¾	4⅛	4 3/32	6 1/16	11/32	5
238142	15000	1⅛ to 1⅜	2⅞	4 11/32	3¾	4⅛	4 3/32	6 1/16	¾	5
238143	15000	1⅜ to 1¾	2⅞	4 11/32	3¾	4⅛	4 3/32	6 1/16	1	5
238144	15000	Max. ¾	3⅞	5 3/32	4⅛	5⅛	4 3/32	6¼	5/16	6
238145	15000	¾ to 1⅛	3⅞	5 3/32	4⅛	5⅛	4 3/32	6¼	11/32	6
238146	15000	1⅛ to 1⅜	3⅞	5 3/32	4⅛	5⅛	4 3/32	6¼	11/32	6
238147	15000	1⅜ to 1¾	3⅞	5 3/32	4⅛	5⅛	4 3/32	6¼	1 5/16	6
238148	15000	1⅛ to 1⅜	4⅞	7 5/16	5⅛	6½	5 21/32	6¾	11/32	8
238149	15000	1⅜ to 1¾	4⅞	7 5/16	5⅛	6½	5 21/32	6¾	1	8
238150	15000	1¾ to 2⅛	4⅞	7 5/16	5⅛	6½	5 21/32	6¾	1 5/16	8
238151	15000	2⅛ to 2½	4⅞	7 5/16	5⅛	6½	5 21/32	6¾	1 11/32	8
238152	25000	Max. ¾	3⅞	5 3/32	4⅛	5⅛	4 3/32	9	5/16	12
238153	25000	¾ to 1⅛	3⅞	5 3/32	4⅛	5⅛	4 3/32	9	11/32	12
238154	25000	1⅛ to 1⅜	3⅞	5 3/32	4⅛	5⅛	4 3/32	9	11/32	12
238155	25000	1⅜ to 1¾	3⅞	5 3/32	4⅛	5⅛	4 3/32	9	1 5/16	12
238156	25000	1⅛ to 1⅜	4⅞	7 5/16	5⅛	6½	5 21/32	9½	11/32	17
238157	25000	1⅜ to 1¾	4⅞	7 5/16	5⅛	6½	5 21/32	9½	1	17
238158	25000	1¾ to 2⅛	4⅞	7 5/16	5⅛	6½	5 21/32	9½	1 5/16	17
238159	25000	2⅛ to 2½	4⅞	7 5/16	5⅛	6½	5 21/32	9½	1 11/32	17
238160	35000	Max. ¾	4⅞	7 5/16	4⅛	6½	4 3/32	12 1/16	5/16	20
238161	35000	¾ to 1⅛	4⅞	7 5/16	4⅛	6½	4 3/32	12 1/16	11/32	20
238162	35000	1⅛ to 1⅜	4⅞	7 5/16	4⅛	6½	4 3/32	12 1/16	11/32	20
238163	35000	1⅜ to 1¾	4⅞	7 5/16	4⅛	6½	4 3/32	12 1/16	1 5/16	20
238164	44000	Max. ¾	4⅞	7 5/16	4⅛	6½	4 3/32	16 1/16	5/16	25
238165	44000	¾ to 1⅛	4⅞	7 5/16	4⅛	6½	4 3/32	16 1/16	11/32	25
238166	44000	1⅛ to 1⅜	4⅞	7 5/16	4⅛	6½	4 3/32	16 1/16	11/32	25
238167	44000	1⅜ to 1¾	4⅞	7 5/16	4⅛	6½	4 3/32	16 1/16	1 5/16	25

Type P bus supports with type F mounting and type R support—For bus rods, bus cable or bus tubes, up to 2½ inches diameter.

All insulator supports listed on this page with diameter of insulator base 2⅞ inches are for light duty, those having a diameter 3⅞ inches are for medium duty, and those of 4⅞ inches are for heavy duty.

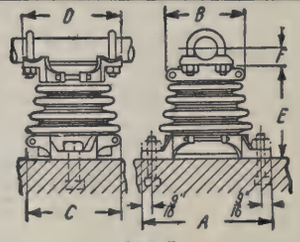


FIG. 7

Complete Support, Style No.	Service Voltage	Outside Diameter of Bus Inches	Diameter of Insulated Base Inches	Approximate Dimensions in Inches						Approximate Shipping Weight, lbs.
				A	B	C	D	E	F	
238168	7500	Max. ¾	2⅞	5⅞	3¾	4⅛	4 3/32	3¾	11/32	5
238169	7500	¾ to 1⅛	2⅞	5⅞	3¾	4⅛	4 3/32	3¾	11/32	5
238170	7500	1⅛ to 1⅜	2⅞	5⅞	3¾	4⅛	4 3/32	3¾	¾	5
238171	7500	1⅜ to 1¾	2⅞	5⅞	3¾	4⅛	4 3/32	3¾	1	5
238172	7500	Max. ¾	3⅞	6⅞	4⅛	5	4 13/32	4 3/32	5/16	6
238173	7500	¾ to 1⅛	3⅞	6⅞	4⅛	5	4 13/32	4 3/32	11/32	6
238174	7500	1⅛ to 1⅜	3⅞	6⅞	4⅛	5	4 13/32	4 3/32	11/32	6
238175	7500	1⅜ to 1¾	3⅞	6⅞	4⅛	5	4 13/32	4 3/32	1 5/16	6

Continued on following page

Order by Style Number

SWITCHBOARD DETAILS—Continued

Table for Figure 7—Continued

Complete Support, Style No.	Service Voltage	Outside Diameter of Bus Inches	Diameter of Insulated Base Inches	Approximate Dimensions in Inches						Approximate Shipping Weight, lbs.
				A	B	C	D	E	F	
238176	7500	1 1/4 to 1 3/8	4 7/8	8 1/16	5 1/8	6 1/2	5 33/64	4 15/32	15/32	8
238177	7500	1 3/8 to 1 1/2	4 7/8	8 1/16	5 1/8	6 1/2	5 33/64	4 15/32	1	8
238178	7500	1 1/2 to 2 1/8	4 7/8	8 1/16	5 1/8	6 1/2	5 33/64	4 15/32	1 1/16	8
238179	7500	2 1/8 to 2 1/4	4 7/8	8 1/16	5 1/8	6 1/2	5 33/64	4 15/32	1 15/32	8
238180	15000	Max. 3/4	2 7/8	5 7/8	3 3/4	4 1/8	4 1/16	5 1/8	15/32	5
238181	15000	3/4 to 1 1/8	2 7/8	5 7/8	3 3/4	4 1/8	4 1/16	5 1/8	15/32	5
238182	15000	1 1/8 to 1 3/8	2 7/8	5 7/8	3 3/4	4 1/8	4 1/16	5 1/8	3/4	5
238183	15000	1 3/8 to 1 3/4	2 7/8	5 7/8	3 3/4	4 1/8	4 1/16	5 1/8	1	5
238184	15000	Max. 3/4	3 7/8	6 7/8	4 1/8	5	4 33/64	5 17/32	1/16	8
238185	15000	3/4 to 1 1/8	3 7/8	6 7/8	4 1/8	5	4 33/64	5 17/32	15/32	8
238186	15000	1 1/8 to 1 3/8	3 7/8	6 7/8	4 1/8	5	4 33/64	5 17/32	15/32	8
238187	15000	1 3/8 to 1 3/4	3 7/8	6 7/8	4 1/8	5	4 33/64	5 17/32	1 1/16	8
238188	15000	1 1/8 to 1 3/8	4 7/8	8 1/16	5 1/8	6 1/2	5 33/64	5 27/32	15/32	12
238189	15000	1 3/8 to 1 3/4	4 7/8	8 1/16	5 1/8	6 1/2	5 33/64	5 27/32	1	12
238190	15000	1 3/4 to 2 1/8	4 7/8	8 1/16	5 1/8	6 1/2	5 33/64	5 27/32	1 1/16	12
238191	15000	2 1/8 to 2 1/2	4 7/8	8 1/16	5 1/8	6 1/2	5 33/64	5 27/32	1 15/32	12
238192	25000	Max. 3/4	3 7/8	6 7/8	4 1/8	5	4 33/64	8 9/32	1/16	12
238193	25000	3/4 to 1 1/8	3 7/8	6 7/8	4 1/8	5	4 33/64	8 9/32	15/32	12
238194	25000	1 1/8 to 1 3/8	3 7/8	6 7/8	4 1/8	5	4 33/64	8 9/32	15/32	12
238195	25000	1 3/8 to 1 3/4	3 7/8	6 7/8	4 1/8	5	4 33/64	8 9/32	1 1/16	12
238196	25000	1 1/8 to 1 3/8	4 7/8	8 1/16	5 1/8	6 1/2	5 33/64	8 11/32	15/32	17
238197	25000	1 3/8 to 1 3/4	4 7/8	8 1/16	5 1/8	6 1/2	5 33/64	8 11/32	1	17
238198	25000	1 3/4 to 2 1/8	4 7/8	8 1/16	5 1/8	6 1/2	5 33/64	8 11/32	1 1/16	17
238199	25000	2 1/8 to 2 1/2	4 7/8	8 1/16	5 1/8	6 1/2	5 33/64	8 11/32	1 15/32	17
238200	35000	Max. 3/4	4 7/8	8 1/16	4 1/8	6 1/2	4 33/64	11 27/32	1/16	20
238201	35000	3/4 to 1 1/8	4 7/8	8 1/16	4 1/8	6 1/2	4 33/64	11 27/32	15/32	20
238202	35000	1 1/8 to 1 3/8	4 7/8	8 1/16	4 1/8	6 1/2	4 33/64	11 27/32	15/32	20
238203	35000	1 3/8 to 1 3/4	4 7/8	8 1/16	4 1/8	6 1/2	4 33/64	11 27/32	1 1/16	20
238204	44000	Max. 3/4	4 7/8	8 1/16	4 1/8	6 1/2	4 33/64	16 17/32	1/16	25
238205	44000	3/4 to 1 1/8	4 7/8	8 1/16	4 1/8	6 1/2	4 33/64	16 17/32	15/32	25
238206	44000	1 1/8 to 1 3/8	4 7/8	8 1/16	4 1/8	6 1/2	4 33/64	16 17/32	15/32	25
238207	44000	1 3/8 to 1 3/4	4 7/8	8 1/16	4 1/8	6 1/2	4 33/64	16 17/32	1 1/16	25

Type P bus supports with type R mounting and type U support for 1¼-inch pipe mounting. Supports for ¾-inch or 2-inch pipe base can be supplied when ordered, except that supports having 4⅞-inch diameter base require a pipe support not less 1¼ inches diameter.

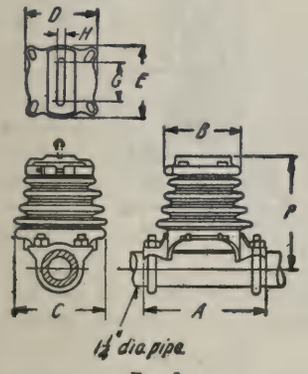


Fig. 8

Complete Support Style No.	Service Voltage	Diam. of Insulator Base Inches	Approximate Dimensions in Inches								Approx. Shipping Weight Pounds
			A	B	C	D	E	F	G	H	
238813	7500	2 7/8	4 33/64	3 5/8	4 1/8	2 7/8	2 7/8	5 1/16	1 1/2	3/8	5
238814	7500	3 7/8	5 13/64	4 3/4	5 1/8	3 11/16	3 5/8	5 1/2	1 7/8	1/16	6
238815	7500	4 7/8	7 1/16	4 7/8	6 1/2	4 33/64	4 1/4	6	2 1/2	1/16	8
238816	15000	2 7/8	4 33/64	3 5/8	4 1/8	2 7/8	2 7/8	6 1/16	1 1/2	3/8	5
238817	15000	3 7/8	5 13/64	4 3/8	5 1/8	3 11/16	3 5/8	6 7/8	1 7/8	1/16	8
238818	15000	4 7/8	7 1/16	4 7/8	6 1/2	4 33/64	4 1/4	7 3/8	2 1/2	1/16	12
238819	25000	3 7/8	5 13/64	4 5/8	5 1/8	3 11/16	3 5/8	9 5/8	1 7/8	1/16	12
238820	25000	4 7/8	7 1/16	4 7/8	6 1/2	4 33/64	4 1/4	10 1/8	2 1/2	1/16	17
238821	35000	4 7/8	7 1/16	4 3/8	6 1/2	3 11/16	3 5/8	13 1/16	1 7/8	1/16	20
238822	44000	4 7/8	7 1/16	4 3/8	6 1/2	3 11/16	3 5/8	17 1/16	1 7/8	1/16	25

All insulator supports listed on this page with diameter of insulator base 2⅞ inches are for light duty, those having diameter 3⅞ inches are for medium duty, and those of 4⅞ inches are for heavy duty.

Type P bus-support with type F mounting and type U support

Complete Support Style No.	Service Voltage	Diam. of Insulator Base Inches	Approximate Dimensions in Inches								Approx. Shipping Weight Pounds
			A	B	C	D	E	F	G	H	
238823	7500	2 7/8	5 7/8	3 5/8	4 1/8	2 7/8	2 7/8	4 1/4	1 1/4	3/8	5
238824	7500	3 7/8	6 7/8	4 3/8	5	3 11/16	3 5/8	4 11/16	1 7/8	1/16	6
238825	7500	4 7/8	8 1/16	4 7/8	6 1/2	4 33/64	4 1/4	5 1/16	2 1/2	1/16	8
238826	15000	2 7/8	5 7/8	3 5/8	4 1/8	2 7/8	2 7/8	5 5/16	1 1/2	3/8	5
238827	15000	3 7/8	6 7/8	4 3/8	5	3 11/16	3 5/8	6 1/16	1 7/8	1/16	8
238828	15000	4 7/8	8 1/16	4 7/8	6 1/2	4 33/64	4 1/4	6 11/16	2 1/2	1/16	12
238829	25000	3 7/8	6 7/8	4 3/8	5	3 11/16	3 5/8	8 11/16	1 7/8	1/16	12
238830	25000	4 7/8	8 1/16	4 7/8	6 1/2	4 33/64	4 1/4	9 1/16	2 1/2	1/16	17
238831	35000	4 7/8	8 1/16	4 3/8	6 1/2	3 11/16	3 5/8	12 1/16	1 7/8	1/16	20
238832	44000	4 7/8	8 1/16	4 3/8	6 1/2	3 11/16	3 5/8	16 1/16	1 7/8	1/16	25

Order by Style Number

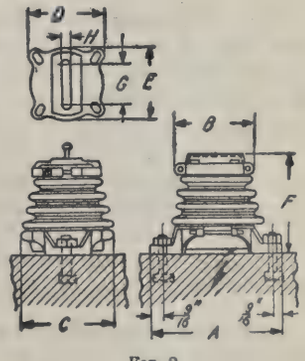


Fig. 9

SWITCHBOARD DETAILS—Continued

Type P bus-supports with type R mounting and type E support—The bus-clamp is of the three-bolt clamp type and will accommodate bus-straps of 2 inches to 6 inches wide. For 1¼ inch pipe mounting.

Style number includes bus-clamping bolts for 1¼-inch bus space and base for 1¼-inch pipe. Supports with greater bus space and with ¾-inch or 2-inch pipe base can be supplied when ordered except that supports having 4⅞ inch base require a pipe support, not less than 1¼ inches.

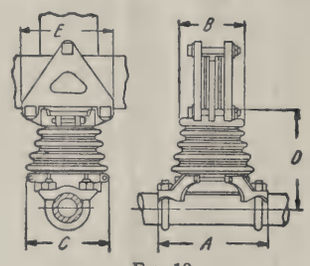


FIG. 10

Complete Support Style No.	Service Voltage	Height of Bus, Inches	Diam. of Insulator Base, Inches	Approximate Dimensions in Inches A	B	C	D	E	Approx. Shipping Wt., Lb.
237804	7500	3	3⅞	5 23/32	4⅛	5⅛	5 3/32	6⅛	10
237805	7500	4	3⅞	5 23/32	4⅛	5⅛	5 3/32	6⅛	10
237806	7500	5	3⅞	5 23/32	4⅛	5⅛	5 3/32	6⅛	10
237807	7500	6	3⅞	5 23/32	4⅛	5⅛	5 3/32	6⅛	10
237808	7500	3	4⅞	7 1/16	5	6½	5 11/32	7⅝	12
237809	7500	4	4⅞	7 1/16	5	6½	5 11/32	7⅝	12
237810	7500	5	4⅞	7 1/16	5	6½	5 11/32	7⅝	12
237811	7500	6	4⅞	7 1/16	5	6½	5 11/32	7⅝	12
237812	15000	3	3⅞	5 23/32	4⅛	5⅛	6 3/32	6⅛	12
237813	15000	4	3⅞	5 23/32	4⅛	5⅛	6 3/32	6⅛	12
237814	15000	5	3⅞	5 23/32	4⅛	5⅛	6 3/32	6⅛	12
237815	15000	6	3⅞	5 23/32	4⅛	5⅛	6 3/32	6⅛	12
237816	15000	3	4⅞	7 1/16	5	6½	6 11/32	7⅝	16
237817	15000	4	4⅞	7 1/16	5	6½	6 11/32	7⅝	16
237818	15000	5	4⅞	7 1/16	5	6½	6 11/32	7⅝	16
237819	15000	6	4⅞	7 1/16	5	6½	6 11/32	7⅝	16
237820	25000	3	3⅞	5 23/32	4⅛	5⅛	9 3/32	6⅛	16
237821	25000	4	3⅞	5 23/32	4⅛	5⅛	9 3/32	6⅛	16
237822	25000	5	3⅞	5 23/32	4⅛	5⅛	9 3/32	6⅛	16
237823	25000	6	3⅞	5 23/32	4⅛	5⅛	9 3/32	6⅛	16
237824	25000	3	4⅞	7 1/16	5	6½	9 11/32	7⅝	21
237825	25000	4	4⅞	7 1/16	5	6½	9 11/32	7⅝	21
237826	25000	5	4⅞	7 1/16	5	6½	9 11/32	7⅝	21
237827	25000	6	4⅞	7 1/16	5	6½	9 11/32	7⅝	21

Type P bus-supports with type F mounting and type E support—The bus clamp is of the three-bolt type and will accommodate bus-straps of 3 inches to 6 inches wide.

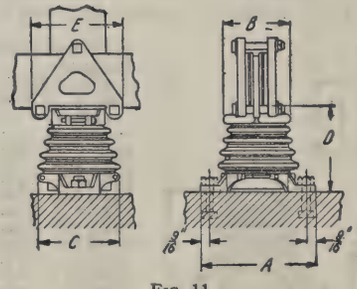


FIG. 11

Style number includes bus-clamping screw for 1¼ inch bus space. Supports with greater space supplied when ordered.

Complete Support Style No.	Service Voltage	Height of Bus, Inches	Diam. of Insulator Base, Inches	Approximate Dimensions in Inches A	B	C	D	E	Approx. Shipping Wt., Lb.
237496	7500	3	3⅞	6⅞	4⅛	5	4 1/16	6⅛	10
237497	7500	4	3⅞	6⅞	4⅛	5	4 1/16	6⅛	10
237498	7500	5	3⅞	6⅞	4⅛	5	4 1/16	6⅛	10
237499	7500	6	3⅞	6⅞	4⅛	5	4 1/16	6⅛	10
237500	7500	3	4⅞	8 1/16	5	6½	4 5/8	7⅝	12
237501	7500	4	4⅞	8 1/16	5	6½	4 5/8	7⅝	12
237502	7500	5	4⅞	8 1/16	5	6½	4 5/8	7⅝	12
237503	7500	6	4⅞	8 1/16	5	6½	4 5/8	7⅝	12
237504	15000	3	3⅞	6⅞	4⅛	5	5 1/16	6⅛	12
237505	15000	4	3⅞	6⅞	4⅛	5	5 1/16	6⅛	12
237506	15000	5	3⅞	6⅞	4⅛	5	5 1/16	6⅛	12
237507	15000	6	3⅞	6⅞	4⅛	5	5 1/16	6⅛	12
237508	15000	3	4⅞	8 1/16	5	6½	6	7⅝	16
237509	15000	4	4⅞	8 1/16	5	6½	6	7⅝	16
237510	15000	5	4⅞	8 1/16	5	6½	6	7⅝	16
237511	15000	6	4⅞	8 1/16	5	6½	6	7⅝	16
237512	25000	3	3⅞	6⅞	4⅛	5	8 1/16	6⅛	16
237513	25000	4	3⅞	6⅞	4⅛	5	8 1/16	6⅛	16
237514	25000	5	3⅞	6⅞	4⅛	5	8 1/16	6⅛	16
237515	25000	6	3⅞	6⅞	4⅛	5	8 1/16	6⅛	16
237516	25000	3	4⅞	8 1/16	5	6½	8¾	7⅝	21
237517	25000	4	4⅞	8 1/16	5	6½	8¾	7⅝	21
237518	25000	5	4⅞	8 1/16	5	6½	8¾	7⅝	21
237519	25000	6	4⅞	8 1/16	5	6½	8¾	7⅝	21

Type P bus-supports with type R mounting and type E support—The bus-clamp is of the four-bolt type and will accommodate bus-straps of 3 inches to 6 inches wide. For 1¼ inch pipe mounting.

Style number includes bus-clamping bolts for 1¼ inch bus space and base for 1¼ inch pipe. Supports with greater bus space and ¾ inch or 2 inch pipe base can be supplied when ordered, except that supports having 4⅞ inch base require pipe support not less than 1¼ inches.

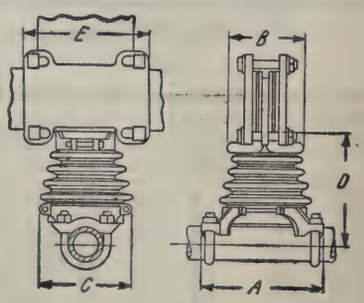


FIG. 12

See table on following page

All insulator supports listed on this page with diameter of insulator base 2⅞ inches are for light duty, those having a diameter 3⅞ inches are for medium duty, and those of 4⅞ inches are for heavy duty.

Order by Style Number

Table for Fig. 12

Complete Support Style No.	Service Voltage	Height of Bus, Inches	Diam. of Insulator Base, Inches	Approximate Dimensions in Inches A	B	C	D	E	Approx. Shipping Weight, Lbs.
237828	7500	3	3 7/8	5 23/32	4 1/8	5 1/8	5 1/32	6 1/8	12
237829	7500	4	3 7/8	5 23/32	4 1/8	5 1/8	5 1/32	6 1/8	12
237830	7500	5	3 7/8	5 23/32	4 1/8	5 1/8	5 1/32	6 1/8	12
237831	7500	6	3 7/8	5 23/32	4 1/8	5 1/8	5 1/32	6 1/8	12
237832	7500	3	4 7/8	7 1/16	5	6 1/2	5 11/32	7 5/8	14
237833	7500	4	4 7/8	7 1/16	5	6 1/2	5 11/32	7 5/8	14
237834	7500	5	4 7/8	7 1/16	5	6 1/2	5 11/32	7 5/8	14
237835	7500	6	4 7/8	7 1/16	5	6 1/2	5 11/32	7 5/8	14
237836	15000	3	3 7/8	5 23/32	4 1/8	5 1/8	6 13/32	6 1/8	14
237837	15000	4	3 7/8	5 23/32	4 1/8	5 1/8	6 13/32	6 1/8	14
237838	15000	5	3 7/8	5 23/32	4 1/8	5 1/8	6 13/32	6 1/8	14
237839	15000	6	3 7/8	5 23/32	4 1/8	5 1/8	6 13/32	6 1/8	14
237840	15000	3	4 7/8	7 1/16	5	6 1/2	6 13/32	7 5/8	18
237841	15000	4	4 7/8	7 1/16	5	6 1/2	6 13/32	7 5/8	18
237842	15000	5	4 7/8	7 1/16	5	6 1/2	6 13/32	7 5/8	18
237843	15000	6	4 7/8	7 1/16	5	6 1/2	6 13/32	7 5/8	18
237844	25000	3	3 7/8	5 23/32	4 1/8	5 1/8	9 3/32	6 1/8	18
237845	25000	4	3 7/8	5 23/32	4 1/8	5 1/8	9 3/32	6 1/8	18
237846	25000	5	3 7/8	5 23/32	4 1/8	5 1/8	9 3/32	6 1/8	18
237847	25000	6	3 7/8	5 23/32	4 1/8	5 1/8	9 3/32	6 1/8	18
237848	25000	3	4 7/8	7 1/16	5	6 1/2	9 21/32	7 5/8	33
237849	25000	4	4 7/8	7 1/16	5	6 1/2	9 21/32	7 5/8	33
237850	25000	5	4 7/8	7 1/16	5	6 1/2	9 21/32	7 5/8	33
237851	25000	6	4 7/8	7 1/16	5	6 1/2	9 21/32	7 5/8	33

Type P bus supports with type F mounting and type E support—The bus-clamp is of the four-bolt type and will accommodate bus-straps of 3 inches to 6 inches wide.

Style number includes bus-clamping bolts for 1¼ inch bus space. Supports with greater bus space can be supplied when ordered.

All insulator supports listed on this page with diameter of insulator base 2⅞ inches are for light duty, those having a diameter 3⅞ inches are for medium duty, and those of 4⅞ inches are for heavy duty.

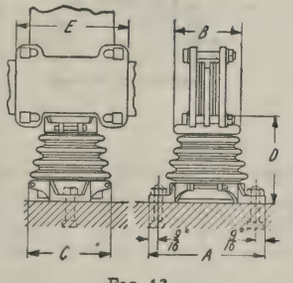


Fig. 13

Complete Support Style No.	Service Voltage	Height of Bus, Inches	Diam. of Insulator Base, Inches	Approximate Dimensions in Inches A	B	C	D	E	Approx. Shipping Weight, Lbs.
237545	7500	3	3 7/8	6 7/8	4 1/8	5	4 3/16	6 1/8	12
237546	7500	4	3 7/8	6 7/8	4 1/8	5	4 3/16	6 1/8	12
237547	7500	5	3 7/8	6 7/8	4 1/8	5	4 3/16	6 1/8	12
237548	7500	6	3 7/8	6 7/8	4 1/8	5	4 3/16	6 1/8	12
237549	7500	3	4 7/8	8 9/16	5	6 1/2	4 5/8	7 5/8	14
237550	7500	4	4 7/8	8 9/16	5	6 1/2	4 5/8	7 5/8	14
237551	7500	5	4 7/8	8 9/16	5	6 1/2	4 5/8	7 5/8	14
237552	7500	6	4 7/8	8 9/16	5	6 1/2	4 5/8	7 5/8	14
237553	15000	3	3 7/8	6 7/8	4 1/8	5	5 1/16	6 1/8	14
237554	15000	4	3 7/8	6 7/8	4 1/8	5	5 1/16	6 1/8	14
237555	15000	5	3 7/8	6 7/8	4 1/8	5	5 1/16	6 1/8	14
237556	15000	6	3 7/8	6 7/8	4 1/8	5	5 1/16	6 1/8	14
237557	15000	3	4 7/8	8 9/16	5	6 1/2	6	7 5/8	18
237558	15000	4	4 7/8	8 9/16	5	6 1/2	6	7 5/8	18
237559	15000	5	4 7/8	8 9/16	5	6 1/2	6	7 5/8	18
237560	15000	6	4 7/8	8 9/16	5	6 1/2	6	7 5/8	18
237561	25000	3	3 7/8	6 7/8	4 1/8	5	8 5/16	6 1/8	18
237562	25000	4	3 7/8	6 7/8	4 1/8	5	8 5/16	6 1/8	18
237563	25000	5	3 7/8	6 7/8	4 1/8	5	8 5/16	6 1/8	18
237564	25000	6	3 7/8	6 7/8	4 1/8	5	8 5/16	6 1/8	18
237565	25000	3	4 7/8	8 9/16	5	6 1/2	8 3/4	7 5/8	33
237566	25000	4	4 7/8	8 9/16	5	6 1/2	8 3/4	7 5/8	33
237567	25000	5	4 7/8	8 9/16	5	6 1/2	8 3/4	7 5/8	33
237568	25000	6	4 7/8	8 9/16	5	6 1/2	8 3/4	7 5/8	33

Type P bus supports with type R mounting and type E-1 support, for vertical bus-straps of light capacity only. For 1¼-inch pipe mounting.

Style number includes base supports for 1¼-inch pipe. Supports with ¾-inch or 2-inch pipe base supplied when ordered, except that supports having 4⅞-inch diameter base, require a pipe support not less than 1¼-inch. Bus rests in the support but is not clamped in it. These supports may be applied when the station capacity does not exceed 5000 Kva.

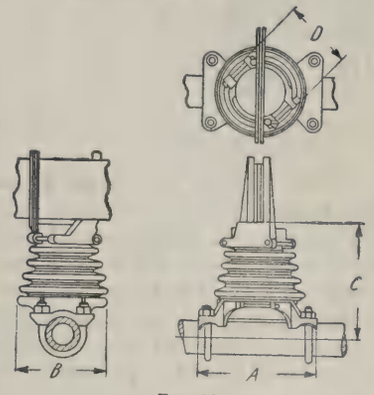


Fig. 14

Complete Support Style No.	Service Voltage	Diam. of Insulator Base, Inches	Dimensions in Inches A	B	C	D	Approx. Shipping Weight, Pounds
238117	7500	2 7/8	4 31/32	4 1/8	4 3/4	3 3/4	5
238118	7500	3 7/8	5 23/32	5 1/8	4 31/32	4 1/8	6
238119	15000	2 7/8	4 31/32	4 1/8	6 1/8	3 3/4	5
238120	15000	3 7/8	5 23/32	5 1/8	6 11/32	4 1/8	8
238121	25000	3 7/8	5 23/32	5 1/8	9 3/32	4 1/8	12
238122	35000	4 7/8	7 7/16	6 1/2	12 29/32	4 1/8	20
238123	44000	4 7/8	7 7/16	6 1/2	17 3/32	4 1/8	25

Type P bus supports with type F mounting and type E-1 support, for vertical bus-straps. Bus rests in the support but is not clamped in it. These supports may be applied when station capacity does not exceed 5000 Kva.

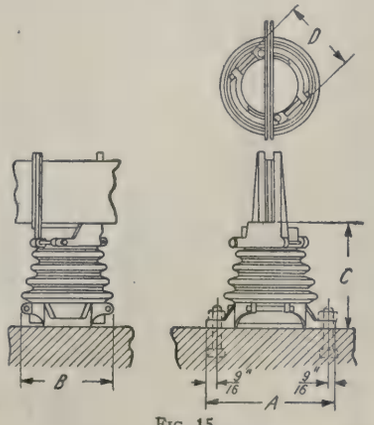


Fig. 15

See table on following page

Order by Style Number

Table for Fig. 15

Complete Support Style No.	Service Voltage	Diameter of Insulator Base, Inches	Approximate Dimensions in Inches				Approx. Shipping Weight Lbs.
			A	B	C	D	
238110	7500	2⅞	5⅞	4⅛	3 11/16	3¾	5
238111	7500	3⅞	6⅞	5	4⅛	4⅛	6
238112	15000	2⅞	5⅞	4⅛	5 1/16	3¾	5
238113	15000	3⅞	6⅞	5	5½	4⅛	8
238114	25000	3⅞	6⅞	5	8¼	4⅛	12
238115	35000	4⅞	8 1/16	6½	12	4⅛	20
238116	44000	4⅞	8 1/16	6½	16⅛	4⅛	25

Type P bus-supports with type R mounting and type F support—The bus clamp is of the four-bolt type and will accommodate bus straps of 3 inches to 6 inches wide and connections of 4½ inches and 6 inches. For 1¼-inch pipe mounting.

Style number includes bus-clamping bolt for 1 inch bus space and base for 1¼-inch pipe. Supports with greater bus space and for ¾-inch or 2-inch pipe base can be supplied when ordered, except that supports having 4⅞-inch diameter base require a pipe support not less than 1¼-inch diameter.

All insulator supports listed on this page with diameter of insulator base 2⅞ inches are for light duty, those having a diameter 3⅞ inches are for medium duty, and those of 4⅞ inches are for heavy duty.

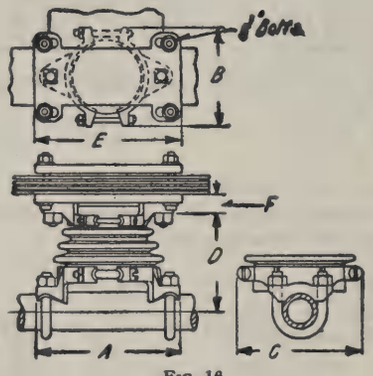


FIG. 16

Complete Support, Style No.	Service Voltage	Width of Bus Inches	Width of Connectors Inches	Diameter of Insulator Base, Inches	Dimensions in Inche						Approximate Shipping Weight Lbs.
					A	B	C	D	E	F	
238636	7500	3	4½	3⅞	5 11/16	4⅛	5⅛	5	6⅛	⅝	12
238637	7500	4	4½	3⅞	5 11/16	4⅛	5⅛	5	6⅛	⅝	12
238638	7500	5	4½	3⅞	5 11/16	4⅛	5⅛	5	6⅛	¾	12
238639	7500	6	4½	3⅞	5 11/16	4⅛	5⅛	5	6⅛	¾	12
238640	7500	3	6	4⅞	7 1/16	5	6½	5 11/16	7⅝	⅝	14
238641	7500	4	6	4⅞	7 1/16	5	6½	5 11/16	7⅝	⅝	14
238642	7500	5	6	4⅞	7 1/16	5	6½	5 11/16	7⅝	¾	14
238643	7500	6	6	4⅞	7 1/16	5	6½	5 11/16	7⅝	¾	14
238644	15000	3	4½	3⅞	5 11/16	4⅛	5⅛	6 3/16	6⅛	⅝	14
238645	15000	4	4½	3⅞	5 11/16	4⅛	5⅛	6 3/16	6⅛	⅝	14
238646	15000	5	4½	3⅞	5 11/16	4⅛	5⅛	6 3/16	6⅛	¾	14
238647	15000	6	4½	3⅞	5 11/16	4⅛	5⅛	6 3/16	6⅛	¾	14
238648	15000	3	6	4⅞	7 1/16	5	6½	6 11/16	7⅝	⅝	18
238649	15000	4	6	4⅞	7 1/16	5	6½	6 11/16	7⅝	⅝	18
238650	15000	5	6	4⅞	7 1/16	5	6½	6 11/16	7⅝	¾	18
238651	15000	6	6	4⅞	7 1/16	5	6½	6 11/16	7⅝	¾	18
238652	25000	3	4½	3⅞	5 11/16	4⅛	5⅛	9 1/16	6⅛	⅝	18
238653	25000	4	4½	3⅞	5 11/16	4⅛	5⅛	9 1/16	6⅛	⅝	18
238654	25000	5	4½	3⅞	5 11/16	4⅛	5⅛	9 1/16	6⅛	¾	18
238655	25000	6	4½	3⅞	5 11/16	4⅛	5⅛	9 1/16	6⅛	¾	18
238656	25000	3	6	4⅞	7 1/16	5	6½	9 11/16	7⅝	⅝	33
238657	25000	4	6	4⅞	7 1/16	5	6½	9 11/16	7⅝	⅝	33
238658	25000	5	6	4⅞	7 1/16	5	6½	9 11/16	7⅝	¾	33
238659	25000	6	6	4⅞	7 1/16	5	6½	9 11/16	7⅝	¾	33

Order by Style Number

SWITCHBOARD DETAILS—Continued

Type P bus-supports with type F mounting and type F support—The bus clamp is of the four-bolt type and will accommodate bus straps of 3 inches to 6 inches wide, and connections of 4½ inches and 6 inches.

Style number includes bus clamping bolt for 1 inch bus space.

Complete Support, Style No.	Service Voltage	Width of Bus, Inches	Width of Connectors Inches	Diam. of Insulator Base, Inches	Approximate Dimensions in Inches						Approx. Shipping Weight Lbs.
					A	B	C	D	E	F	
238660	7500	3	4½	3⅞	6⅞	4⅛	5	4⅛	6⅛	5/8	9½
238661	7500	4	4½	3⅞	6⅞	4⅛	5	4⅛	6⅛	5/8	13
238662	7500	5	4½	3⅞	6⅞	4⅛	5	4⅛	6⅛	3/4	13
238663	7500	6	4½	3⅞	6⅞	4⅛	5	4⅛	6⅛	3/4	13
238664	7500	3	6	4⅞	8 9/16	5	6½	4⅝	7⅝	5/8	14
238665	7500	4	6	4⅞	8 9/16	5	6½	4⅝	7⅝	5/8	17
238666	7500	5	6	4⅞	8 9/16	5	6½	4⅝	7⅝	3/4	17
238667	7500	6	6	4⅞	8 9/16	5	6½	4⅝	7⅝	3/4	19
238668	15000	3	4½	3⅞	6⅞	4⅛	5	5½	6⅛	5/8	10
238669	15000	4	4½	3⅞	6⅞	4⅛	5	5½	6⅛	5/8	13
238670	15000	5	4½	3⅞	6⅞	4⅛	5	5½	6⅛	3/4	14
238671	15000	6	4½	3⅞	6⅞	4⅛	5	5½	6⅛	3/4	15
238672	15000	3	6	4⅞	8 9/16	5	6½	6	7⅝	5/8	15
238673	15000	4	6	4⅞	8 9/16	5	6½	6	7⅝	5/8	18
238674	15000	5	6	4⅞	8 9/16	5	6½	6	7⅝	3/4	19
238675	15000	6	6	4⅞	8 9/16	5	6½	6	7⅝	3/4	20
238676	25000	3	4½	3⅞	6⅞	4⅛	5	8¼	6⅛	5/8	13
238677	25000	4	4½	3⅞	6⅞	4⅛	5	8¼	6⅛	5/8	16
238678	25000	5	4½	3⅞	6⅞	4⅛	5	8¼	6⅛	3/4	17
238679	25000	6	4½	3⅞	6⅞	4⅛	5	8¼	6⅛	3/4	18
238680	25000	3	6	4⅞	8 9/16	5	6½	8¾	7⅝	5/8	18
238681	25000	4	6	4⅞	8 9/16	5	6½	8¾	7⅝	5/8	21
238682	25000	5	6	4⅞	8 9/16	5	6½	8¾	7⅝	3/4	22
238683	25000	6	6	4⅞	8 9/16	5	6½	8¾	7⅝	3/4	23

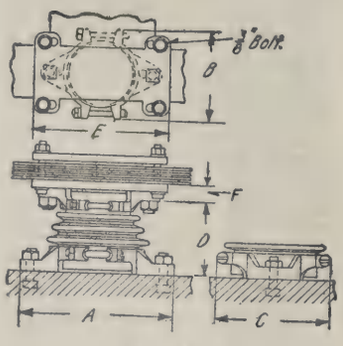


FIG. 17

Corrugated porcelain insulators, parts of bus-bar supports listed and illustrated on previous pages.

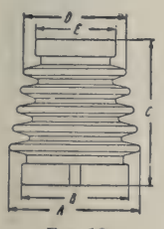


FIG. 18

Porcelain Insulator Style No.	Maximum Service Voltage	Approximate Dimensions in Inches					Number Rings	Approx. Shipping Weight Lbs.
		A	B	C	D	E		
242000	7500	5⅜	4⅞	4 7/16	4¾	3⅞	3	2
242001	7500	4¾	3⅞	3⅞	3¾	2⅞	3	2
242002	7500	3¾	2⅞	3⅝	3¼	2⅜	3	3
242003	15000	5¾	4⅞	5 11/16	4¾	3⅞	5	2
242004	15000	4¾	3⅞	5¼	3¾	2⅞	5	4
242005	15000	3¾	2⅞	5	3¼	2⅜	5	5
242009	25000	4¾	3⅞	8	3¾	2⅞	9	[illegible]
242008	25000	5¾	4⅞	8 7/16	4¾	3⅞	9	12
242007	35000	5¾	4⅞	11¾	3¾	2⅞	14	16
242006	44000	5¾	4⅞	15⅞	3¾	2⅞	20	20

Type P bus-bar support, rear-connected—Figs. 19 and 19A show rear connected type P bus-bar supports. If rear-connected supports are to be used with front-connected supports, give cross reference in ordering, to insure that the two sets match.

Style Number includes support complete without contact nuts and mounting blocks. See Fig. 19B.

All insulator supports listed on this page with diameter of insulator base 2⅞ inches are for light duty; those having a diameter of 3⅞ inches are for medium duty, and those for 4⅞ inches are for heavy duty.

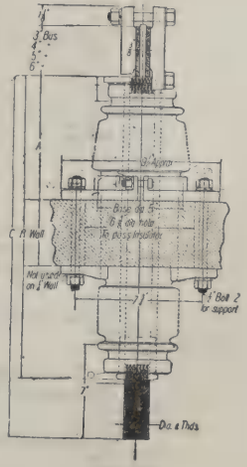


FIG. 19

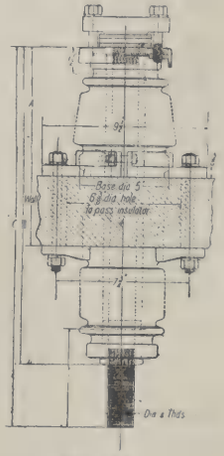


FIG. 19A

Order by Style Number

TYPE P BUS-BAR SUPPORTS, REAR-CONNECTED WITH 3 TO 6-INCH TYPE E BUS CLAMPS

With 5-Inch Base

Amperes	Width of Busses Inches	Style No.	Amperes	Width of Busses Inches	Style No.
		For 7500 Volts			
		Thickness of Wall ¼ Inch			
400	3	288348	400	5	288358
600	3	288349	600	5	288359
1200	3	288350	1200	5	288360
1600	3	288351	1600	5	288361
2000	3	288352	2000	5	288362
400	4	288353	400	6	288363
600	4	288354	600	6	288364
1200	4	288355	1200	6	288365
1600	4	288356	1600	6	288366
2000	4	288357	2000	6	288367
		Thickness of Wall 4 Inches			
400	3	288368	400	5	288378
600	3	288369	600	5	288379
1200	3	288370	1200	5	288380
1600	3	288371	1600	5	288381
2000	3	288372	2000	5	288382
400	4	288373	400	6	288383
600	4	288374	600	6	288384
1200	4	288375	1200	6	288385
1600	4	288376	1600	6	288386
2000	4	288377	2000	6	288387
		For 15000 Volts			
		Thickness of Wall ¼ Inch			
400	3	288388	400	5	288398
600	3	288389	600	5	288399
1200	3	288390	1200	5	288400
1600	3	288391	1600	5	288401
2000	3	288392	2000	5	288402
400	4	288393	400	6	288403
600	4	288394	600	6	288404
1200	4	288395	1200	6	288405
1600	4	288396	1600	6	288406
2000	4	288397	2000	6	288407
		Thickness of Wall 4 Inches			
400	3	288408	400	5	288418
600	3	288409	600	5	288419
1200	3	288410	1200	5	288420
1600	3	288411	1600	5	288421
2000	3	288412	2000	5	288422
400	4	288413	400	6	288423
600	4	288414	600	6	288424
1200	4	288415	1200	6	288425
1600	4	288416	1600	6	288426
2000	4	288417	2000	6	288427
		For 25000 Volts			
		Thickness of Wall ¼ Inch			
400	3	291520	400	5	291530
600	3	291521	600	5	291531
1200	3	291522	1200	5	291532
1600	3	291523	1600	5	291533
2000	3	291524	2000	5	291534
400	4	291525	400	6	291535
600	4	291526	600	6	291536
1200	4	291527	1200	6	291537
1600	4	291528	1600	6	291538
2000	4	291529	2000	6	291539
		Thickness of Wall 4 Inches			
400	3	291540	400	5	291550
600	3	291541	600	5	291551
1200	3	291542	1200	5	291552
1600	3	291543	1600	5	291553
2000	3	291544	2000	5	291554
400	4	291545	400	6	291555
600	4	291546	600	6	291556
1200	4	291547	1200	6	291557
1600	4	291548	1600	6	291558
2000	4	291549	2000	6	291559

With 4-Inch Base

		For 7500 Volts			
		Thickness of Wall ¼ Inch			
400	3	288444	600	3	288448
400	4	288445	600	4	288449
		Thickness of Wall 4 Inches			
400	3	288446	600	3	288450
400	4	288447	600	4	288451
		For 15000 Volts			
		Thickness of Wall ¼ Inch			
400	3	288452	600	3	288456
400	4	288453	600	4	288457
		Thickness of Wall 4 Inches			
400	3	288454	600	3	288458
400	4	288455	600	4	288459

Order by Style Number

SWITCHBOARD DETAILS—Continued

TYPE P BUS-BAR SUPPORTS, REAR-CONNECTED WITH 3 TO 6-INCH TYPE F BUS CLAMPS

With 5-Inch Base

Amperes	Width of Busses Inches	Style No.	Amperes	Width of Busses Inches	Style No.
		For 7500 Volts			
		Thickness of Wall ¼ Inch			
400	3	287630	400	5	287640
600	3	287631	600	5	287641
1200	3	287632	1200	5	287642
1600	3	287633	1600	5	287643
2000	3	287634	2000	5	287644
400	4	287635	400	6	287645
600	4	287636	600	6	287646
1200	4	287637	1200	6	287647
1600	4	287638	1600	6	287648
2000	4	287639	2000	6	287649
		Thickness of Wall 4 Inches			
400	3	287650	400	5	287660
600	3	287651	600	5	287661
1200	3	287652	1200	5	287662
1600	3	287653	1600	5	287663
2000	3	287654	2000	5	287664
400	4	287655	400	6	287665
600	4	287656	600	6	287666
1200	4	287657	1200	6	287667
1600	4	287658	1600	6	287668
2000	4	287659	2000	6	287669
		For 15000 Volts			
		Thickness of Wall ¼ Inch			
400	3	287670	400	5	287680
600	3	287671	600	5	287681
1200	3	287672	1200	5	287682
1600	3	287673	1600	5	287683
2000	3	287674	2000	5	287684
400	4	287675	400	6	287685
600	4	287676	600	6	287686
1200	4	287677	1200	6	287687
1600	4	287678	1500	6	287688
2000	4	287679	2000	6	287689
		Thickness of Wall 4 Inches			
400	3	287690	400	5	287700
600	3	287691	600	5	287701
1200	3	287692	1200	5	287702
1600	3	287693	1600	5	287703
2000	3	287694	2000	5	287704
400	4	287695	400	6	287705
600	4	287696	600	6	287706
1200	4	287697	1200	6	287707
1600	4	287698	1600	6	287708
2000	4	297699	2000	6	287709
		For 25000 Volts			
		Thickness of Wall ¼ Inch			
400	3	291806	400	5	291816
600	3	291807	600	5	291817
1200	3	291808	1200	5	291818
1600	3	291809	1600	5	291819
2000	3	291810	2000	5	291820
400	4	291811	400	6	291821
600	4	291812	600	6	291822
1200	4	291813	1200	6	291823
1600	4	291814	1600	6	291824
2000	4	291815	2000	6	291825
		Thickness of Wall 4 Inches			
400	3	291827	400	5	291837
600	3	291828	600	5	291838
1200	3	291829	1200	5	291839
1600	3	291830	1600	5	291840
2000	3	291831	2000	5	291841
400	4	291832	400	6	291842
600	4	291833	600	6	291843
1200	4	291834	1200	6	291844
1600	4	291835	1600	6	291845
2000	4	291836	2000	6	291846

Order by Style Number

TYPE P BUS-BAR SUPPORTS—REAR-CONNECTED WITH 3 TO 6-INCH TYPE F BUS CLAMPS
With 4-Inch Base

Amperes	Width of Busses Inches	Style No.	Amperes	Width of Busses Inches	Style No.
		For 7500 Volts			
		Thickness of Wall ¼ Inch			
400	3	288428	600	3	288432
400	4	288429	600	4	288433
		Thickness of Wall 4 Inches			
400	3	288430	600	3	288434
400	4	288431	600	4	288435
		For 15000 Volts			
		Thickness of Wall ¼ Inch			
400	3	288436	600	3	288440
400	4	288437	600	4	288441
		Thickness of Wall 4 Inches			
400	3	288438	600	3	288442
400	4	288439	600	4	288443

Corrugated porcelain insulator, for rear-connected bus-bar supports.

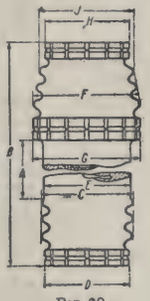


FIG 20

Porcelain Insulator Style No.	Maximum Service Voltage	Thickness of Wall or Base Inches	Dimensions in Inches A	B	C	D	E	F	G	H	J	Approx. Shipping Weight Lbs.
238801	7500	¼	1 3/32	7¾	3 1/16	2 7/8	3	3 13/16	3 7/8	2 7/8	3 3/8	15
238802	7500	4	5 3/32	11 13/16	3 1/8	2 7/8	3	3 13/16	3 7/8	2 7/8	3 3/8	15
238803	7500	¼	1 3/32	8½	4 1/8	3 7/8	4	4 13/16	4 7/8	3 7/8	4 3/8	15
238804	7500	4	5 3/32	12 11/16	4 1/8	3 7/8	4	4 13/16	4 7/8	3 7/8	4 3/8	18
238805	15000	¼	1 3/32	10 3/8	3 1/8	2 7/8	3	3 13/16	3 7/8	2 7/8	3 5/16	18
238806	15000	4	5 3/32	14 5/16	3 1/8	2 7/8	3	3 13/16	3 7/8	2 7/8	3 5/16	18
238807	15000	¼	1 3/32	10 5/16	4 1/8	3 7/8	4	4 13/16	4 7/8	3 7/8	4 5/16	18
238808	15000	4	5 3/32	15 5/8	4 1/8	3 7/8	4	4 13/16	4 7/8	3 7/8	4 5/16	20
238809	25000	¼	1 3/32	16 3/8	3 3/8	2 7/8	3	4¼	3 7/8	2 7/8	3½	20
238810	25000	4	5 3/32	20 3/32	3 3/8	2 7/8	3	4¼	3 7/8	2 7/8	3½	20
238811	25000	¼	1 3/32	16 31/32	4 3/8	3 7/8	4	5¼	4 7/8	3 7/8	4½	20
238812	25000	4	5 3/32	20 31/32	4 3/8	3 7/8	4	5¼	4 7/8	3 7/8	4½	20

Bus-strap brackets for 4 to 10 inch bus, low tension, 600 volts maximum, heavy capacity, frame mounting. This bracket is designed to carry very heavy buses; it consists of a slate slab for the rider and slate blocks for the spacers. A separate set of riders and spacers is required for each bus.

Style No.	Dimensions in Inches A	B	Approx Shipping Weight, Lbs.
164253	4	2	10
164254	6	2	10
164255	8	2	12
164256	10	2	12
164257	4	4	12
164258	6	4	12
164259	8	4	14
164260	10	4	14

The bracket is designed to be supported on a flat surface, such as the top side of a horizontal angle. The style number includes all necessary parts for one complete bracket, except the supporting angle.

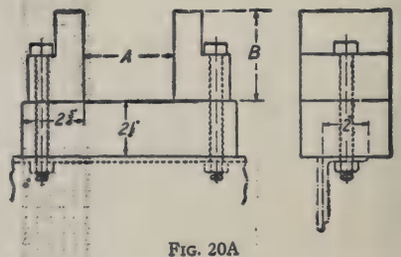


FIG. 20A

Order by Style Number.

SWITCHBOARD DETAILS—Continued

Universal mounting block for post type bus supports, front-connected.—Fig. 21 shows a useful arrangement for mounting the corrugated, insulated post type bus support to wall. The mounting block should be built into the wall, of concrete or brick, during construction, making a handy mounting for the supports, as the mounting bolts may be placed in position later.

Style No.	Description
247235	Cast iron universal mounting block, without mounting bolts.

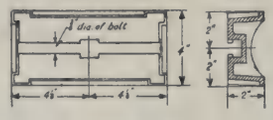


FIG. 21

Mounting blocks for rear-connected supports (Fig. 21A) make a convenient mounting for the supports as all that is necessary to mount the support is to bolt it to studs already in place. The blocks are of suitable dimensions for building in brick or concrete wall. Insulators may be removed from the wall without disturbing the bus or breaking out the blocks.

Style No.	Dimensions in Inches				
	Diam. Ins. Base	Thickness of Wall	A	B	C
291009	5	4	8¼	8¼	2¾
291011	4	4	8¼	8¼	2 3/16
291010	5	8¼	12½	12½	2¾
291012	4	8¼	12½	12½	2 3/16

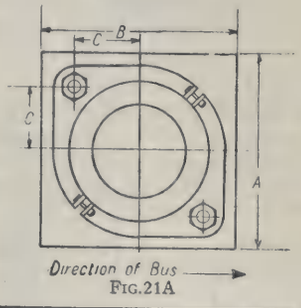


FIG. 21A

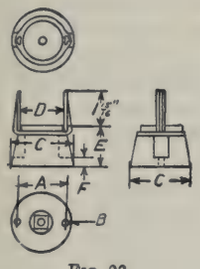


FIG. 22

Bus-strap support with plain insulator, for 3500 volts maximum service, consists of dry process porcelain insulator with necessary iron fittings. For light or medium weight service, with ½ inch to 2½ inches bus space for flat mounting. Supports bus in place but does not clamp the bus.

Ampere capacity for D.C. busses limited only by bus space available.

Ampere capacity for A.C. busses limited to 10,000 amperes maximum, symmetrical short-circuit current.

Style number includes one bus support complete with mounting details.

Bus-Strap Support Style No.	Max. Service Voltage	Approximate Dimensions in Inches						Approx. Shipping Weight Lbs.
		A	B	C	D	E	F	
238470	3500	1⅞	¼	2½	1½	2 13/16	3/8	2
238471	3500	2¾	1/16	3½	2½	2 13/16	½	2

Bus-bar brackets with plain insulators, for 3500 volts maximum service. These brackets are made of cast iron and consist of a number of individual supports as given in table and described more fully above. Bus is supported in place but is not clamped.

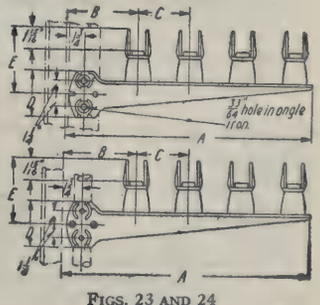
Ampere capacity for D.C. busses limited only by bus space available.

Ampere capacity for A. C. busses limited to 10,000 amperes maximum, symmetrical short-circuit current.

Style number includes one bracket complete with supports and mounting bolts.

Bus-Bar Bracket Style No.	Individual Insulator Style No.	Number of Support	Max. Service Voltage	Type of Frame	*Dimensions in Inches					Approx. Shipping Weight Lbs.
					A	B	C	D	E	
240191	238470	2	3500	Angle Iron	9½	4¾	3	4¼	5½	10
240192	238470	2	3500	Pipe	9½	4¾	3	4¼	5½	10
240197	238470	3	3500	Angle Iron	16 5/16	6¾	4	4¼	6	10
240198	238470	3	3500	Pipe	16 5/16	6¾	4	4¼	6	10
240199	238470	4	3500	Angle Iron	22¾	6¾	4¾	4¼	6	10
240200	238470	4	3500	Pipe	22¾	6¾	4¾	4¼	6	10

*Dimensions of bracket only.



FIGS. 23 AND 24

Order by Style and Number

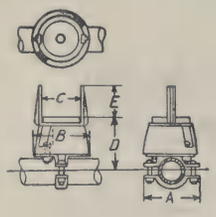


FIG. 25

Bus-strap supports for light and medium weight duty, 1½ inches to 2½ inches bus space for pipe frame mounting.

It supports the bus in place, but does not clamp it. The ampere capacity for D.C. busses is limited only by the available bus space, and for A.C. busses is limited to 10,000 amperes, maximum symmetrical short-circuit current.

Bus-Strap Support Style No.	Service Voltage	Diameter of Pipe Inches	Dimensions in Inches					Approx. Shipping Weight Lbs.
			A	B	C	D	E	
238464	3500	¾	2¾	2½	1½	3 9/16	1 13/16	3
238465	3500	¾	2¾	3½	2½	3 9/16	1 13/16	3
238466	3500	1¼	3½	2½	1½	3 7/8	1 13/16	3
238467	3500	1¼	3½	3½	2½	3 7/8	1 13/16	3

Bus-strap supports for heavy duty, 3-inch to 6-inch bus-straps, **flat mounting.** It supports the bus in place, but does not clamp it. The bus space is adjustable within the limits of the given dimensions. The ampere capacity of D.C. busses is limited only by the available bus space, and for A.C. busses is limited to 25,000 amperes maximum short-circuit current, bus spacing to be not less than 10-inch centers. For heavier currents, type P supports should be ordered.

Style number includes support complete.

Bus-Strap Support Style No.	Service Voltage	Dimensions in Inches					Approx. Shipping Weight Lbs.
		A	B	C	D	E	
238838	3500	3½	5¼	0	3 9/16	2 13/16	6
238839	3500	3½	10¾	5¼	9	2 13/16	6

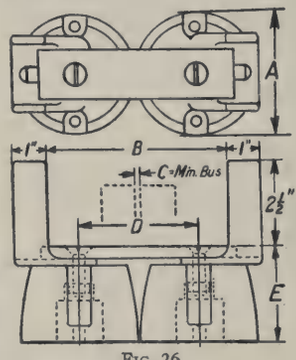


FIG. 26

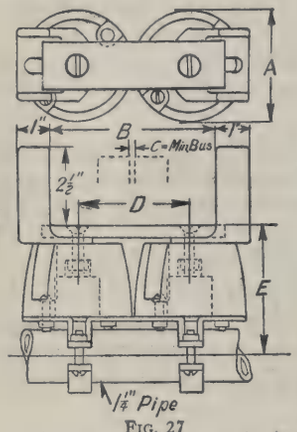


FIG. 27

Bus-strap supports for heavy duty, for 3-inch to 6-inch bus-straps and 1¼-inch **pipe frame mounting.** It supports the bus in place, but does not clamp it. The bus space is adjustable within the limits of the given dimensions. The ampere capacity of D.C. busses is limited only by the available bus space, and for A.C. busses is limited to 25,000 amperes maximum short-circuit current, bus spacing to be not less than 10-inch centers. For heavier currents, type P supports should be ordered.

Style number includes support complete with mounting bolts.

Bus-Strap Support Style No.	Service Voltage	Dimensions in Inches					Approx. Shipping Weight Lbs.
		A	B	C	D	E	
238842	3500	3½	5¼	0	3 9/16	3 7/8	8
238843	3500	3½	10¾	5¼	9	3 7/8	8

Bus-rod supports for bus-rods of ½ inch to 2¼ inches diameter, **flat mounting.**

Style number includes support complete.

Bus-Rod Support Style No.	Service Voltage	Maximum Diameter of Bus-Rod Inches	Dimensions in Inches						Approx. Shipping Weight Lbs.
			A	B	C	D	E	F	
239401	3500	½	3	7/16	15/16	2	2½	1 7/8	3
239401	3500	¾	3	7/16	15/16	2	2½	1 7/8	3
239402	3500	1	3	7/16	15/16	2	2½	1 7/8	3
239402	3500	1¼	3	7/16	15/16	2	2½	1 7/8	3
*239405	3500	1½	3¼	7/16	15/16	3 1/8	3½	2¾	3
*239405	3500	1¾	3¼	7/16	15/16	3 1/8	3½	2¾	3
*239406	3500	2	3¼	7/16	15/16	3 1/8	3½	2¾	3
*239406	3500	2¼	3¼	7/16	15/16	3 1/8	3½	2¾	3

*For A.C. applications where mechanical stresses due to short circuits may have to be met, space between center line of busses to be not less than 10 inches.

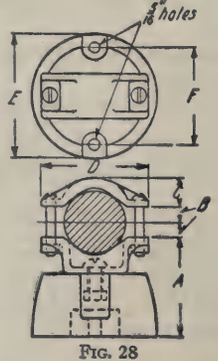


FIG. 28

SWITCHBOARD DETAILS—Continued

Bus-rod supports for bus rods of ½ inch to 2¼ inches diameter. **For pipe frame mounting.** Style number includes support complete and mounting bolts.

Bus-Rod Support Style No.	Service Voltage	Maximum Diameter of Bus-Rod Inches	Diameter of Pipe Inches	Dimensions in Inches A	B	C	D	E	Approx. Shipping Weight Lb.
239385	3500	½	¾	3¾	1/32	11/16	2	2½	4
239385	3500	¾	¾	3¾	1/32	11/16	2	2½	4
239386	3500	1	¾	3¾	1/16	11/16	2	2½	4
239386	3500	1¼	¾	3¾	1/16	11/16	2	2½	4
239389	3500	½	1¼	4 5/16	1/32	11/16	2	2½	4
239389	3500	¾	1¼	4 5/16	1/32	11/16	2	2½	4
239390	3500	1	1¼	4 5/16	1/16	11/16	2	2½	4
239390	3500	1¼	1¼	4 5/16	1/16	11/16	2	2½	4
*239393	3500	1½	¾	3¾	1/32	1/16	3⅛	3½	4
*239393	3500	1¾	¾	3¾	1/16	1/16	3⅛	3½	4
*239394	3500	2	¾	3¾	1/32	1/16	3⅛	3½	4
*239394	3500	2¼	¾	3¾	3/64	1/16	3⅛	3½	4
*239397	3500	1½	1¼	4 5/16	1/32	1/16	3⅛	3½	4
*239397	3500	1¾	1¼	4 5/16	1/16	1/16	3⅛	3½	4
*239398	3500	2	1¼	4 5/16	1/32	1/16	3⅛	3½	4
*239398	3500	2¼	1¼	4 5/16	3/64	1/16	3⅛	3½	4

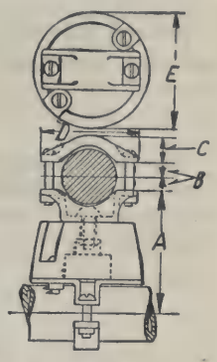


FIG. 29

*For A.C. applications where mechanical stresses due to short circuits may have to be met, space between center line of busses to be not less than 10 inches.

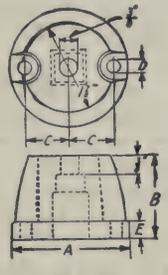


FIG. 30

Plain procelain insulators, dry process, for bus-bar supports shown in Figs. 22 to 29.

Approximate shipping weight 1 pound.

Insulator Style No.	Maximum Service Voltage	Dimensions in Inches A	B	C	D	E
234973	3500	2½	2¼	1⅜	¼	⅜
234974	3500	3½	2¼	1⅜	5/16	½

Bus-rod brackets, consisting of a line insulator and cast iron pin. This pin is designed for clamping on to a 1¼-inch pipe by a U bolt, or may be bolted to a flat surface. Style number includes insulator, pin and U bolt.

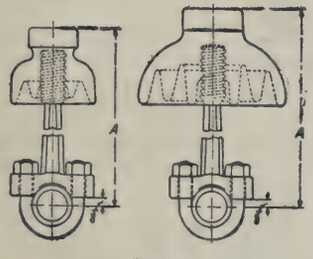


FIG. 32

Style No.	Voltage Indoor Service	Groove, Inches	Dimension A, Inches	Style No. Insulator	Approx. Shipping, Wt.,Lb.
127806	6600	¾	6¾	91074-A	8
127523	6600	1¼	7	91073-A	8
164295	15000	⅞	8⅛	91071-A	8
164296	25000	¾	10¼	91075-A	8

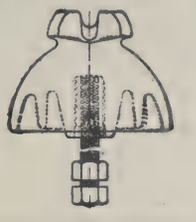


FIG. 31

Bus-rod brackets, line insulator type, for frame mounting—These bus-rod brackets, or insulated supports, consist of a line type insulator and an iron pin. While quite a number of brackets are listed here, the essential difference outside of the voltage rating is in the shape of the pin. These shapes cover a very wide range of application, and should be sufficient to satisfy any probable condition.

The threaded rod pins are ordinarily cemented in the insulator.

The cast iron pins have a thread cast on the insulator end, and easily threads into the insulator, a tight fit being obtained by first winding oakum around the threaded part of the pin. This eliminates the consideration as to whether the insulator groove is in the correct position in regard to the location of the mounting holes of the pin as the insulators may be turned, sufficiently on the pin to obtain the desired relation. The style number includes the insulator and pin assembled.

The bus-rod bracket consists of a line insulator threaded rod pin, six inches long, and two hexagon iron nuts.

Style No.	Voltage Indoor Service	Groove, Inches	Dimen. A Inches.	Diam. Pin, In.	Style No. Insulator	Approx. Shipp. Wt.,lb.
164265	6600	¾	7⅛	½	111040	[illegible]
164266	6600	1¾	7⅜	½	111039	[illegible]
164267	15000	⅞	7½	¾	91071-A	[illegible]
164268	25000	¾	7⅝	¾	91075-A	8

SWITCHBOARD DETAILS—Continued

Bus-rod brackets, line insulator type, for wall and shelf mounting—The description of the same line above for frame mounting is also applicable to these brackets.

The pin is designed to bolt to a shelf or wall. The position of the mounting bolt slots is such that the bracket may be removed without withdrawing the bolts.

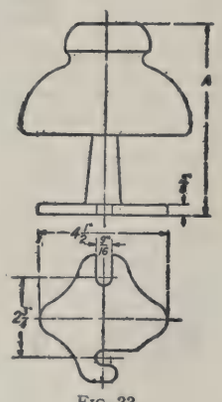


FIG. 33

Style No.	Voltage Indoor Service	Groove Inches	Dimension A Inches Fig. 33	Style No. Insulator	Approx. Shipping Wt.,Lb.
164272	6600	¾	5⅜	91074-A	8
164273	6600	1¼	5⅝	91074-A	8
164274	15000	⅞	6¾	91071-A	8
164275	25000	¾	8⅛	91075-A	8

Knob insulators, white glazed porcelain, designed for 2500-volts maximum indoor service with 2500-volt insulated wire or rod.

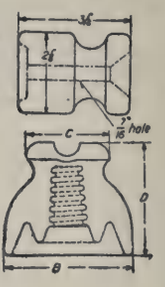


FIG. 34

FIG. 35

STYLE No.	DESCRIPTION
79634-A	Porcelain Insulator, 13/16 inch groove.
79636	Porcelain Insulator, ½ inch groove.

Line insulators, brown glazed porcelain, threaded for standard 1 inch wooden insulator pin.

Style No.	Voltage Indoor Service	Test Voltage for one Minute	Groove, Inches	DIMENSIONS IN INCHES		
				B	C	D
91074-A	6600	20000	¾	3½	2¼	3⅛
91073-B	6600	20000	1¼	3½	2⅜	3¼
91071-A	15000	45000	⅞	6	3 1/16	3⅞
91075-A	25000	66000	¾	6¾	3⅝	4⅞

These line insulators, with a tapped sleeve cemented in the pin hole, are very serviceable for ready mounting on the projecting ends of threaded rods or bolts which have previously been fastened in the walls or other masonry during construction of the building. These sleeves have a ½ inch 13 tap.

STYLE No.	DESCRIPTION
111040	Insulator includes style No. 91074-A with tapped sleeve cemented in.
111039	Insulator includes style No. 91073-A with tapped sleeve cemented in.

Bus-rod brackets, knob insulator type, for frame mounting—These brackets are of cast iron, suitable for bolting to angle iron frame or clamping to pipe frame, and are provided with porcelain knob insulator for supporting the bus rods. They are designed for 2500 volts maximum indoor service, with wire or rod insulated for 2500 volts.

Style number includes bracket complete with insulators and with bracket mounting bolts.

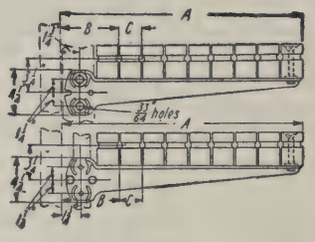


FIG. 36

FIG. 37

Bracket Style No.	Type of Frame	Figure	Number of Rods	Diameter of Rod Inches	DIMENSIONS IN INCHES			Approx. Shipping Weight Lb.
					A	B	C	
238844	Angle Iron	36	2	½	9 13/16	5½	2 3/16	10
238845	Angle Iron	36	2	⅝	9 13/16	5½	2 3/16	10
217752	Angle Iron	36	3	½	14 5/16	7 11/16	2 3/16	10
217756	Angle Iron	36	3	⅝	14 5/16	7 11/16	2 3/16	10
217753	Angle Iron	36	4	½	14 5/16	5½	2 3/16	10
217757	Angle Iron	36	4	⅝	14 5/16	5½	2 3/16	10
217754	Angle Iron	36	6	½	22 13/16	9⅞	2 3/16	10
217758	Angle Iron	36	6	⅝	22 13/16	9⅞	2 3/16	10
217755	Angle Iron	36	8	½	22 13/16	5½	2 3/16	10
217759	Angle Iron	36	8	⅝	22 13/16	5½	2 3/16	10
238846	1¼ Inch Pipe	37	2	½	9 13/16	5½	2 3/16	10
238847	1¼ Inch Pipe	37	2	⅝	9 13/16	5½	2 3/16	10
217760	1¼ Inch Pipe	37	3	½	14 5/16	7 11/16	2 3/16	10
217764	1¼ Inch Pipe	37	3	⅝	14 5/16	7 11/16	2 3/16	10
217761	1¼ Inch Pipe	37	4	½	14 5/16	5½	2 3/16	10
217765	1¼ Inch Pipe	37	4	⅝	14 5/16	5½	2 3/16	10
217762	1¼ Inch Pipe	37	6	½	22 13/16	9⅞	2 3/16	10
217766	1¼ Inch Pipe	37	6	⅝	22 13/16	9⅞	2 3/16	10
217763	1¼ Inch Pipe	37	8	½	22 13/16	5½	2¾	10
217767	1¼ Inch Pipe	37	8	⅝	22 13/16	5½	2 3/16	10

Bus Wires and Insulated Turnbuckles—These brackets are used for supporting small wiring busses across the switchboard panels and will accommodate four wires. Additional brackets mounted along the frame will hold the wires at a uniform spacing. Fig. 47 illustrates the method of using and the style numbers of the parts. The **style number** of the bracket includes the bracket complete for supporting four wires.

The turnbuckles are used for tightening the wires and additional ones can be ordered as desired. The **style number** includes the turnbuckle complete with a tightener for one wire.

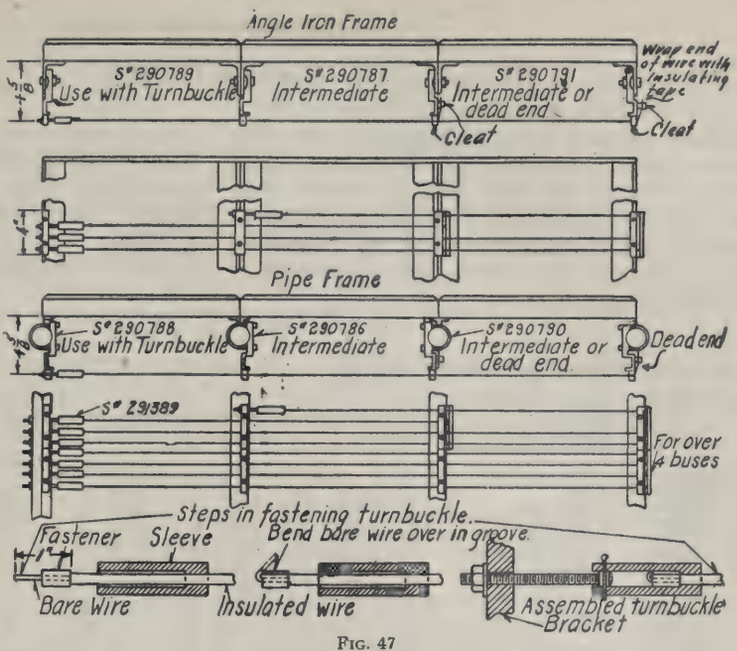


FIG. 47

STYLE NO.		Description	Approx. Ship. Wt., Lbs.
Pipe Frame	Angle Frame		
290788	290789	Wiring Bracket—Turnbuckle End	2
290786	290787	Wiring Bracket—Intermediate	2
290790	290791	Wiring Bracket—Intermediate or Dead End	2
291389	291389	Insulated Turnbuckle	¼

Installation Directions—Place wires in brackets, cleats being loose and turnbuckle in longest position. Pull wire at dead end taut, clamp top cleat of dead end bracket, add side cleat, tighten turnbuckle and clamp intermediate cleats.

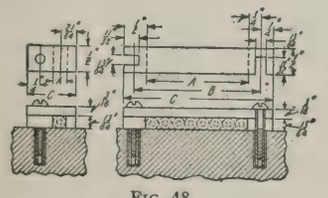


FIG. 48

Micarta cleats used for small wiring (with rubber-covered wire) on the rear of switchboard. The cleats are so designed that the wiring may run in two or more tiers, as required.

Style number includes micarta cleat only, without screws or screw anchors.

Micarta Cleat Style No.	No. of Wires	*No of Screws and Anchors	DIMENSIONS IN INCHES A	B	C	Approx. Ship. Wt., Lbs.
199651	1	1	$\frac{9}{32}$	. . .	$\frac{31}{32}$	1
199652	2	2	$\frac{17}{32}$	$1\frac{1}{16}$	$1\frac{17}{32}$	1
199653	3	2	$\frac{25}{32}$	$1\frac{5}{16}$	$1\frac{25}{32}$	1
199654	4	2	$1\frac{1}{16}$	$1\frac{13}{32}$	$2\frac{1}{16}$	1
199655	5	2	$1\frac{5}{16}$	$1\frac{27}{32}$	$2\frac{5}{16}$	1
199656	6	2	$1\frac{9}{16}$	$3\frac{3}{32}$	$2\frac{9}{16}$	1
199657	7	2	$1\frac{27}{32}$	$2\frac{3}{8}$	$2\frac{27}{32}$	1
199658	8	2	$2\frac{3}{32}$	$2\frac{5}{8}$	$3\frac{3}{32}$	1

*For fastening cleat on panel, screw anchors, style No. 113820, and No. 8 x 1 inch round head, iron wood screw should be ordered extra for single tier, or No. 8 x 1½ inch round head iron wood screws for double tiers.

Order by Style Number

BUS-BAR CLAMPS

These clamps are made of malleable iron. For direct-current application, two single iron clamps with necessary **iron** bolts may be used to make a complete clamp, while for alternating-current application two single iron clamps with the necessary **brass** bolts may be used. Brass clamps will be supplied on special order.

Style number includes one single clamp only. Bolts should be ordered extra to suit bus thickness desired; two bolts for each two-bolt clamp connection; three bolts for each three-bolt clamp connection and four bolts for each four-bolt clamp connection. For bus space, see Figs. 4 and 5 and 10 to 13.

Two-bolt type

Malleable Iron Clamp Style No.	Width of Bus, Inches	Width of Connector, Inches	Dimensions in Inches							Approx. Shipping Wt., Lbs.
			A	B	C	D	E	F*	G	
196303	1½	1 to 1½	2⅜	2 11/16	3 3/16	1¼	⅜	1⅛	5/16	1
196303	2	1	2⅜	2 11/16	3 3/16	1¼	⅜	1⅛	5/16	1
196305	2	1½ to 2	3	3¾	4 5/16	1½	⅜	1½	⅜	1
196305	3	1	3	3¾	4 5/16	1½	⅜	1½	⅜	1
196307	3	1½ to 2	3 7/16	4 5/8	5½	1¾	½	1½	⅜	1
196307	4	1	3 7/16	4 5/8	5½	1¾	½	1½	⅜	1
196309	3	3	4 7/16	5¼	6¼	1¾	9/16	1¾	½	2
196309	4	1½	4 7/16	5¼	6¼	1¾	9/16	1¾	½	2
196311	4	3	5⅜	6⅛	7⅛	1¾	⅝	1¾	½	2
196313	4	4	6½	7⅛	8⅛	2	⅝	1¾	½	2
196313	6	1 to 2	6½	7⅛	8⅛	2	⅝	1¾	½	2

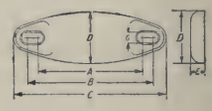


FIG. 49

Three-bolt type

Malleable Iron Clamp Style No.	Width of Bus, Inches	Width of Connector Inches	Dimensions in Inches							Approx. Shipping Wt., Lbs.
			A	B	C	D	E	F*	G	
253584	3	5 to 6	5½	6½	3½	7⅝	4½	1¾	⅝	3
253585	4	5 to 6	5½	6½	4½	7⅝	5½	1¾	⅝	3
253586	3	4 to 4¾	4⅜	5	3½	6⅛	4½	1¾	⅝	3
253587	4	4 to 4¾	4⅜	5	4½	6⅛	5½	1¾	⅝	3
253588	5	5 to 6	5½	6½	5½	7⅝	6½	2	¾	4
253589	6	5 to 6	5½	6½	6½	7⅝	7½	2	¾	4
253590	5	4 to 4¾	4⅜	5	5½	6⅛	6½	2	¾	4
253591	6	4 to 4¾	4⅜	5	6½	6⅛	7½	2	¾	4

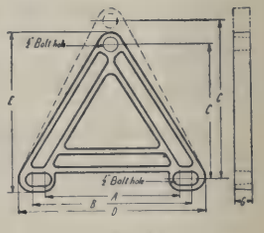


FIG. 50

Four-bolt type

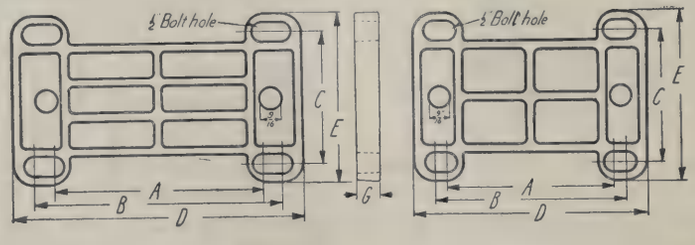


FIG. 51

Malleable Iron Clamp, Style No.	Width of Bus, Inches	Width of Connector Inches	Dimensions in Inches							Approx. Shipping Wt., Lbs.
			A	B	C	D	E	F*	G	
238628	3	5 to 6	5½	6½	3½	7⅝	4½	2	⅞	5
238629	4	5 to 6	5½	6½	4½	7⅝	5½	1¾	⅞	5
238630	5	5 to 6	5½	6½	5½	7⅝	6½	2	1	5
238631	6	5 to 6	5½	6½	6½	7⅝	7½	2	1	5
238632	3	4 to 4½	4¼	5	3½	6⅛	4½	1¾	⅞	4
238633	4	4 to 4½	4¼	5	4½	6⅛	5½	1¾	⅞	4
238634	5	4 to 4½	4¼	5	5½	6⅛	6½	2	⅞	4
238635	6	4 to 4½	4¼	5	6½	6⅛	7½	2	⅞	4

*Total length of clamping bolt required equals dimension F in table, plus thickness of bus, all bolts ⅜-inch diameter.

Order by Style Number

SWITCHBOARD DETAILS—Continued

Iron machine bolts—The following iron machine bolts are used with bus-bar clamps and clamp terminals. Iron machine bolts should be used for direct-current service, and for alternating-current service only with a clamp terminal; in all other cases a brass machine screw or bolt should be used.

Size of Bolt, Inches	Size of Bolt, Inches	Size of Bolt, Inches
¼ x 1½	⅜ x 1¾	½ x 2
¼ x 1¾	⅜ x 2	½ x 2¼
¼ x 2	⅜ x 2¼	½ x 2½
¼ x 2½	⅜ x 2½	½ x 3
¼ x 3	⅜ x 3	½ x 4
¼ x 3½	⅜ x 3½	½ x 4½
	⅜ x 4	

Brass machine screws and bolts—The following fillister head brass machine screws and brass machine bolts with iron nuts are used with bus-bar clamps for alternating-current service.

Brass Machine Screw Size—Inches	Brass Machine Screw Size—Inches
.242–24 x 1¼	.372–16 x 1½
.242–24 x 1½	.372–16 x 1¾
.242–24 x 1¾	.372–16 x 2¼
.242–24 x 2¼	.372–16 x 2¾
.242–24 x 2¾	.372–16 x 3½
.242–24 x 3	.372–16 x 4
.242–24 x 3½	

Size—Inches	Brass Machine Bolt Style No., Bolt with Iron Nut	Approximate Shipping Weight Lb.
½ x 2	253362	1
½ x 2½	253363	1
½ x 3	253364	1
½ x 2½	253365	1
½ x 4	253366	1
½ x 4½	253367	1

Note—½-inch bolts are required only with the two-bolt clamp, style numbers 196309 to 196314, inclusive, and with the two-bolt clamp terminals, style numbers 196399 to 196403, inclusive, and 196319 to 196323, inclusive.

BUS-BAR TERMINALS

Bus-bar terminals for lead parallel to side of bus-bar. Length of bolt required equals thickness of bus, plus dimension D in table.

One bus-bar clamp, Fig. 49, and one terminal, Fig. 52, compose one complete bus-bar clamp.

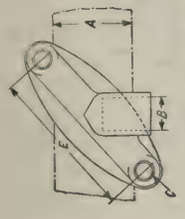


FIG. 52

Fig. 52, Terminal	Fig 49 Clamp	Dimensions in Inches					Approx Ship.
Style No.	Style No.	A	B	C	D	E	Wt.Lb.
240201	196303	2	½	5/16	1 1/8	2 11/16	3
240202	196303	2	3/8	5/16	1 1/8	2 11/16	3
240203	196303	2	9/32	5/16	1 1/8	2 11/16	3
196394	196305	2	13/16	3/8	1½	3¾	3
196395	196305	2	1 1/16	3/8	1½	3¾	3
240204	196305	3	½	3/8	1½	3¾	3
240205	196305	3	3/8	3/8	1½	3¾	3
240206	196305	3	9/32	3/8	1½	3¾	3
196397	196305	3	13/16	3/8	1½	3¾	3
196398	196305	3	1 1/16	3/8	1½	3¾	3
196399	196309	3	1 5/16	½	1¾	5¼	3
196400	196313	5	* 11/32	½	1¾	7⅛	5
196400	196313	6	* 11/32	½	1¾	7⅛	5
196401	196313	5	13/16	½	1¾	7⅛	5
196401	196313	6	13/16	½	1¾	7⅛	5
196402	196313	5	1 1/16	½	1¾	7⅛	5
196402	196313	6	1 1/16	½	1¾	7⅛	5
196403	196313	5	1 5/16	½	1¾	7⅛	5
196403	196313	6	1 5/16	½	1¾	7⅛	5

Dimension A is maximum width of bus space.
*Maximum diameter of hole for cable, to be drilled as required.

Bus-bar terminals for clamp connection to flat bus-bar. These terminals are made of cast brass or cast copper and are designed primarily for making a clamp connection to flat bus-bar. Iron clamps for the opposite side of the bus when required, bus spacers when required, and bolts should be ordered extra.

One bus-bar terminal, Fig. 53, and one clamp, Fig. 49, compose one complete bus-bar clamp.

Length of bolt required equals thickness of bus, plus dimension D in table.

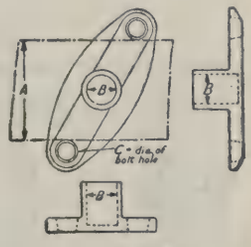


FIG. 53

Fig. 53, Terminal	Fig. 49, Clamp	Dimensions in Inches				Approx. Shipping Wt., Lb.
Style No.	Style No.	A	B	C	D	
196315	196303	2	* 11/32	5/16	1⅛	3
196316	196305	3	* 11/32	3/8	1½	3
196317	196305	2	13/16	3/8	1½	3
196317	196305	3	13/16	3/8	1½	3
196318	196305	2	1 1/16	3/8	1½	3
196318	196305	3	1 1/16	3/8	1½	3
196319	196309	3	1 5/16	½	1¾	3
196320	196311	5	* 11/32	½	1¾	5
196320	196313	6	11/32	½	1¾	5
196321	196311	5	13/16	½	1¾	5
196321	196313	6	13/16	½	1¾	5
196322	196311	5	1 1/16	½	1¾	5
196322	196313	6	1 1/16	½	1¾	5
196323	196311	5	1 5/16	½	1¾	5
196323	196313	6	1 5/16	½	1¾	5

Dimension A is maximum width of bus space.
*Maximum diameter of hole for cable, to be drilled as required.

SWITCHBOARD DETAILS—Continued

TEE CONNECTORS

Tee connectors for clamped main connection and soldered branch connections. Style number includes connector with clamp and stove bolts.

Connector Style No.	Fig. No.	Diam. of Main Hole Inches	Diam. of Branch Hole Inches	Drilled for Connectors: Main Inches	Drilled for Connectors: Branch Inches	Dimensions in Inches: A	B	C	D	Approx. Shipping Wt.,lb.
240208	54	17/64	9/32	.258	.258	1	1 3/8	5/8	3/16	2
240207	54	3/8	3/8	.365	.365	1	1 3/8	5/8	9/16	2
240210	54	1/2	9/32	.460	.258	1 1/4	1 5/16	13/16	9/16	2
240209	54	1/2	3/8	.460	.365	1 1/4	1 5/16	13/16	7/16	2
8689	54	1/2	13/32	.460	.460	1 1/4	1 21/32	13/16	7/8	2
164968	54	*1/2	*7/8	....	....	2 1/2	2 1/4	1 3/16	1 3/16	2
74508	54	3/4	*1/2	3/4	....	1 1/4	1 3/4	1 1/16	13/16	2
74509	55	3/4	*1/2	3/4	....	3	1 3/4	1 1/16	5/4	2
164969	54	3/4	*7/8	3/4	....	3	2 5/16	1 3/16	1 1/8	2
196202	54	3/4	*1 3/16	3/4	....	3	3 3/8	1 3/16	1 3/4	2
196203	54	1	*1/2	1	....	1 1/2	1 7/8	1 1/16	13/16	3
196204	55	1	*1/2	1	....	3	1 7/8	1 1/16	3/4	3
196205	54	1	*7/8	1	....	3	2 13/16	1 1/16	1 1/2	3
196206	54	1	*1 1/16	1	....	3	2 13/16	1 1/16	1 3/4	3

*Style No. includes Tee Connectors, undrilled. Dimensions given are the maximum diameter of hole for which connector may be drilled. Specify drilling when ordering.

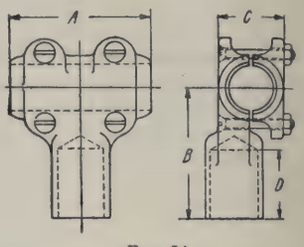


FIG. 54

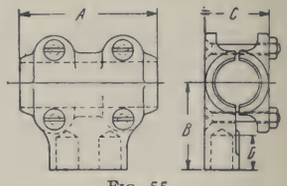


FIG. 55

COPPER TUBE CONNECTORS

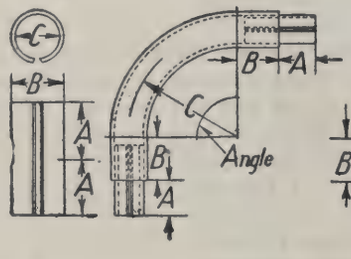


FIG. 56

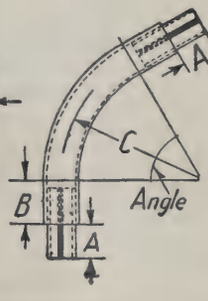


FIG. 57

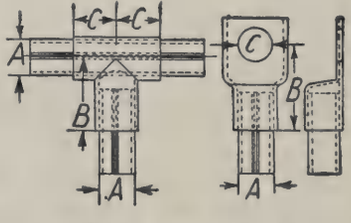


FIG. 58

FIG. 59

Connector, Style No.	Capacity in Amperes	Figure No.	Angle, Degrees	Inner Diameter, Inches	Outer Diameter, Inches	Dimensions in Inches: A	B	C
244257	100	56	Straight	.558	....	3/4	13/32	13/32
244258	200	56	Straight	.87	....	1	13/32	13/32
244259	300	56	Straight	1.02	....	1 1/4	1	3/4
244260	400	56	Straight	1.12	....	1 1/2	1 3/32	11/16
244261	600	56	Straight	1.385	....	1 1/2	1 5/8	1 1/8
244262	100	57	90	.558	11/16	3/4	1	4 11/32
244263	200	57	90	.87	1	1	1 1/8	4 1/2
244264	300	57	90	1.02	1 1/16	1 1/4	1 3/8	5 1/32
244265	400	57	90	1.12	1 5/16	1 1/2	1 5/8	5 11/32
244266	600	57	90	1.385	1 5/8	1 1/2	1 5/8	6 1/16
244267	100	57	60	.558	11/16	3/4	1	4 11/32
244268	200	57	60	.87	1	1	1 1/8	4 1/2
244269	300	57	60	1.02	1 1/16	1 1/4	1 3/8	5 1/32
244270	400	57	60	1.12	1 5/16	1 1/2	1 5/8	5 11/32
244271	600	57	60	1.385	1 5/8	1 1/2	1 5/8	6 1/16
244272	100	57	45	.558	11/16	3/4	1	4 11/32
244273	200	57	45	.87	1	1	1 1/8	4 1/2
244274	300	57	45	1.02	1 1/16	1 1/4	1 3/8	5 1/32
244275	400	57	45	1.12	1 5/16	1 1/2	1 5/8	5 11/32
244276	600	57	45	1.385	1 5/8	1 1/2	1 5/8	6 1/16
244277	100	57	30	.558	11/16	3/4	1	4 11/32
244278	200	57	30	.87	1	1	1 1/8	4 1/2
244279	300	57	30	1.02	1 1/16	1 1/4	1 3/8	5 1/32
244280	400	57	30	1.12	1 5/16	1 1/2	1 5/8	5 11/32
244281	600	57	30	1.385	1 5/8	1 1/2	1 5/8	6 1/16
244282	100	58	Three-way	.558	11/16	13/16	1 1/4	3/4
244283	200	58	Three-way	.87	1	1 1/16	1 5/8	1
244284	300	58	Three-way	1.02	1 1/16	1	2	1 1/4
244285	400	58	Three-way	1.12	1 5/16	1 3/32	2 1/4	1 1/2
244286	600	58	Three-way	1.385	1 5/8	1 3/4	2 1/16	1 1/2
244287	100	59	Straight	.558	11/16	13/16	1 5/16	13/16
244288	200	59	Straight	.87	1	1 1/16	2 3/32	13/16
244289	300	59	Straight	1.02	1 1/16	1	2 3/4	11/16
244290	400	59	Straight	1.12	1 5/16	1 3/32	3	11/16
244291	600	59	Straight	1.385	1 5/8	1 3/8	3 1/16	1 1/16

SWITCHBOARD DETAILS—Continued

TERMINAL CONTACT NUTS

Nut Style No.	For Studs, Diameter in Inches	Dimensions in Inches A	B	C	D
46868	1/4	1/16	1/32	3/8	.242–24
15309-A	5/16	11/64	1/4	1/2	5/16–18
7299-A	3/8	13/64	5/16	5/8	3/8–16
7543	1/2	1 9/32	3/8	1	1/2–13
7544-A	5/8	1 7/16	7/16	1 1/4	5/8–11
12951-A	3/4	1 11/64	1/2	1 1/2	3/4–16
7545-A	1	2 11/64	5/8	1 7/8	1 –14
7546-A	1 1/4	2 13/32	3/4	2 1/4	1 1/4–14
7547	1 1/2	2 13/32	3/8	2 1/2	1 1/2–14
7549	1 3/4	3 13/32	3/8	3	1 3/4–12
7550	2	3 15/32	3/8	3	2 –12
12973	2 1/4	4 1/32	3/8	3 1/2	2 1/4–12
8824	2 1/2	4 1/32	3/8	3 1/2	2 1/2–12

FIG. 61

COPPER TERMINALS

The terminals listed in the following tables are made from drawn copper. Straight terminals up to and including .559 inches inside diameter are seamless all around and are superior in appearance to any others. All the other terminals are made from seamless copper tubing. The best conductivity is secured in both types.

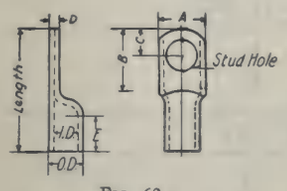


FIG. 62

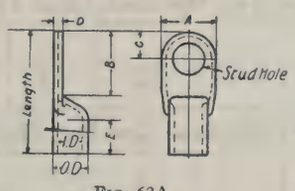


FIG. 62A

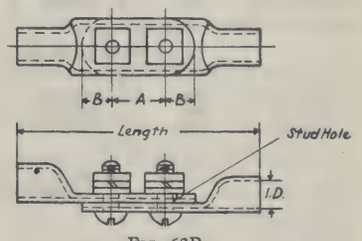


FIG. 62B

Style No.	Ampere capacity Rubber Insulated Conductors	Maximum stranded wire or cable size	Dimensions in Inches I. D.	O. D.	Diam. of Stud Hole	Length	A	B	C	D	E
Straight Terminals—One Bolt Hole—Figs. 62 and 62A											
229105	35	8	.186	.25	7/32	1 1/32	3/8	1/2	7/32	1/16	3/8
243981	70	4	.285	.375	9/32	1 11/32	7/16	5/8	9/32	1/16	7/16
229112	70	4	.285	.375	11/32	1 11/32	7/16	5/8	11/32	1/16	7/16
229114	125	0	.398	.50	13/32	1 3/4	3/4	1	13/32	3/32	5/8
243982	125	0	.398	.5	11/32	1 3/4	3/4	1	11/32	3/32	5/8
229113	125	0	.398	.5	13/32	1 3/4	3/4	1	13/32	3/32	5/8
269917	225	0000	.559	.688	17/32	2 5/32	31/32	1 5/32	17/32	3/32	27/32
229120	225	0000	.559	.688	17/32	2 9/32	31/32	1 5/32	17/32	3/32	27/32
243988	275	300000	.745	.875	17/32	2 15/16	1 1/16	1 1/16	5/16	.13	1
229127	400	500000	.918	1.063	21/32	3 1/2	1 13/32	1 1/2	11/16	.144	1 1/4
229128	400	500000	.918	1.063	11/16	3 1/2	1 13/32	1 1/2	11/16	.144	1 1/4
243993	550	800000	1.12	1.313	11/16	4 5/16	1 31/32	1 11/16	13/16	.1925	1 1/2
229133	650	1000000	1.28	1.5	11/16	4 13/16	2 1/4	1 13/16	13/16	.22	1 3/4
229134	650	1000000	1.28	1.5	13/16	4 13/16	2 1/4	1 13/16	13/16	.22	1 3/4
292234	1000	1500000	1.5	1.813	13/16	5 5/8	2 11/16	2 1/4	1	5/16	2 1/16
235904	1000	1500000	1.5	1.813	1 1/16	5 5/8	2 11/16	2 1/4	1	5/16	2 1/16
233459	1200	2000000	1.75	2.063	13/16	6 11/16	3 1/16	2 3/4	1 1/4	5/16	2 1/2
229773	1200	2000000	1.75	2.063	1 5/16	6 11/16	3 1/16	2 3/4	1 1/4	5/16	2 1/2

Order by Style Number

SWITCHBOARD DETAILS—Continued

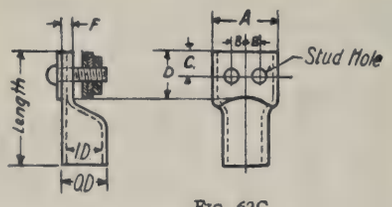


FIG. 62C

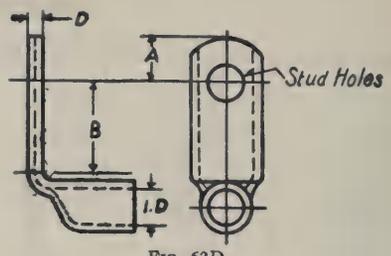


FIG. 62D

Style No.	Ampere capacity Rubber Insulated Conductors	Maximum Stranded wire or cable size	DIMENSIONS IN INCHES								
			I. D.	O. D.	Diam. of Stud Hole	Length	A	B	C	D	E
Straight Terminals—Two Vertical Bolt Holes—Fig. 62B											
270528	80	3	.259	.....	7/32	2 7/16	9/16	1/4	...	.....	...
270529	125	0	.384	.....	11/32	3 1/8	5/8	5/16			
270532	225	0000	.559	.....	17/32	4 1/4	3/4	3/8	...	.....	...
270533	275	300000	.745	.....	23/32	4 3/4	7/8	1/2	...	.....	...
272214	400	500000	.918	.....	29/32		1	9/16	...	.....	...
Straight Terminals—Two Horizontal Bolt Holes—Fig. 62C											
259431	650	1000000	1.28	1.5	7/16	4 3/8	2 1/4	1/2	3/4	1 1/2	...
282087	1000	1500000	1.5	1.813	7/16	5 1/8	2 11/16	5/8	7/8	1 3/4	...
282089	1200	2000000	1.75	1.75	9/16	5 11/16	3 1/16	3/4	1	2	...
90 Degree Angle Terminals—One Bolt Hole—Fig. 62D											
281786	80	3	.259	.....	7/32	.....	9/32	1/4	....	.084	....
244130	80	3	.259	.....	7/32	.....	9/32	21/64	....	.084	....
292250	80	3	.259	.....	11/32	.....	9/32	21/64	....	.084	....
279970	80	3	.259	.....	11/32	.....	9/32	1/4	....	.084	....
244133	125	0	.384	.....	11/32	.....	11/32	11/32	....	.084	....
244134	125	0	.384	.....	13/32	.....	11/32	11/32	....	.084	....
179758	125	0	.384	.....	13/32	.....	13/32	11/32	....	.084	....
269923	225	0000	.559	.....	17/32	.....	1/2	13/32	....	.084	....
244144	225	0000	.559	.....	17/32	.....	1/2	11/16	....	.13	....

The straight terminals with two horizontal bolt holes shown in Fig. 62C and listed above are designed for general application where the one-bolt-hole terminals as listed are not suitable—for example, where large cable connections are made to studs of large diameters, to laminated studs, to flat terminal plates, etc. By providing a properly formed adapter, made from flat copper strap, between the listed terminal and the stud or plate to which connection is desired, means are provided for securing varied terminal arrangements.

For general guidance, several common arrangements shown in Fig. 64 are available on special order. The style number of the terminal includes the lug without the adapting strap.

Order by Style Number

SWITCHBOARD DETAILS—Continued

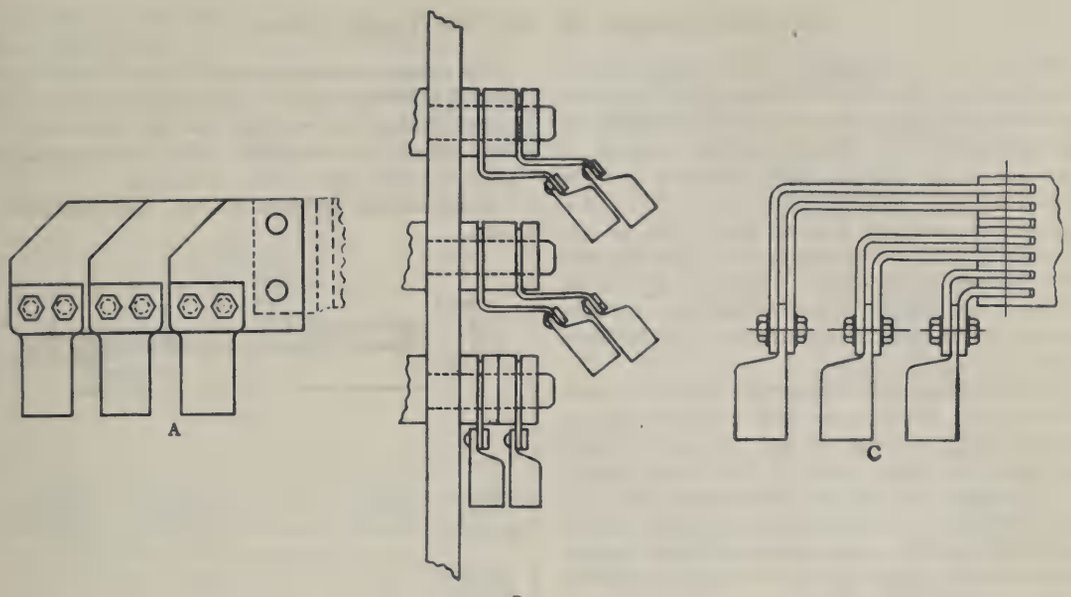


FIG. 64

UNIVERSAL MOUNTING BRACKETS

Universal auxiliary brackets—This cast iron bracket is designed particularly to be bolted to the universal mounting brackets or straps, thus providing a suitable mounting for current and voltage transformers, etc., in various locations.

Style number includes bracket and ⅜-inch diameter stove bolt.

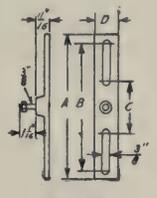


FIG. 65

Style No.	Dimensions in Inches				Approx. Shipping Weight lb.
	A	B	C	D	
72752	7	6	3⅛	1½	1
177512	9	8	3⅛	1½	1

Mounting brackets for fuse and disconnecting switch base mounting—This cast iron bracket is designed particularly to be bolted to the end lug of the universal bracket and to provide a support for fuse and disconnecting switch bases. For individually mounted bases, two universal brackets and two end brackets are required per base, but where the bases are mounted adjacent to each other, in the same line and plane, an intermediate support for the two may be formed by using one universal bracket and one intermediate bracket. Style number includes bracket with mounting bolt.

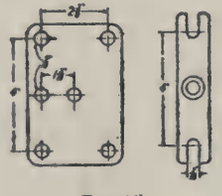


FIG. 66

Style No.		Approximate Shipping Weight lb
59570	End Bracket	1¼
59571	Intermediate Bracket	1½

Order by Style Number

SWITCHBOARD DETAILS—Continued

UNIVERSAL MOUNTING BRACKETS AND STRAPS

The group of mounting brackets, listed below, consist of a number of cast iron slotted brackets, provided with an end lug and arranged to project at right angles to the frame uprights; a number of cast iron slotted straps, which extend across the panel, bolted to the end lug of the bracket; and a number of auxiliary brackets which bolt on the bracket or strap, as the case may be. This arrangement provides an almost unlimited number of different mountings for current and voltage transformers, fuse bases, disconnecting switches, insulator pins, knob insulators, etc.

Universal mounting brackets—For pipe or angle iron frame. Brackets are cast with slots in side, are provided with an end lug and are designed to project at right angles to the frame upright. The brackets are suitable for mounting on either 1¼ inch pipe frame or angle iron frame; suitable adjusting eccentric washers are provided for holding the brackets rigidly, to prevent sagging, ordinarily due to bolt hole clearances.

Style number and list price include bracket complete with straight mounting bolts for angle iron frames or with U bolts for pipe frame mounting.

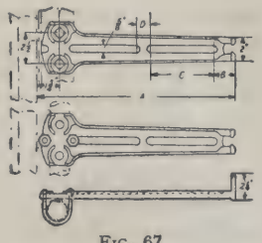


FIG. 67

Mounting Bracket Style No.	Description of Frame	No. of Slots	Dimensions, Inches				Approx. Shipping Wt., lb.
			A	B	C	D	
216750	Angle Iron	0	4	0	0	...	4
216751	Angle Iron	1	6	1¾	1 7/16	...	4
216752	Angle Iron	1	8	1¾	3 7/16	...	4
216753	Angle Iron	1	10	1¾	5 7/16	...	4
216754	Angle Iron	2	12	1¾	3⅛	1⅛	5
216755	Angle Iron	2	14	1¾	4⅛	1⅛	5
216756	Angle Iron	2	16	1¾	5⅛	1⅛	5
216757	Angle Iron	3	18	1¾	3 11/16	1⅛	5
216758	Angle Iron	3	20	1¾	4⅜	1⅛	6
216759	Angle Iron	3	22	1¾	5 7/16	1⅛	6
216760	Angle Iron	4	24	1¾	4	1⅛	6
216761	Angle Iron	4	26	1¾	4½	1⅛	6
216762	1¼ Inch Pipe	0	4	0	0	...	4
216763	1¼ Inch Pipe	1	6	1¾	1 7/16	...	4
216764	1¼ Inch Pipe	1	8	1¾	3 7/16	...	4
216765	1¼ Inch Pipe	1	10	1¾	5 7/16	...	4
216766	1¼ Inch Pipe	2	12	1¾	3⅛	1⅛	5
216767	1¼ Inch Pipe	2	14	1¾	4⅛	1⅛	5
216768	1¼ Inch Pipe	2	16	1¾	5⅛	1⅛	5
216769	1¼ Inch Pipe	3	18	1¾	3 11/16	1⅛	5
216770	1¼ Inch Pipe	3	20	1¾	4⅜	1⅛	6
216771	1¼ Inch Pipe	3	21	1¾	5 7/16	1⅛	6
216772	1¼ Inch Pipe	4	24	1¾	4	1⅛	6
216773	1¼ Inch Pipe	4	26	1¾	4½	1⅛	6

Universal mounting straps, made of cast iron with 7/16 inch slots in the side, are designed particularly to be bolted on the end lugs of the universal mounting brackets, thus forming a mounting or supporting medium across the switchboard panels.

Style number includes bracket with mounting bolts.

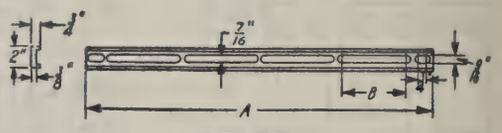


FIG. 68

Universal Strap, Style No.	Width of Panel, Inches	No. of Slots	Dimensions in Inches		Approx. Shipping Weight lb.
			A	B	
109008	16	2	15 1/16	5⅜	4
109009	20	2	19 1/16	7⅜	4
109010	22	2	21 1/16	6⅜	4
72749	24	3	23 1/16	6	6
72750	32	4	31 1/16	6 1/16	6
72751	40	4	39 1/16	8 1/16	6

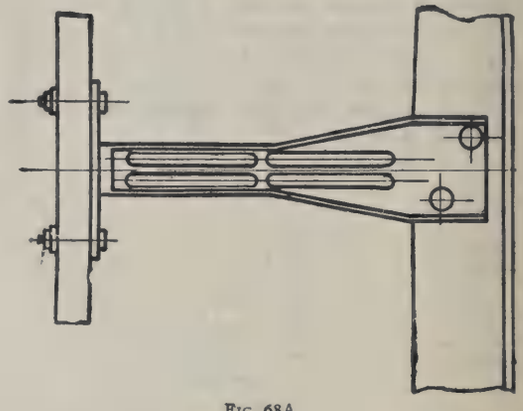


FIG. 68A

Mounting bracket for light bases used generally for supporting terminals, and testing bases on rear of switchboard for angle iron frame mounting. It is not necessary to remove the bracket from frame when shipping.

Style No.	Approx. Shipping Wt., Lbs.
291189	3

Order by Style Number

SWITCHBOARD DETAILS—Continued

Mounting brackets for mounting oil circuit breakers, made of cast iron and designed to hold the supporting pipes or pipe stringers, when breakers are supported on switchboard frame instead of switchboard panel. Note that breakers with horizontal pull mechanism are ordinarily required.

Style number includes bracket and mounting bolt.

Bracket Style No.		Approximate Shipping Weight Lb.
*216738	Mounting bracket with U bolt for pipe frame	6
216737	Mounting bracket with mounting bolts for angle iron	6

*Bracket and breaker cover plate should be located so as not to interfere with panel frame brackets.

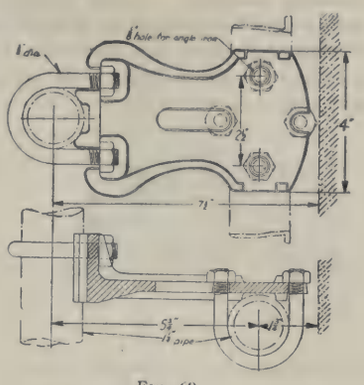


FIG. 69

Mounting brackets, Fig. 71, for types FS and FB current transformers, are made of cast iron and are designed for supporting the transformers from flat surface, as in Fig. 72.

Style number includes one bracket only.

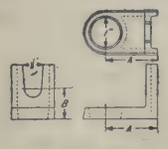


FIG. 71

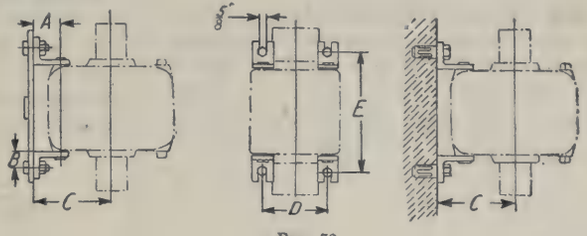


FIG. 72

Fig. 71 Mounting Bracket Style No.	Application	For Mounting Transformers Style No.	Dimensions in Inches				
	Mounting		A	B	C	D	E
*217611	Pipe	125053 to 125056	1 21/32	1	4	3½	7⅛
†217611	Flat	125053 to 125056	1 21/32	1	4	4	7⅝
*217611	Pipe	125057 to 125059	1 21/32	1	5 1/16	4½	8
†217611	Flat	125057 to 125059	1 21/32	1	5 1/16	4⅜	7⅜
*217611	Pipe	125060 to 125062	1 21/32	1	5¼	4½	8
†217611	Flat	125060 to 125062	1 21/32	1	5¼	4⅜	7⅜
*217611	Pipe	125063 to 125066	1 21/32	1	3¾	4¼	7⅝
†217611	Flat	125063 to 125066	1 21/32	1	3¾	5⅜	7⅞
*217611	Pipe	125067 to 125069	1 21/32	1	5	4¼	7⅝
†217611	Flat	125067 to 125069	1 21/32	1	5	5⅜	7⅞
*217611	Pipe	125070 to 125072	1 21/32	1	5⅜	4¼	7⅝
†217611	Flat	125070 to 125072	1 21/32	1	5⅜	5⅜	7⅞

Approximate shipping weight 1 pound.

*For 1¼-inch pipe mounting, order in addition two Style No. 127776 brackets, and four ⅜-inch by 1¼-inch machine bolts for each transformer.

†For flat mounting on auxiliary bracket as shown on the left of Fig. 72, order in addition, two style No. 177512 brackets, and four ⅜-inch by 1¼-inch machine bolts for each transformer.

Order by Style Number

SWITCHBOARD DETAILS—Continued

Pipe mounting brackets. These brackets are made of cast iron for clamping on 1¼ inch pipe frame by means of U bolts; for supporting instrument transformers, fuse blocks, disconnecting switches, etc.

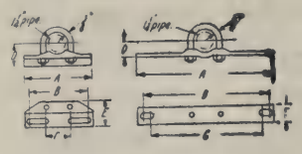


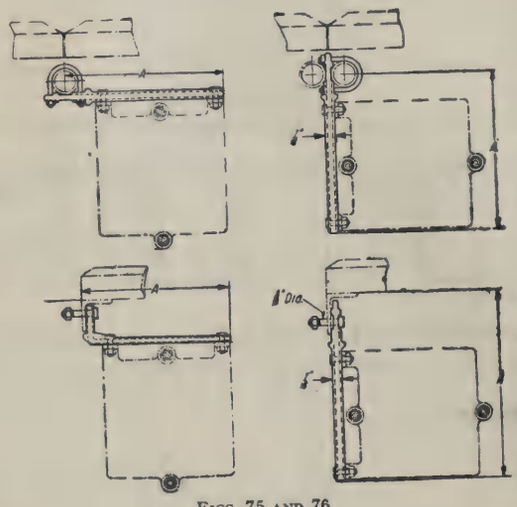
FIG. 73 FIG. 74

Bracket Style No.	Figure	Dimensions in Inches					
		A	B	C	D	E	F
127768	73	5⅝	4⅞	2	1¾	2	1⅛
239023	74	9¼	8	5	1¼	1 1/16	1 1/16
127776	74	9	8	2⅛	1¼	1½	...
239024	74	11	10	9	1¼	1½	...

Approximate shipping weight 2 pounds.

Mounting bracket, light duty type, made of cast iron and designed for supporting Westinghouse condenser sections for voltage regulator and for meter resistance, etc.

Style number includes bracket only, which is shown in full lines.



FIGS. 75 AND 76

Mounting Bracket Style No.	Type of Mounting Frame	Figure	Dimension A, Inches
228886	Angle Iron	75	11¾
228887	Pipe, 1¼ inch	76	10
228888	Angle Iron	75	9 1/16

Approximate shipping weight 3 pounds.

I-beam clamp for fastening transverse I-beams—This cast iron fitting securely clamps a transverse I-beam to another I-beam, without the necessity of cutting or drilling either beam.

It is used extensively to hold the supporting I-beam to remote hand control oil circuit breaker bell cranks.

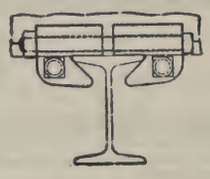


FIG. 77

Style No.
162516 Clamp without bolts, Fig. 77.

Approximate shipping weight 5 pounds.

In addition to the above, there should be ordered two ½ inch machine bolts, 3¼ inches longer than the width of one I-beam flange, and two ½ inch machine bolts, 3¼ inches longer than the width of the other I-beam flange.

Hanger clamp.—This cast iron clamp is designed for any size I-beam without the necessity of cutting or drilling the beam. It is of service in hanging various brackets and supports from the ceiling and offers a substantial base for oil switch or circuit breaker bell crank bearings.

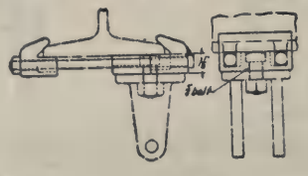


FIG. 78

Style No.
162519 Clamp without bolts, Fig. 78.

Approximate shipping weight 6 pounds.

In addition to the above, there should be ordered two ½ inch machine bolts, 3¼ inches longer than the width of the I-beam flange.

I-beam hanger clamp, light duty type—This iron clamp is designed for the same general purpose as the heavy duty type clamp, but for use as a support for lighter apparatus.

Style number includes clamps and one ⅜ inch x 1¼ inch machine bolt.

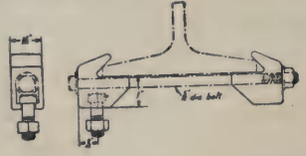


FIG. 79

Style No.
***223406** Hanger clamp with one machine bolt.

Approximate shipping weight 3 pounds.

*In addition there shold be ordered two 1/16 inch washers and two ⅜ inch diameter machine bolts, 2¾ inches longer than the width of the I-beam flange.

Order by Style Number

SWITCHBOARD DETAILS—Continued

Iron pipe conduit clamps, ceiling mounting—These clamps are designed to fasten conduits to a reverse I-beam and will not require greater spacing of conduits than that necessary for the regular conduit fittings. The style number includes clamp complete.

FIG. 80

Style No.
164987 For ¾-inch conduit.
164988 For 1-inch conduit.
164989 For 1¼-inch conduit.
Approximate shipping weight 1 pound.

Pipe brackets made of cast iron and designed to bolt to an angle frame and to support a 1¼-inch pipe at right angles to the frame upright. The bracket is tapped with straight thread of standard size to provide adjustment of the pipe to the horizontal position.

Style number includes bracket complete with mounting bolts and pipe lock nut, but does not include the pipe.

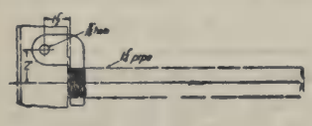


FIG. 51

StyleNo.
162515 Bracket complete.
Approximate shipping weight 2 pounds.

Pipe saddle clamps made of malleable iron, and are tapped to receive pipe with standard pipe thread for branch connections, while the main connection is of the U clamp type.

Style number includes clamp with U bolt.

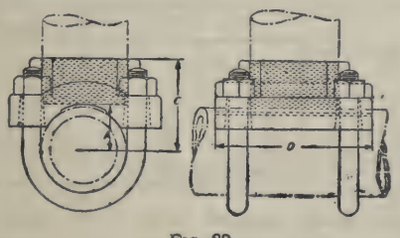


FIG. 82

Clamp Style No.	Size of Pipe		Dimensions in Inches		
	Main, Inches	Branch, Inches	A	C	D
226325	¾	¾	1/16	1¼	2¾
226324	1¼	¾	⅛	1⅝	2⅞
226323	1¼	1¼	⅛	1¾	3½
216390*	2	1¼	1 1/16	2¼	3½
216389*	2	2	1 1/16	2½	4¼

*Made of cast iron.
Approximate shipping weight 2 pounds.

Pipe mounting brackets—These brackets are made of cast iron for clamping on 1¼-inch pipe frames. They are designed for supporting, from two parallel pipes, various kinds of apparatus having one mounting bolt or for clamping two parallel pipes together 4 inches between centers of pipes.

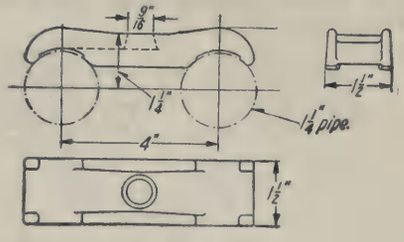


FIG. 83

Style No.
227599 Pipe mounting bracket only.
Approximate shipping weight 1 pound.

Clamps for fastening pipe to I-beam.—This is a cast iron fitting that securely clamps transverse pipe to an I-beam, as shown in Figs. 84 and 85, without the necessity of cutting or drilling either the pipe or beam.

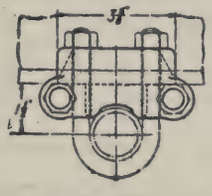


FIG. 84

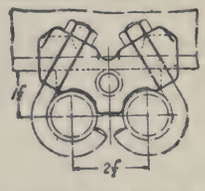


FIG. 85

Style No.
162513 Clamp for one 1¼-inch pipe.
162514 Clamp for two 1¼-inch pipes.
Approximate shipping weight 2 pounds.

The above style numbers do not include bolts, as the bolt length will vary according to size of I-beam.

In addition to above style number there should be ordered for single-pipe clamp two ½-inch machine bolts, 3¼ inches longer than width of I-beam flange; for two-pipe clamp, one ½-inch machine bolt, 3¼ inches longer than width of I-beam flange.

Pipe end clamp—This is a cast iron fitting which securely clamps a 1¼-inch pipe to an I-beam without the necessity of cutting the I-beam.

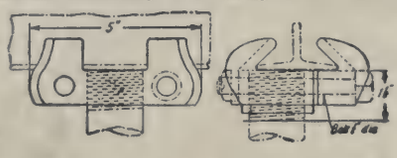


FIG. 86

Style No.
240131 Pipe end clamp.
Approximate shipping weight 2 pounds.

Order by Style Number

Wall or floor brace complete with angular adjustment, heavy duty type. This brace consists of a wall or floor clamp of the threaded type, a brace pipe clamp of the threaded type and one piece of one inch wrought iron pipe, 4 feet, 2 inches long, threaded at both ends.

Style number includes brace complete with necessary bolts

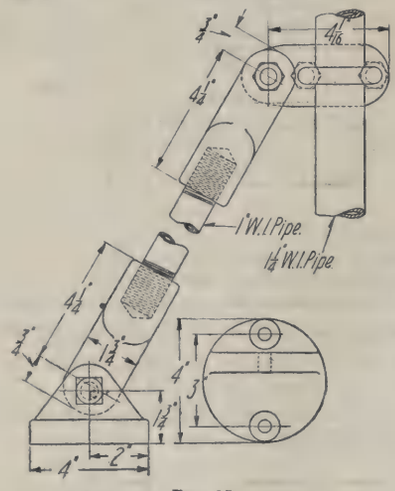


FIG. 87

Style No.	Description
130398	Wall or floor brace complete.

Approximate shipping weight 10 pounds.

Angle-iron frame mounting brace, heavy duty U-bolt type—Style No. 291181, covers complete brace with 4-foot length of pipe.

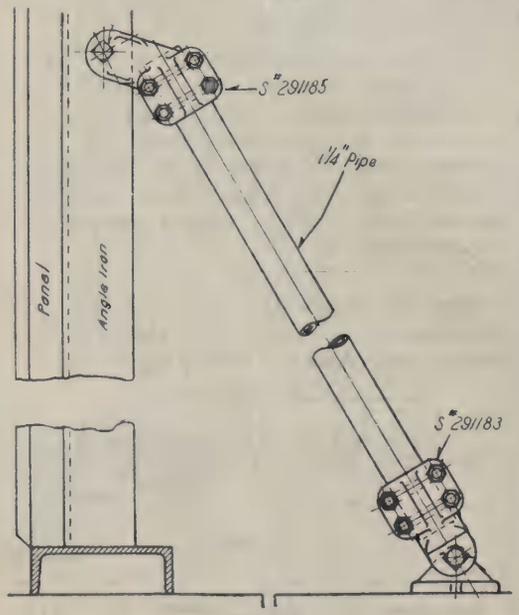


FIG. 87B

Pipe frame mounting brace, heavy duty U-bolt type—Style No. 299118, covers complete brace with 4-foot length of pipe.

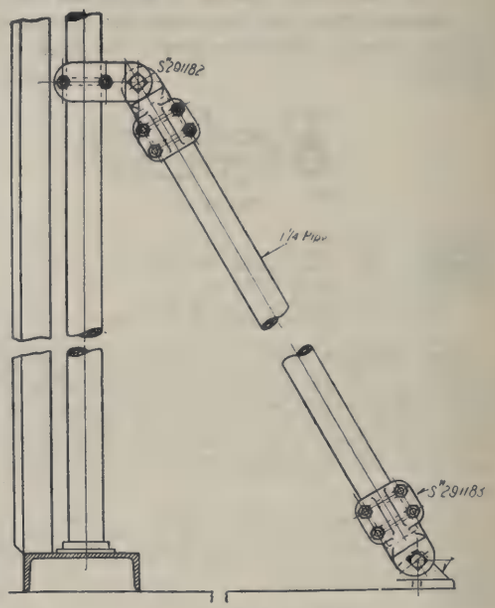


FIG. 87A

Pipe ends—These cast iron pipe ends are tapped with a straight thread of standard size, and are suitable for bolting to the angular flanges or to angular pipe tees. Straight thread is utilized to obtain adjustment between points of attachment.

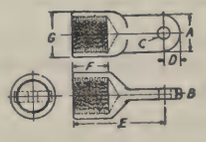


FIG. 88

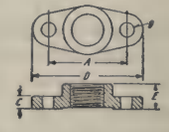


FIG. 89

Pipe End Style No.	Size Pipe, In.	FIG. 88, DIMENSIONS IN INCHES						
		A	B	C	D	E	F	G
83129	¾	1¼	11/16	33/64	.5/8	3	1 1/8	1 3/8
162517	1	1¾	½	½	¾	4¼	1½	1¾
128597	1¼	1¾	½	½	⅞	4¼	1⅝	2⅛

Approximate shipping weight 1 pound.

Pipe flange, tapped type—These flanges are made of malleable or cast iron and are tapped to receive pipe with standard pipe thread. The 1¼-inch flange is also used as the floor flange on types J and L switchboard frames.

Pipe Flange Style No.	Size Pipe Inches	Material of Flange	FIG 89, DIMENSIONS IN INCHES				
			A	B	C	D	E
162512	¾	C. I.	2⅜	⅜	⅜	3¼	¾
225654	1¼	M. I.	3⅜	⅝	⅜	4¼	¾
162510	2	C. I.	5	¾	.⅝	6½	1½

Approximate shipping weight 1 pound.

Order by Style Number

SWITCHBOARD DETAILS—Continued

Pipe brace clamp, One-U-bolt type—For ordinary applications. These brace clamps are made of malleable iron and are clamped to pipe structure by means of U-bolts. Fig. 90 shows the clamp bracing a 1¼-inch pipe to angle-iron frame.

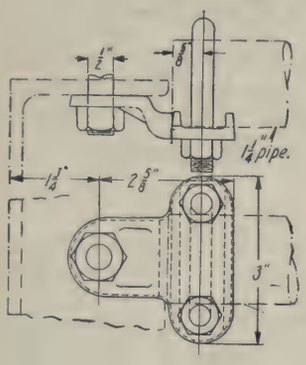


FIG. 90

Style No.
226471 Pipe brace clamp with bolts.
Approximate shipping weight 1 pound.

Pipe brace clamp, Two-U-bolt type—These are clamped to pipe structure by means of two U-bolts. Style No. 291184 covers the straight clamp complete and style No. 291185 covers the offset clamp. Style No. 291186 covers clamp for wall end.

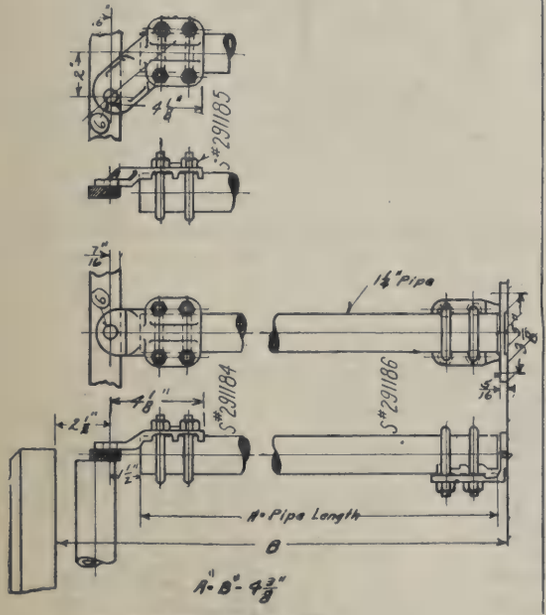


FIG. 90A

Pipe mounting bracket—This bracket is made of cast iron and is designed to be clamped to 1¼-inch pipe by means of U-bolt and to support straps or similar parts on the pipe frame.

Style number includes strap and mounting bolt.

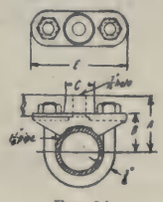


FIG. 91

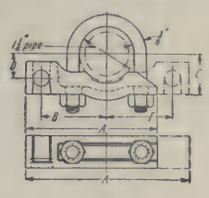


FIG. 92

Bracket Style No.	FIG 91, DIMENSIONS IN INCHES				
	A	B	C	D	E
112878	1 1/16	1¼	⅞	⅝	3¼

Approximate shipping weight 1 pound.

Pipe clamping brackets, for top iron of frame structure—These brackets are of cast iron and are designed to clamp on the top end of 1¼-inch pipe upright, forming part of a type J or L switchboard frame, and for holding the top iron of the frame to the pipe upright.

Style No. 223577 is for end bracket.

Style No. 223578 is for intermediate bracket.

Style number includes brackets and clamping bolts.

Bracket Slyle No.	FIG. 92, DIMENSIONS IN INCHES					
	A	B	C	D	E	F
223577	4¼	2	1 9/32	25/32	1	..
223578	5	2¼	1 9/32	25/32	1	2

Approximate shipping weight 1 pound.

Wall brace complete with angular adjustment, light duty type—The brace consists of a wall clamp of the U-bolt type, one piece of ¾-inch wrought iron pipe, 4 feet long, and a pipe brace clamp of the U-bolt, see Fig. 93.

Style No. 225110 includes Style Nos. 226445 and 226473 with U-bolts and 4 feet of ¾-inch pipe.

Pipe brace clamp, U-bolt clamp type, with angular adjustment—These brace clamps are made of malleable iron and are clamped to pipe structure by U-bolts. The brace end of the clamp is provided with suitable openings so that the brace pipe may be clamped at any desired angle to main pipe, angle iron, floor or wall. Fig. 94 shows the clamp for bracing to another pipe. Fig. 95 to switchboard angle iron frame, and Fig. 96 to floor or wall.

Style number includes clamp complete with U-bolts.

Order by Style Number

SWITCHBOARD DETAILS—Continued

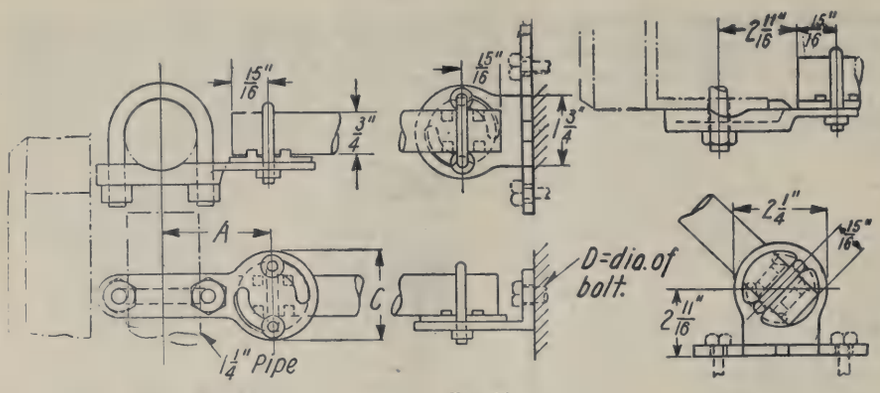


FIG. 94 FIG. 93 FIG. 95 FIG. 96

Clamp Style No.	Figure	Size of Pipe Inches	Brace To	Dimensions in Inches A	B	C	D
226445	94	3/4	1 1/4-Inch Pipe	2 11/16	15/16	2 1/4	..
238998	94	1 1/4	1 1/4-Inch Pipe	2 3/4	15/16	3 1/8	..
238706	94	3/4	2-Inch Pipe	3 3/16	15/16	2 1/2	..
226444	95	3/4	3-Inch Angle Iron	2 7/8	15/16	2 1/4	..
226473	96	3/4	Floor or Wall	1 11/16	15/16	2 3/8	3/8

Approximate Shipping Weight 6 pounds.

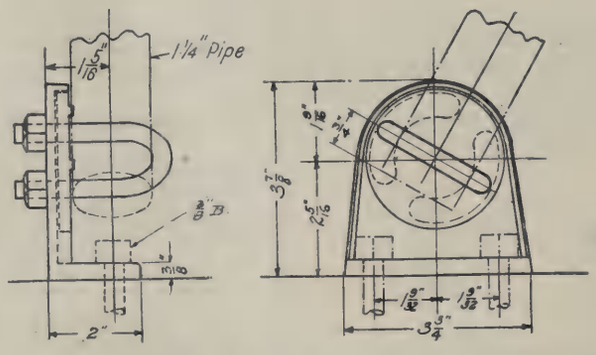


FIG. 96A

Floor brace for angular adjustment—Floor brace style No. 253700 covers brace complete with U-bolt.

Approximate Shipping Weight 6 pounds.

Barrier brackets, for pipe mounting—These cast iron brackets are designed to support asbestos lumber or micarta barriers on a pipe frame structure.

Style number includes bracket and U-bolt.

Barrier Bracket Style No.	Figure	Dimensions in Inches A	B	C	D	E	F
239027	97	2 11/16	1 15/16	3	7/8	1	1/2
239026	98	1 3/16	2 7/16	4 3/16	1/8	1 1/4	..

Approximate Shipping Weight 1 pound

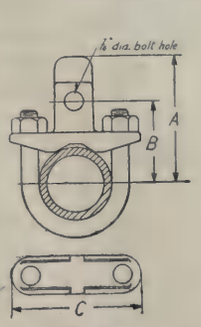


FIG. 97

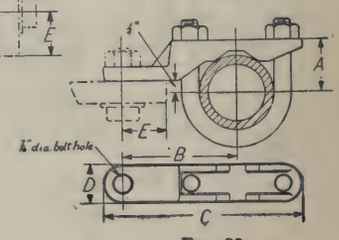


FIG. 98

Order by Style Number

SWITCHBOARD DETAILS—Continued

Mounting brackets for pipe panels.—These brackets are clamped on the pipe structure by U bolts and are designed particularly to support the switchboard panels of types J and L frames. Right hand, left hand and intermediate brackets are listed. The left hand bracket is mounted in opposite direction to right hand bracket, the intermediate bracket consists of a right hand bracket and left hand bracket bolted together by standard machine bolts.

Style number includes bracket and bolts.

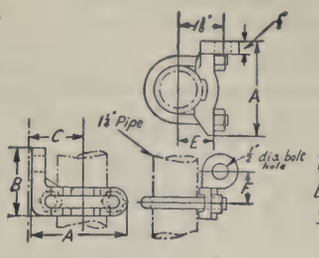


FIG. 99

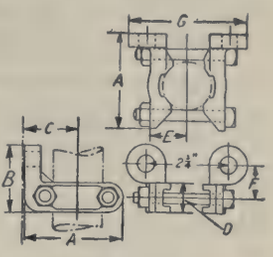


FIG. 100

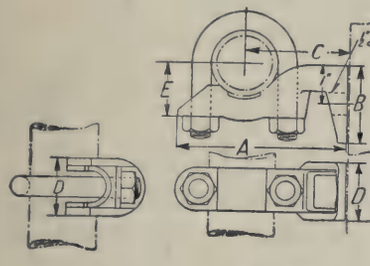


FIG. 101

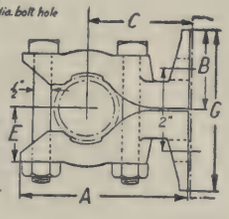


FIG. 102

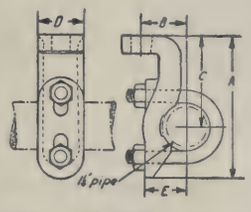


FIG. 103

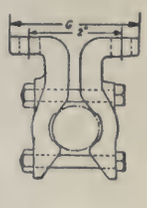


FIG. 104

Approximate Shipping Weight 1 pound.

Mounting Bracket Style No.	Direction of Mounting	Figure	Size of Pipe, Inches	Dimensions in Inches						
				A	B	C	D	E	F	G
223579	Left Hand	99	1¼	3 3/32	2¼	1¾	...	1 9/32	1⅛	...
223580	Right Hand	99	1¼	3 3/32	2¼	1¾	...	1 9/32	1⅛	...
223581	Intermediate	100	1¼	3 3/32	2¼	1¾	1	1 9/32	1⅛	4
228889	Right or Left	101	1¼	4	1 5/16	2½	1⅜	1 9/32	...	...
228890	Intermediate	102	1¼	4	1 5/16	2½	...	1 9/32	...	3⅞
239021	Right or Left	103	¾	2 1/16	1	■	1	⅞	...	...
239022	Intermediate	104	¾	...	...	...	...	...	...	2⅞

Pipe cross clamp—These clamps are made of malleable iron and are clamped to the pipe frames by U bolts. They are shaped symmetrically on each side, which permits the right angularly positioned pipes to be located in line with each other, or the pipes may be crossed as shown in Fig. 106. This clamp may be used as a pipe tee, a pipe elbow, or a pipe cross. Clamps holding pipes on either side of a perpendicular pipe will not interfere with each other, thus allowing great flexibility in design of pipe structures, see Fig. 105.

Style number includes clamp complete with two U bolts.

Clamp Style No.	Size of Pipe, Inches	Dimensions in Inches		
		A	B	C
216511A	¾ x ¾	1¾	1¾	1½
216510A	¾ x 1¼	1 3/32	2 3/32	1⅞
216509A	1¼ x 1¼	2 5/16	2 5/16	2 5/16
238703	1¼ x 2	2 5/16	2 11/16	2¾
238702	2 x 2	3	3	3⅛

Approximate shipping weight 1½ pounds.

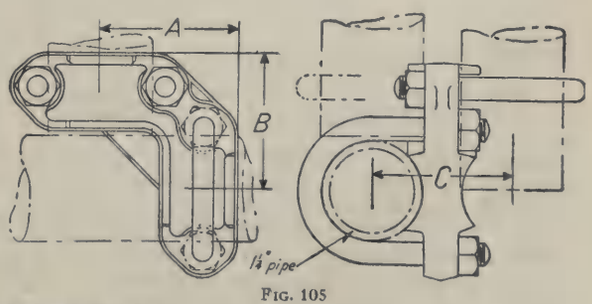


FIG. 105

Order by Style Number

Pipe cross clamp—This is a double one-piece clamp for use about the structure to give it additional rigidity.

Style No.	Size of Pipe Inches	Dimensions in Inches			Approx. Shipping Wt., Lbs.
		A	B	C	
291178	1¼x1¼	4 5/8	4 5/8	1 5/32	1
291179	1¼x2	5 3/8	5 1/8	1 9/16	1
291180	2 x2	6	6	1 9/16	1

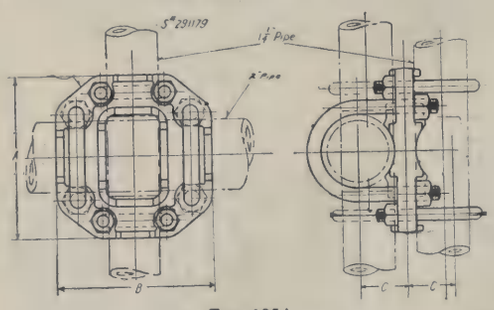


FIG. 105A

Pipe cross clamps, three to six-way, U-bolt clamp type—These clamps are made of malleable iron and are similar to the cross clamps, except that an additional clamping fixture is provided. The clamp as shown constitutes a three-way clamp, but by suitably combining two or more clamps and substituting straight bolts in place of U-bolts where required, four to six-way clamps may be made up.

Style number includes one clamp complete with three U-bolts.

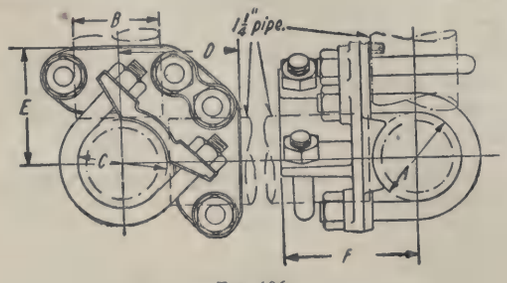


FIG. 106

Clamp Style No.	DIMENSIONS IN INCHES						Approx. Shipping Wt. Lbs.
	Pipe Sizes			D	E	F	
	A	B	C				
223411	1¼	1¼	1¼	2 5/16	2 5/16	2 5/8	2
238705	2	1¼	1¼	2 9/16	2 11/16	3 1/16	2
238704	2	2	2	3	3	3 3/16	2

Pipe flange clamps are made of malleable iron and are clamped to the pipe frame by U-bolts.

Style number includes pipe flange complete with U-bolt.

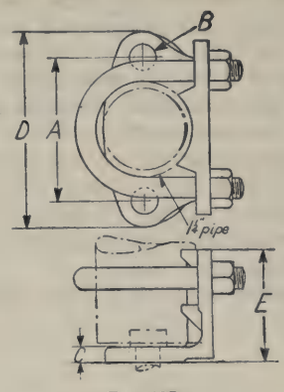


FIG. 107

Pipe Flange Clamp Style No.	Size of Pipe, Inches	Dimensions in Inches					Approx. Shipping Wt. Lbs.
		A	B	C	D	E	
226443	1¼	2 3/16	3/8	5/16	3 7/16	2	1
238707	2	4½	1½	3/8	5 1/16	2 3/16	1

Clamp for 1¼-inch pipe.—Base to wall, pipe parallel to wall. (Style No. 291187).

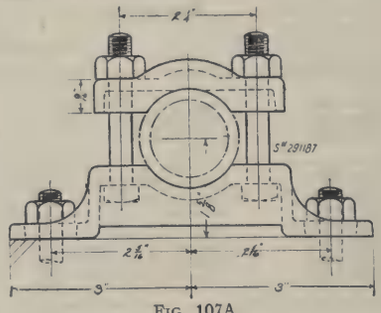


FIG. 107A

Mounting clamp brackets for pipe or angle iron frame, cast with slot in end lug, designed for general mounting. This bracket may be used as part of rheostat idlers, shown in Figs. 110 and 111.

Style number includes bracket and mounting bolt.

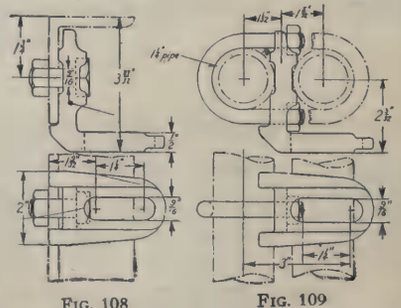


FIG. 108 FIG. 109

Style No.	Description
216449	Pipe mounting bracket, Fig. 108, for angle iron mounting.
216450	Pipe mounting bracket, Fig. 109, for frame mounting.

Approximate Shipping Weight 1 lb.

Order by Style Number

SWITCHBOARD DETAILS—Continued

Idler brackets with idlers are of cast iron, designed for mounting on angle iron or pipe frame construction, for guiding sprocket chain transmission on rear of switchboard panel, for remote control of rheostats. Various methods of arranging sprockets and chains may be applied with the use of these idler brackets.

Style number includes idler bracket, idler and mounting bolt.

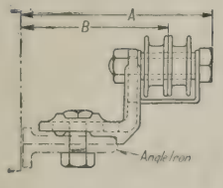


FIG. 110

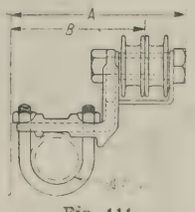


FIG. 111

Idler Bracket Style No.	Frame Mounting	Figure	Dimensions in Inches		Approx. Shipping Wt., Lbs.
			A	B	
216451	Angle Iron	110	6 1/4	4 3/4	2
216452	1 1/4 Inch Pipe	111	6 1/8	4 3/4	2
216453	1 1/4 Inch Pipe	111	9 3/8	8	2

U-bolts for wrought iron pipe are listed in iron and brass.

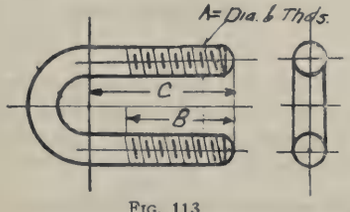


FIG. 113

Style No.	Size of Pipe	Dimensions in Inches			Radius
		A	B	C	
IRON BOLTS					
127932	1 1/2	1/2-13	3/4	3 21/32	
124586	1 1/2	1/2-13	1 1/8	1 27/32	
127800	1 1/2	1/2-13	1 1/4	2 5/32	
127933	1 1/2	5/8-16	1	1 11/16	
210697	1 1/4	5/8-16	7/8	2	
192929	3/4	5/16-18	1	2 5/8	
192930	3/4	5/16-18	1	1 3/8	
BRASS BOLTS					
247149		3/8-16	1 7/8	1	1 1/32
247150		3/8-16	1 1/2	1	31/32
247151		3/8-16	1 1/16	7/8	15/16
247152		3/8-16	1 7/16	7/8	15/16
247153		3/8-16	2 1/8	1	1 1/16
247154		3/8-16	1 7/8	1	1 1/32
247155		1/4-20	1 3/16	5/8	7/8
247156		1/4-20	1 9/16	3/4	9/16
247157		5/16-18	1 3/16	3/4	9/16
247158		5/16-18	1 1/32	7/8	13/32
247159		1/4-20	1 1/2	7/8	15/16
247160		1/4-20	1 1/4	3/4	23/32

Shunt lead holder — For mounting on rear of board to take up slack shunt leads.

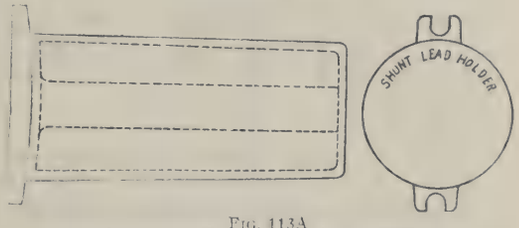


FIG. 113A

Style No.	Approx. Shipping Weight, Lbs.
271177	2

Order by Style Number

SWITCHBOARD DETAILS—Continued

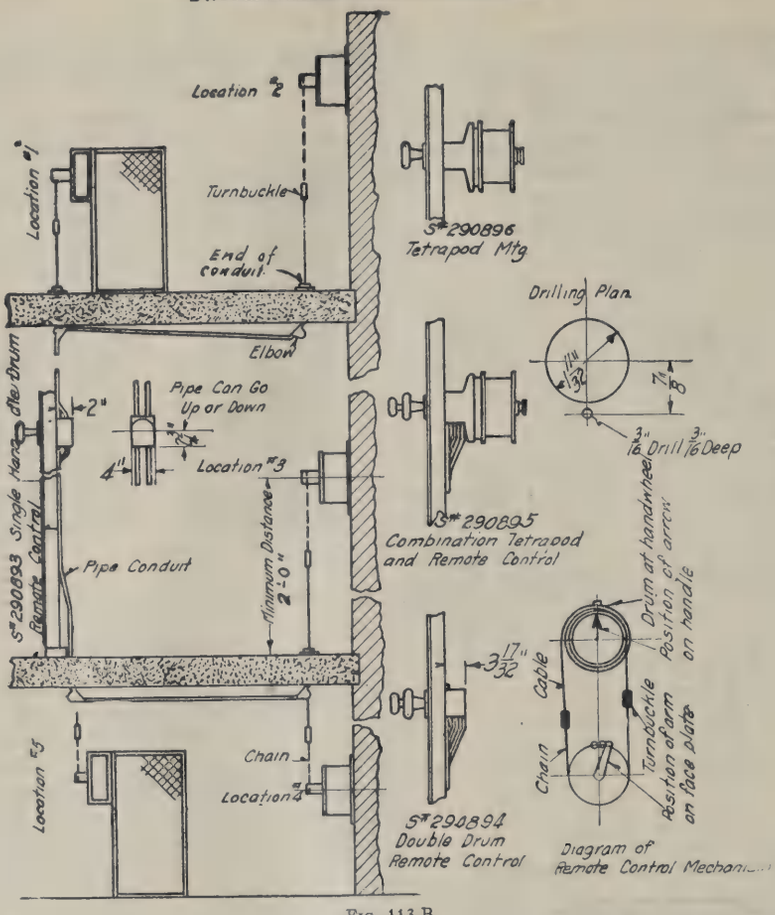


FIG. 113 B

Switchboard mountings and control mechanisms for rheostats—The tetrapods for supporting rheostats (with 4 mounting bolts) at the switchboard will accommodate rheostats with a minimum of 5¾ inches and a maximum of 11¼ inches between bolt centers. Remote hand-control rheostats are operated from the handwheel on the front of the switchboard through a system of drum and cable transmission at the switchboard to a chain and sprocket at the rheostat. At the switchboard, the cable is enclosed in pipe conduit, thus eliminating all danger of short circuits on the panel due to a broken chain or cable falling against the connections.

The handwheels are made of black moulded material and have a black highly polished finish.

Cable conduit may be run from the cable drum housing at the panel to a point not less than 2 feet from the sprocket at the rheostat. Conduit should be ⅛-inch pipe with smooth inside surfaces and all ends reamed to prevent abrasion of cable. Conduit may be bent for small angles on a radius of not less than 6 inches. For 90-degree bends use roller elbows. Extra roller elbows and conduit which are provided with mounting holes, may be ordered as required. Conduit should be supported at bends.

Cable adjustment and installation—At the middle point of the cable, open the strands and fasten to the drum with screw and washer as provided. Arrange drum, handwheel, sprocket, turnbuckles, chain and cable in relative position as shown in sketch, tighten turnbuckles to take up slack. With pointer vertical, rheostat resistance to be all out, turn handwheel to right until other extreme position is reached and mark position of the pointer on dial plate.

Style number for remote-control mechanism includes (in addition to mechanisms mounted on the switchboard panels) cable, chain, 2 turnbuckles, and four ⅛-inch pipe roller elbows for 10-foot run between drum at the panel and sprocket at the rheostat. The **style number** does not include the rheostat, rheostat sprocket, or ⅛-inch pipe conduit.

Style No.	Description	Approx. Ship. Wt., Lbs.
290893	Single Handwheel—Remote Control	5
290894	Double Handwheel—Remote Control	8
290895	Double Handwheel—Combination Tetrapod and Remote Control	20
290896	Single Handwheel—Tetrapod Mounting	15

Order by Style Number

SWITCHBOARD DETAILS—Continued

Shunt supporitng brackets of cast iron, for supporting ammeter shunts on the rear of switchboard panels and are intended to relieve the ammeter shunt of the weight of outgoing cable.

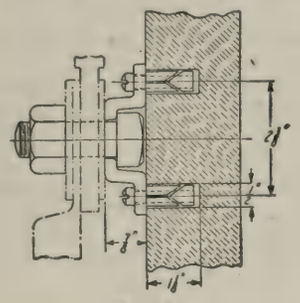


FIG. 114

Style No.	Description
217236	Shunt supporting bracket with expansion sleeves. Shunt bolts to be ordered separately to suit requirements.

Approximate shipping weight 1 pound.

Meter swivel brackets suitable for any Westinghouse round type meters, 7 inches or 9 inches diameter, and are intended for mounting in upright position on top of iron structure of types E, G, J or L swithcboard frames. Bracket is swiveled so that the face of the meter may be turned in any desired position.

Style number and list price include bracket and mounting bolts, as shown in full lines.

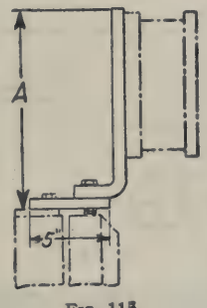


FIG. 115

Approximate shipping weight 5 pounds.

Swivel Bracket Style No.	Size of Meter, Inches	Dimension A Inches
164970	9	11 5/8
168824	7	9 3/8

Meter swivel brackets for mounting one Westinghouse illuminated dial meter on top iron of frame construction of types E, G, J or L switchboard frames.

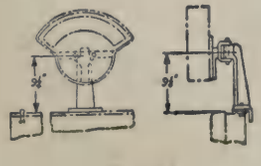


FIG. 116

Style No.
239799 Meter swivel bracket with mounting bolts.

Approximate shipping weight 5 pounds.

Meter swivel brackets suitable for mounting 3 or 4 Westinghouse round type meters, 7 inch diameter, on the top iron of frame structure of types E, G, J or L switchboard frames.

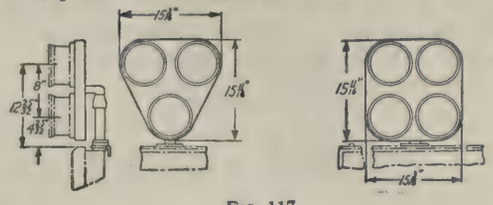


FIG. 117

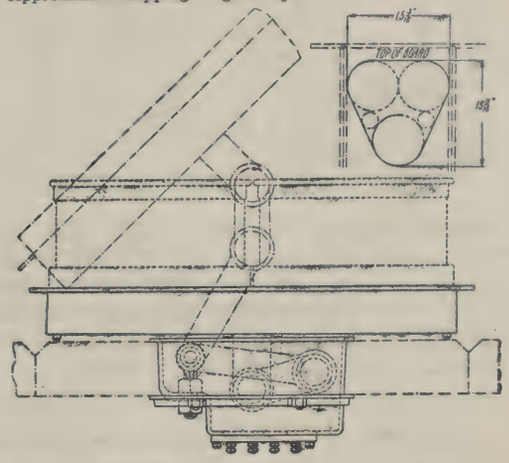
Style No.
239179 Meter swivel bracket with mounting bolts for mounting three meters.
239178 Meter swivel bracket with mounting bolts for mounting four meters.

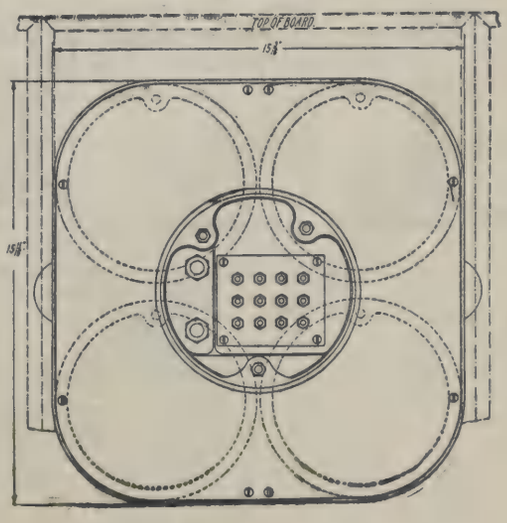
Approximate shipping weight 15 pounds.

Meter swivel brackets for mounting Westinghouse round type meters of 7 inches diameter, except for polyphase wattmeters, on face of switch board panel. These brackets may be turned at various angles to face of panel or pushed back when desired.

Style No.
238991 Bracket complete for three meters, Fig. 118.
238992 Bracket complete for four meters, Fig 119.

Approximate shipping weight 20 pounds.





FIGS. 118 AND 119

SWITCHBOARD DETAILS—Continued

Panel swinging brackets designed for mounting a 2-inch swinging panel. The bracket is hinged so that the face of the panel may occupy any desired position from one parallel to the face of the board to one at right angle to switchboard. When used with switchboard pipe frame, the brackets must be located so as to clear panel mounting bracket.

Style number includes bracket only.

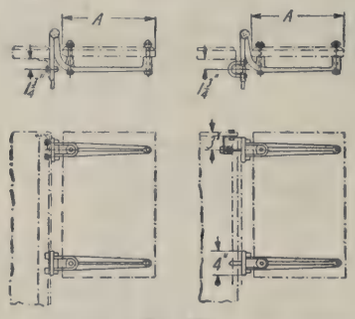


FIG. 120

Swinging Bracket Style No.	Width of Panel Inches	Dimension A Inches	Frame Mounting	Approx. Shipping Wt.,Lb.
217863	12	12	Angle Iron	10
217864	16	16	Angle Iron	10
217865	20	20	Angle Iron	10
217866	24	24	Angle Iron	10
217867	12	12	Pipe	10
217868	16	16	Pipe	10
217869	20	20	Pipe	10
217870	24	24	Pipe	10

Meter swinging bracket for Westinghouse illuminated dial meters.

Style number and list price include bracket and mounting bolts.

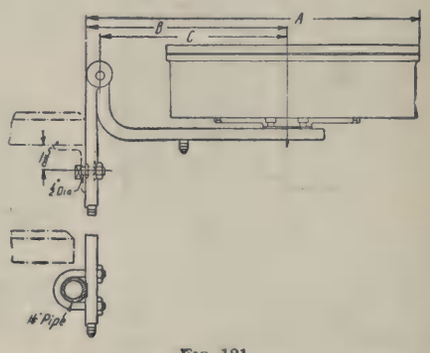


FIG. 121

Bracket Style No.	Frame Mounting	Dimensions in Inches			Approx. Shipping Wt.,Lb.
		A	B	C	
177513	Angle Iron	21	12¾	11⅞	10
238990	1¼ Inch Pipe	21	12¾	11⅞	10

Meter swinging bracket suitable for any Westinghouse round type, 7 inch or 9 inch meters except polyphase wattmeters. Bracket is hinged so that the face of the meter may occupy any desired position from one parallel to the plane of the board to one at right angles to the board.

Style number includes bracket and mounting bolts.

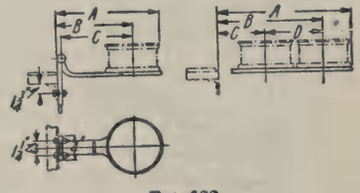


FIG. 122

Swinging Bracket, Style No.	Size of Meter Inches	Number of Meters per Bracket	Frame Mounting	Dimensions in Inches			
				A	B	C	D
217858	9	1	Angle Iron Frame	18	13	12 3/16	..
217861	9	2	Angle Iron Frame	23	18	8	10
217859	9	1	1¼ Inch Pipe	18 11/16	13 11/16	12 3/16	..
217862	9	2	1¼ Inch Pipe	23 11/16	18 11/16	8 11/16	10
217852	7	1	Angle Iron	14⅜	10½	9 11/16	..
217855	7	2	Angle Iron	18⅜	14½	6½	8
217853	7	1	1¼ Inch Pipe	15 5/16	11 5/16	9 11/16	..
217856	7	2	1¼ Inch Pipe	19 5/16	15 5/16	7 3/16	8

Order by Style Number

SWITCHBOARD DETAILS—Continued

Metal Switchboard Caps—These caps are used for covering holes in panels drilled for future installation of apparatus.

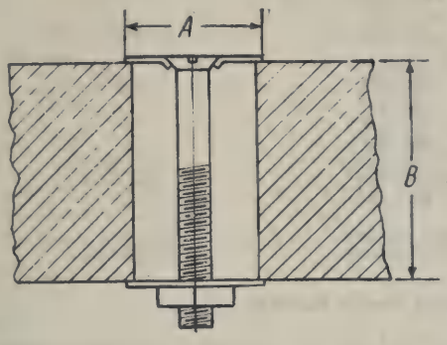


Fig. 124

Style No.	Dimensions in Inches	
	A	B
282799	½	2
282800	⅝	2
282801	⅞	2
282802	½	1½
282803	⅝	1½
282804	⅞	1½
282805	1¼	2
282806	1¾	2
282807	2⅜	2
282808	3½	2
282809	4⅜	2
285459	1¼	1½
285460	1¾	1½
285461	2⅜	1½
285462	3½	1½
285463	4⅜	1½

Uninsulated bolts for types E, G, L, and J switchboard frames. Style number includes bolt with soft rubber washer, standard hexagon nut and black marine finished bolt head and washer for front of panel

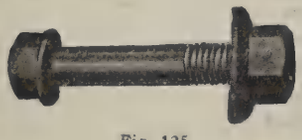


Fig. 125

Style No.	Length of Bolt-Inches	Thickness of Pipe Frame	Panel-Inches Angle Frame
253102	2	¾	1
253103	2¼	1	1¼
253104	2½	1¼	1½
253105	2¾	1½	...
253106	3	...	2
253107	3¼	2	...
253108	3½	...	2½
253109	3¾	2½	...
253110	4	...	3
253111	4¼	3	...

Insulated bolts for types E, G, L and J switchboard frames—Style number includes bolt with fiber bushing, rubber washer and black marine finished bolt head and washer.

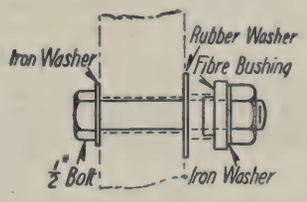


Fig. 126

Style No.	Length of Bolt-Inches	Thickness of Pipe Frame	Panel-Inches Angle Frame
253112	2¼	¾	1
253113	2½	1	1¼
253114	2¾	1¼	1½
253115	3	1½	...
253116	3¼	...	2
253117	3½	2	...
253118	3¾	...	2½
253119	4	2½	...
253120	4¼	...	3

Fancy hexagon nuts, black marine finish, may be used with the bolts just described, or any standard iron bolt.

Style number applies to nuts finished in black marine.

Style No.	Diameter Bolt Inches	Threads per Inch
7559-A	⅜	16
7560	½	13

Fig. 127

Beveled washers, black marine finish, are for use with nut shown in Fig. 127.

Style No.	Diameter Bolt	Thickness
3379	⅜	⅛
3380	½	⅛

Card holders—These card holders are designed for mounting on the front of panels to hold cards giving name of the machines or circuits controlled and are finished in black marine.

Style No.	Overall Dimensions in Inches	Size of Opening in Inches
55190-A	2½ x 1¼	1¾ x ¾
55191-A	3 x 1⅜	2¼ x ¾

Fig. 128

Caps for ends of pipes.

Cap. Style No.	Size of Pipe
240529	¾
240530	1¼
240531	2

Approximate shipping weight 1 pound.

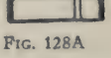


Fig. 128A

Order by Style Number

SWITCHBOARD DETAILS—Continued

Calibrating Terminals for Secondary Circuits. For conveniently making connections for the calibration of instruments. The thumb nuts are made of insulating material.

Style No.	Description
281442	One Current Coil Terminal*
275984	One Removable Link
281443	One Voltage Coil Terminal.

*Includes one stud only with necessary nuts and terminals.

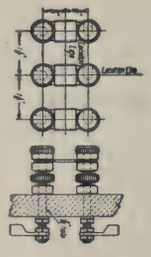


Fig. 129 Current Coil Terminal

Fig. 130 Voltage Coil Terminal

Terminal Posts for Switchboard Small Wiring

Figure 131 shows a convenient and inexpensive terminal post for terminating the small wiring on rear of switchboard panels. The post provides one set of crimp washers and lock-nuts for the permanent connections from the panel, and another set for the outgoing lead. These posts are set directly in the rear of the panel with a setting tool and are intended to be located when the wiring of the panel is done. Each post requires a hole in the panel 5/8-inch diameter and 3/4-inch deep.

Style No.	Description
280279	Terminal Post
281441	Setting Tool

FIG. 131

NAMEPLATES

Nameplates on the switchboard for identifying the switchboard apparatus with the circuits or machines controlled, add materially to the security of operation. The name plates here listed are 3 inches wide and 1 inch high, are fastened to the panels with brass escutcheon pins and are neat and pleasing in appearance. The letters and rim are polished copper on black matt.

Order by name plate number. Nameplates with other lettering than here listed will be supplied as ordered at a list price of $5.00 for first plate and $ .60 for each duplicate plate.

Lettering on Nameplate	Nameplate No.
A. C. Rotary No. 1	1172
A. C. Generator Field	1928
A. C. Generator	1938
Air Compressor	1797
Air Pressure	1974
Air Pump	1847
Alternating Current, Light	796
Alternating Current, Power	797
Alternating Current, Street Service	870
Arc Lights	2792
Auditorium	821
Auxiliary Bus	3017
Auxiliary Bus Running	3024
Auxiliary Bus Starting	3025
Bal. Coil No. 1	883
Bal. Coil No. 2	884
Basement	1771
Battery	3045
Boiler Feed Pump	862
Boiler House	2353
Boiler Room	2262
Building No. 1	2347
Building No. 2	2348
Building No. 3	2349
Building No. 4	2350
Bridge	2279
Calibrating Voltmeter	3471
Car Department	2839
Channel	2276
Charge	3044
Circuit No. 1	3614
Circuit No. 2	3615
Circuit No. 3	3616
Circuit No. 4	3617
Circuit No. 5	3618
Circuit No. 6	3619
Circuit No. 7	3620
Circuit No. 8	3621

Order by Style Number

SWITCHBOARD DETAILS—Continued

Nameplates—Continued

Lettering on Nameplate	Nameplate No.
Circuit No. 9	3622
Circuit No. 10	3623
Circulating Pump	1856
Control No. 1	3046
Control No. 2	3047
Control No. 3	3048
D. C. Panel	935
D. C. Rotary No. 1	1171
D. C. Street Service	887
Direct Current Generator	812
Direct Current Laboratory	810
Direct Current, Power	811
Discharge	3043
Dredger	3070
Emergency Line	2644
Emergency Switch	2417
Emergency Switches	2698
Equalizer	888
Equalizer Rheostat	2775
Equalizer Switch	3457
Exchange	3069
Engine Generator, Field	806
Engine Generator	799
Exciter	2181
Exciter Bus	3016
Exciter No. 1	816
Exciter No. 2	817
Exciter No. 3	2684
Exciters	815
Exhaust Fan	1689
Fans	1467
Fan No. 1	1685
Fan No. 2	1686
Feeder No. 1	2029
Feeder No. 2	2030
Feeder No. 3	2031
Fire Pump	2566
General Power Circuit	2565
Generator	2182
Generator No. 1	1682
Generator No. 2	1683
Generator No. 3	1981
Generator No. 4	2820
Generator No. 5	2817
Generator No. 6	2814
Generator Voltmeter Switch	3477
Ground Detectors	2800
Ground Detector Lamps	3479
Gymnasium	2645
Incoming	2355
Incoming Line	2797
Laboratory	1470
Laundry	3517
Light	2795
Lights	2424

Lettering on Nameplate	Nameplate No.
Light Main	2663
Lighting System	2646
Line No. 1	947
Line No. 2	958
Line No. 3	959
Line No. 4	961
Local Feeders	3154
Local Service	2823
Main Bus	3015
Main Bus Running	3022
Main Bus Starting	3023
Main Control	1712
Main Light Breaker	1822
Main Light Switch	3514
Main Line	1462
Main Power Breaker	1823
Main Power Switch	3515
Main Switch	1798
Motor	2230
Motors	2354
Motor Circuit	2642
Motor Generator, Running	867
Motor Generator, Starting	868
Motor No. 1	2027
Motor No. 2	2028
Negative	814
Negative D. C. Generator	882
Neutral Switches	1434
Night Lights	1855
No. 1 Feeder Circuit	1939
No. 2 Feeder Circuit	1940
No. 1 Motor	2696
No. 2 Motor	2697
No. 3 Motor	2758
No. 4 Motor	2759
No. 1 Rotary	2243
Panel A	1824
Panel B	1825
Panel C	1826
Panel D	1827
Panel E	1828
Panel F	1829
Panel G	1830
Panel H	1831
Panel J	1832
Panel No. 1	1697
Panel No. 2	1698
Panel No. 3	1699
Positive	813
Positive A. C. Generator	880
Power	3510
Power Feeder No. 1	2023
Power Feeder No. 2	2022
Power Feeder No. 3	2021
Power Feeder No. 4	2024

SWITCHBOARD DETAILS—Continued

Nameplates—Continued

Lettering on Nameplate	Nameplate No.
Power Feeder No. 5	2025
Power Feeder No. 6	2026
Power House Lighting	2563
Power House Lights	1178
Power Line	2639
Power Main	2661
Pump No. 1	952
Pump No. 2	955
Pump No. 3	956
Pump No. 4	957
Pump No. 5	2486
Rotary	2229
Running Position	1220
Second Position	2751
Service Light	2550
Service Power	2546
Single Phase Teaser Transformer	2647
Single Phase Transformer	2648
Spare Transformer	2638
Starting Position	1219
Storage Battery	3150
Supply	1857
Synchronous Motor	1925
Synchronous Motor	1941
Transformer	2798
Transformer No. 1	1174
Transformer Bank No. 1	2636
Transformer Bank No. 2	2637
Transformer Bank No. 3	2825
Transformer Bank No. 4	2819
Transformer Bank No. 5	2816
Transformer Bank No. 6	2813
Transformer and Line No. 1	3152
Transformer and Line No. 2	3153
Turbine Generator	798
Valve Control	944
Voltage Regulator	3151
Water Pressure	1973
Water Pump	2183
1st Floor	2491
2d Floor	1773
3d Floor	1774
4th Floor	1775
5th Floor	1776
6th Floor	1777
7th Floor	1778
8th Floor	1779
9th Floor	1780
10th Floor	1781
10 K. W. Exciter	2847
20 K. W. Exciter	2848
35 K. W. Exciter	1923
50 K. W. Exciter	1937

BUS BAR COPPER

Copper straps suitable for bus and strap connections are listed below. The straps are hard, cold rolled or drawn to size; they have a conductivity of 98 per cent., of Matthiesson's standard and are supplied in lengths of from 10 to 14 feet.

As a general indication of the amount of copper required for any particular connection, the carrying capacity of single-strap and two-strap connections are given in the table below. These values are not good for more than two straps in one connection, for above this, the conditions of installation, such as spacing between straps and spacing between adjacent bus-bars for alternating current, greatly affect the temperature rise.

Briefly, the capacity of the bus is increased by making the spacing between straps of the same bus greater, amounting to an increase of approximately 25 per cent. for ¼ inch spacing, instead of ⅛ inch spacing. On alternating current buses, mounted adjacent to each other, the mutual induction of returning circuits increases the heating greatly.

Attention is called to the fact that straps ⅛ inch in thickness should be used rather than half the number of ¼ inch straps, as the radiating surface is greater.

Prices will be quoted on application.

Size of Strap		Weight in in Pounds per 1000 Feet	Carrying Capacity Amperes 20 degrees C Rise	
Thickness, Inches	Width, Inches		One Strap, A. C. or D. C. Amperes	Two Strap, D. C. ⅜" Space between Straps Amperes
⅛	½	240	100	....
⅛	1	240	150	....
¼	1	480	200	....
⅛	1½	720	300	....
⅛	2	960	400	....
⅛	2	1925	550	....
¼	3	1440	600	1075
⅛	3	2885	850	1500
¼	4½	2165	925	1600
⅛	4½	4330	1250	2250
¼	6	2885	1225	2125

TYPE OA WATTHOUR METERS

ALTERNATING CURRENT

SINGLE-PHASE METER

Low maintenance cost and long-life accuracy are features equal in importance to initial accuracy. This fact has been kept in mind in developing and constantly improving the type OA meters. The permanence of the calibration of these meters results in the least loss of revenue from inaccuracy, and entails the least cost for service tests. Their durable mechanical construction minimizes the renewal of parts.

Operation

The type OA watthour meters operate on the induction principle. The torque that rotates the disk is proportional to the product of voltage, current and power factor of the circuit, and is counterbalanced by a retarding force exactly proportional to the speed. The speed of rotation is, therefore, proportional to the power in the circuit.

Distinctive Features

Mechanical—One-piece cast-iron case; all parts mounted on central cast-iron frame; perfect dust-proofing; covers easily removed and sealed; ball-bearing moving element; two permanent magnets clamped together as a unit; low-speed worm.

Electrical—High ratio of torque to weight of moving element, insuring long life accuracy; accurate within close limits over a wide range; accurate on varying voltage; accurate on varying frequency; nor affected by wave form, power factor, or external fields; permanent magnets shielded from electromagnets; low shunt loss.

Arrangement—Four-index dial arranged in straight line; micrometer full-load adjustment; micrometer light-load adjustment; both adjustments accessible from front of meter and only a screwdriver required; meter cover need not be removed at installation; shunt field connections made in terminal chamber.

Construction

All parts of the meter element are mounted on a supporting casting and can be removed from the case as a unit without changing the calibration. The moving element is of the disk type, acted on by the electromagnets at one edge and the permanent magnets at the opposite edge. The electromagnet punchings are in one piece, and shifting of one part

SINGLE-PHASE METER
(Cover Removed)

with reference to another is thus obviated. They form a closed magnetic circuit, a feature that makes the meter remarkably free from the effects of stray fields.

Case and Cover—The case is of cast iron and the covers of pressed zinc with dead black finish, or of glass. The cover is fitted with a dust-proof gasket and the glass windows are sealed. These precau-

For switchboard-type watthour meters see section on "Instruments and Relays"

A.C. WATTHOUR METERS, TYPE OA—Continued

tions absolutely prevent the entrance of dust, which would in time cause friction errors.

Terminal Chamber—A separately sealed terminal chamber is provided at the bottom, separated by a dust-proof partition from the meter chamber. The main cover does not have to be removed at installation, and no dust can enter the meter in making the connection. Leads enter at the bottom in the single-phase meters, and at the sides in the polyphase.

Register—The registering mechanism is designed for minimum friction.

Ratchet Attachment—A ratchet attachment to prevent backward registration will be furnished for a net additional price of **$1.00** if ordered with meter.

Bearings—The main (lower) bearing is a highly polished and hardened steel ball resting between two sapphire cup jewels. The minute gyrations of the shaft give the ball a rolling action which makes a very low coefficient of friction and, by presenting constantly new bearing surface, gives an extremely long life. The upper bearing is a self-oiling guide bearing.

Torque and Weight—The ratio of torque to weight in type OA meters is very high, insuring a long life and freedom from friction errors for long periods. A higher torque or lower weight of disk would require permanent magnets of greater strength than long experience has indicated as practicable without danger of weakening.

Connections—Both sides of the circuit are brought into the terminal chamber, and the shunt connection is in this chamber. Left-hand feed is standard.

Adjustments—The ends of the permanent magnet support slide in machined grooves and are each clamped by two screws. This prevents deflecting the magnets in tightening the clamping screws after making micrometer full-load adjustment. A micrometer light-load adjustment, absolutely independent of current, is provided, The only tool required to make adjustments is a screwdriver.

Three-wire meters are identical in appearance with the two-wire. The rated current is that in each outside wire.

POLYPHASE METERS

Polyphase Meters—Polyphase type OA meters are based on the same mechanical and electrical principles that have made the single-phase meters so successful. Each meter is in reality two single-phase meter elements supported on one mounting frame, both moving elements being mounted on a common shaft and driving a common register.

When properly connected, these meters indicate the true power in a two-phase three-wire or four-wire, or a three-phase three-wire circuit, regardless of the power factor or the degree of unbalance between phases.

Capacity—The rated current capacity of the polyphase meter is that in each wire of the circuit; the rated voltage is that across each phase.

Approximate Dimensions (Inches) and Weights

	Width	Height	Depth	Weight Net	Weight Boxed
Single Phase Meters	6½	8⅞	6½	9½	11
Polyphase Meters	10	12	5¼	29	36

The Reputation of Westinghouse Watthour Meters for Sustained Accuracy Rests upon the Ball-Bearing

SINGLE-PHASE SELF-CONTAINED METERS

Left-Hand Feed

Style number and list price include meter complete with metal or glass cover as listed, ready for installation.

Capacity Volts	Amps.	Kw.	25-Cycle Style Nos. Metal Cover	Glass Cover	List Price	40-Cycle Style Nos. Metal Cover	Glass Cover	List Price	60-Cycle Style Nos. Metal Cover	Glass Cover	List Price
Two-Wire											
100	5	.5	183728	183763	$11 60	170780	170790	$10 90	161363	161373	$10 90
100	10	1	183729	183764	13 45	170781	170791	12 75	161364	161374	12 75
100	15	1.5	183730	183765	15 10	170782	170792	14 40	170818	170824	14 40
100	25	2.5	183732	183767	18 10	170784	170794	17 40	170820	170826	17 40
100	50	5	227216	227225	24 50	224769	224793	23 80	224817	224851	23 80
100	75	7.5	227217	227226	28 20	224770	224794	27 50	224818	224852	27 50
100	100	10	183736	183771	30 85	224771	224795	30 15	224819	224853	30 15
100	150	15	227218	227227	33 20	224772	224796	32 50	224820	224854	32 50
100	200	20	183738	183773	34 20	224773	224797	33 50	224821	224855	33 50
100	300	30	183739	183774	34 90	224774	224798	34 20	224822	224856	34 20
200	5	1	183740	183775	12 95	195521	195549	12 25	195570	195582	12 25
200	10	2	183741	183776	14 75	195522	195550	14 05	195571	195583	14 05
200	15	3	183742	183777	16 45	195523	195551	15 75	195572	195584	15 75
200	25	5	183744	183779	19 80	195525	195553	19 10	195574	195586	19 10
200	50	10	227219	227228	26 50	224775	224799	25 80	224823	224857	25 80
200	75	15	227220	227229	30 20	224776	224800	29 50	224824	224858	29 50
200	100	20	183748	183783	32 85	224777	224801	32 15	224825	224859	32 15
200	150	30	227221	227230	35 55	224778	224802	34 85	224826	224860	34 85
200	200	40	183750	183785	36 90	224779	224803	36 20	224827	224861	36 20
200	300	60	183751	183786	37 60	224780	224804	36 90	224828	224862	36 90
400	5	2	195391	195403	14 55	195415	195427	13 85	195463	195475	13 85
400	10	4	195392	195404	16 45	195416	195428	15 75	195464	195476	15 75
400	15	6	195393	195405	18 20	195417	195429	17 50	195465	195477	17 50
400	25	10	195395	195407	21 85	195419	195431	21 15	195467	195479	21 15
400	50	20	227222	227231	28 90	224781	224805	28 20	224829	224863	28 20
400	75	30	227223	227232	32 60	224782	224806	31 90	224830	224864	31 90
400	100	40	195399	195411	35 30	224783	224807	34 60	224831	224865	34 60
400	150	60	227224	227233	38 45	224784	224808	37 75	224832	224866	37 75
400	200	80	195401	195413	40 40	224785	224809	39 70	224833	224867	39 70
400	300	120	195402	195414	41 10	224786	224810	40 40	224834	224868	40 40
Three-Wire											
100-200	5	1	183752	183787	12 95	170785	170795	12 25	161367	161377	12 25
100-200	10	2	183753	183788	14 75	170786	170796	14 05	161368	161378	14 05
100-200	15	3	183754	183789	16 45	170787	170797	15 75	170821	170827	15 75
100-200	25	5	183756	183791	19 80	170789	170799	19 10	170823	170829	19 10
100-200	50	10	227234	227236	26 50	224789	224813	25 80	224847	224881	25 80
100-200	75	15	227235	227237	30 20	224790	224814	29 50	224848	224882	29 50
100-200	100	20	183760	183795	32 85	224791	224815	32 15	224849	224883	32 15
100-200	150	30	183762	183797	35 55	224792	224816	34 85	224850	224884	34 85

500-volt 60-cycle meters can be supplied on special order at the same price as 400-volt meters of the same ampere capacity

133-cycle meters can be supplied on special order at same price as 60-cycle meters.

SINGLE-PHASE METERS FOR USE WITH TRANSFORMERS

Left-Hand Feed

These meters are arranged for use with current transformers with 5-ampere secondaries, for current capacities higher than those listed in the preceding table. The 100-volt meters listed below can be used with voltage transformers with 100-volt secondaries for voltages higher than those listed.

Style number and list price include 5-ampere meter of the voltage listed, for use with transformers, but do not include transformers. When a meter is desired with register reading directly in kilowatt-hours in the primary circuit, it should be ordered as: "Meter similar to Style No. (give Style No. of 100-volt meter from the following table), except with register for...../5-ampere and...../ 100-volt transformer;" or "Meter similar to Style No. (give Style No. of 200, or 400-volt meter from the following table), except with register for...../5-ampere transformer." Price for the meter with register as ordered will be the same as for meter listed. Transformers should be added at regular prices.

Capacity Volts	Amps.	Kw.	25-Cycle Style Nos. Metal Cover	Glass Cover	List Price	40-Cycle Style Nos. Metal Cover	Glass Cover	List Price	60-Cycle Style Nos. Metal Cover	Glass Cover	List Price
Two-Wire											
100	5	.5	183954	183957	$14 60	195533	195561	$13 90	183960	183963	$13 90
200	5	1	183955	183958	15 95	195534	195562	15 25	183961	183964	15 25
400	5	2	.....	.....	.....	224787	224811	16 85	224845	224879	16 85
Three-Wire											
100-200	5	1	183956	183959	15 95	195541	195569	15 25	183962	183965	15 25

133-cycle meters can be supplied on special order at same price as 60-cycle meters.

Order by Style Number

POLYPHASE SELF-CONTAINED METERS

Left-Hand Feed

The style number and list price include self-contained meter only, which does not require either voltage or current transformers. Meters as listed are for two-phase or three-phase, three-wire circuits and have metal covers.

Current Per Wire Amp.	Kw.	Style No. 25-Cycle	40-Cycle	60-Cycle	List Price
		100 Volts			
5	½	230486	224296	224329	$34 40
10	2	230487	224297	224330	37 05
15	3	230488	224298	224331	39 25
25	5	230489	224299	224332	42 35
50	10	230490	224300	224333	48 50
75	15	230491	224301	224334	52 90
100	20	230492	224302	224335	56 10
150	30	230493	224303	224336	60 00
200	40	230494	224304	224337	63 50
300	60	230495	224305	224338	70 55
		400 Volts			
5	4	230506	224316	224349	46 75
10	8	230507	224317	224350	49 40
15	12	230508	224318	224351	51 60
25	20	230509	224319	224352	54 70
50	40	230510	224320	224353	60 85
75	60	230511	224321	224354	65 25
100	80	230512	224322	224355	68 45
150	120	230513	224323	224356	72 35
200	160	230514	224324	224357	75 85
300	240	230515	224325	224358	82 [illegible]

Current Per Wire Amp.	Kw.	Style No. 25-Cycle	40-Cycle	60-Cycle	List Price
		200 Volts			
5	2	230496	224306	224339	$38 80
10	4	230497	224307	224340	41 45
15	6	230498	224308	224341	43 65
25	10	230499	224309	224342	46 75
50	20	230500	224310	224343	52 90
75	30	230501	224311	224344	57 30
100	40	230502	224312	224345	60 50
150	60	230503	224313	224346	64 40
200	80	230504	224314	224347	67 90
300	120	230505	224315	224348	74 95
		500 Volts			
5	5	.....	.....	224359	46 75
10	10	.....	.....	224360	49 40
15	15	.....	.....	224361	51 60
25	25	.....	.....	224362	54 70
50	50	.....	.....	224363	60 85
75	75	.....	.....	224364	65 25
100	100	.....	.....	224365	68 45
150	150	.....	.....	224366	72 35
200	200	.....	.....	224367	75 85
300	300	.....	.....	224368	[illegible] 90

133-cycle meters can be supplied on special order at same price as 60-cycle meters.

Glass Covers will be supplied on meters instead of metal covers without extra charge. Order "similar to Style No.....except to have glass cover."

Meters for three-phase, four-wire circuits can be furnished self-contained in capacities of five to twenty-five amperes inclusive, above which size it is necessary to use a transformer type of meter with three current transformers. In either case specify in the order that the meter is for a three-phase four-wire circuit, giving current capacity, frequency, and voltage between neutral and each phase and across phases.

Prices for self-contained three-phase four-wire watthour meters for 100 volts "Y" connected will be the same as for standard listed 200-volt meters of corresponding current capacity, and for 200 volts "Y" connected, prices will be the same as for 400 volts standard listed meters of corresponding current capacity. Prices for transformer type three-phase four-wire watthour meters will be the same as for standard listed transformer type meters.

POLYPHASE METERS FOR USE WITH TRANSFORMERS

These meters are arranged for use with current transformers with 5-ampere secondaries, for current capacities higher than those listed in the preceding table. The 100-volt meters listed below can be used with voltage transformers with 100-volt secondaries for voltages higher than those listed.

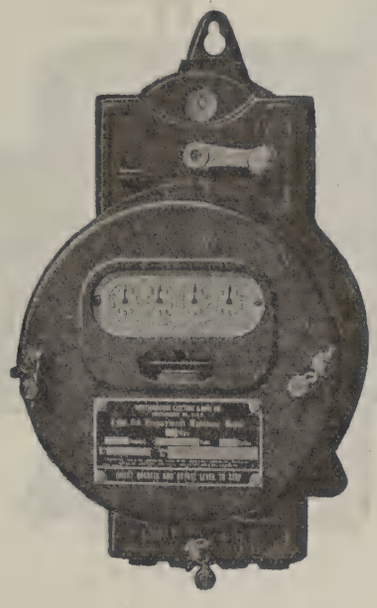
Style number and list price include 5-ampere meter of the voltage listed, for use with transformers, but do not include transformers. When a meter is desired with register reading directly in kilowatt-hours in the primary circuit, it should be ordered as: "Meter similar to Style No. (give Style No. of 100-volt meter from the following table), except with register for...../5-ampere and...../[illegible] 100-volt transformer;" or "Meter similar to Style No. (give Style No. of 200, 400 or 500-volt meter from the following table), except with register for...../5-ampere transformer." Price for the meter with register as ordered will be the same as for meter listed. Transformers should be added at regular prices.

Volts	Amps.	Kw.	Style No. 25-Cycle	40-Cycle	60-Cycle	List Price
100	5	1	230516	224326	224369	$34 40
200	5	2	230517	224327	224370	38 80
400	5	4	230518	224328	224371	46 75
500	5	5	.....	.....	224372	46 75

133-cycle meters can be supplied on special order at same price as 60-cycle meters.

Order by Style Number

TYPE OA PREPAYMENT WATTHOUR METERS



Application—The type OA prepayment meter is especially useful when supplying current to small consumers, as it collects the bill and saves bookkeeping. It is also useful when supplying a shifting population, such as at summer resorts, for it saves following up the consumer to collect the bill. Many other uses can also be found for these meters.

Operation—The type OA prepayment meter is arranged to receive quarters, and not only registers the amount of energy consumed but indicates by an additional dial the number of quarters, up to ten, remaining to the credit of the consumer. As energy to the value of each quarter prepaid is consumed, the dial changes to indicate one less quarter credited. When no more coins remain to the credit of the customer the supply is shut off automatically. The coin box will hold $25.00 in quarters.

The meter is supplied for rates of 5 to 25 cents (full cents only) per kilowatt-hour as specified in order. **When ordering specify the rate.** Meters for other rates can be supplied on special order, prices on application.

Construction—The type OA prepayment meter is similar to the standard single-phase meter, except that it is provided with mechanism that allows the customer to prepay for a definite amount of electrical energy.

The prepayment mechanism, including the cut-out mechanism, is entirely mechanical, operating by gears and levers. The coin mechanism is manually operated. Power for operating the cut-out switch and the coin indicator is obtained from a powerful clock spring which is wound up in the action of registering the coin. The release of this spring to carry the coin indicator back step by step as energy is consumed in no way affects the accuracy of the meter.

Keys for type OA prepayment meters are shipped by registered mail to the lighting company's superintendent, manager, or official whose name must be mentioned on the requisition, and who will give his receipt for them. This obviates any possibility of the keys being retained by unauthorized persons that may unpack the goods.

Two keys will be supplied to each purchaser with the first meter. Additional keys may be obtained for $0.40 each net, on request of an authorized official.

SINGLE-PHASE PREPAYMENT WATTHOUR METERS—60-CYCLE

Two-Wire 100-Volt				Two-Wire 200-Volt				Three-Wire 100-200-Volt			
Capacity Amp.	Kw.	Style No.	List Price	Capacity Amp.	Kw.	Style No.	List Price	Capacity Amp.	Kw.	Style No.	List Price
5	.5	178928	$35 75	5	1	178932	$39 90	5	1	178936	$39 90
10	1	178929	38 10	10	2	178933	44 45	10	2	178937	44 45
15	1.5	178930	41 25	15	3	178934	48 40	15	3	178938	48 40
25	2.5	227149	47 60	25	5	227150	55 55	25	5	227151	55 55

133-cycle meters can be supplied on special order at same price as 60-cycle meters.

Order by Style Number

TYPE RO WATTHOUR DEMAND METERS

SINGLE-PHASE AND POLYPHASE

POLYPHASE METER

Application

The type RO watthour demand meter gives both the kilowatt-hours consumed and the maximum kilowatt demand, but does not show the time at which the maximum occurs. The meter is of the lagged type requiring an apppreciable time to show the full value of the demand. On account of its simplicity and reliability it is especially applicable for determining the demand of lighting and power installations except where a permanent record of the demand, involving the time of occurrence, is required.

It is particularly useful in installations which are so inaccessible that they cannot be reached except at long time intervals. When used on power installations which fluctuate widely and rapidly, a meter should be selected with a time interval approximating the time interval of the peak.

Distinctive Features

The watthour demand meter is installed as an ordinary watthour meter and requires no additional apparatus or wiring. The maximum demand is indicated by a pointer sweeping over a 4-inch dial, and the watthour load on a 4-dial counter.

The instrument has no clock, contacts, or other delicate parts that are likely to require attention, and the mechanism is so simple that maintenance costs are little more than with watthour meters.

Operation

Principle of Operation—The meter is a combination of induction watthour meter, induction wattmeter, and an escapement form of time element. The instrument has a standard type OA watthour meter movement including electromagnet, permanent-magnet, and disk, and in addition an auxiliary disk supported on a jewel-and-ball bearing so that it can move in the air-gap of the electromagnet in such a way that it does not interfere with the accuracy of the main disk, which always rotates at a speed proportional to the load. The rotation of the auxiliary disk is restrained by a spiral spring, making its final deflection proportional to the watts load. The auxiliary disk with its spring and pointer constitute an indicating wattmeter.

The shaft of the auxiliary disk is geared to an escapement wheel, and the claw restricting this wheel is oscillated by an eccentric driven from the main shaft. The auxiliary disk, therefore, advances step by step at a speed determined by the speed of the main watthour meter disk; that is, at a speed proportional to the load. It continues to advance until the spring tension balances the torque produced in the auxiliary disk. The demand mechanism is then in equilibrium and the pointer indicates the watts.

As the total deflection and the rate of deflection of the auxiliary disk vary in direct proportion, the time required to reach the maximum position when any constant load is passed through the instrument is a constant. For example, if a load of 500 watts is applied to a 10-ampere, 100-volt meter with 15-minute time element, the demand mechanism will reach equilibrium at the 500-watt point in 15 minutes. If instead a load of 1000 watts is applied to the meter, the demand mechanism will have to

TYPE RO WATTHOUR DEMAND METERS—Continued

move twice as far, to the 1000-watt point, to reach equilibrium; but the double load will move the watthour disk twice as fast, causing the escapement to allow the demand disk to move twice as fast, and it will cover the double arc in the same time.

The auxiliary disk drives the demand pointer through a dog, and a fine-toothed rachet and pawl holds the demand pointer in the position of maximum deflection, until released by hand. A second ratchet and pawl allows the auxiliary disk to fall back to equilibrium under its spring tension if the load falls below that corresponding to its position at any movement, but prevents it from advancing except as controlled by the escapement as above.

Resetting—The demand pointer is reset by pressing a sealed button on the cover.

Dial Marking—The demand dial of the polyphase meter is direct reading and will register up to 50 per cent overload. The single-phase dial is uniform, not direct reading, and will register up to 100 per cent overload.

Time Interval—Meters are listed for 15-minute interval, but 1, 2, 5 and 30-minute interval can be furnished if required, at the same price as listed meters.

Polyphase Meters—The polyphase type RO watthour demand meter is virtually two independent single-phase meters enclosed in the same case and having the watthour register and the demand dial in common. The two watthour meter elements are on the same shaft so that, each element exerting its torque on the shaft, the total rotative torque is proportional to the total power in the metered phases. Likewise, the two wattmeter elements are on the same shaft and, having one escapement governed by an eccentric on the watthour meter shaft, the indication of the demand dial is therefore that of the combined demand in the metered phases.

The polyphase meter, therefore, when properly connected, indicates the true power in any two-phase or three-phase circuit, regardless of power factor or the degree of unbalance between phases.

For four-wire three-phase circuits of 25-amperes and less, special self-contained polyphase meters can be furnished on order. The transformer type polyphase meter requires three current transformers for this service.

Construction

All parts of the meter element are mounted on a supporting casting and can be removed from the case as a unit without changing the calibration. The electromagnets embody the same excellent construction as the type OA watthour meter.

Terminal Chamber—Separately sealed terminal chambers are provided, separated by a dust-proof partition from the meter chamber. As the main covers do not need to be removed at installation the meter seals applied in the central stations laboratory can be retained. The terminals have one clamping screw each.

SINGLE-PHASE METER

In the single-phase meters the terminal chamber is at the bottom. In the polyphase meters, two terminal chambers are provided, one on the left-hand front side of the meter for the line connections, and one on the right-hand front side for the load connections, the leads entering the sides of these chambers.

Bearings—The lower bearing of the main disk and that of the auxiliary disk is each a highly-polished and hardened steel ball resting between two sapphire cup jewels, identical with that of the type OA meter. The upper bearings are self-oiling bearings.

Watthour Adjustments—Micrometer light-load and full-load adjustments are provided as in the type OA meters. The only tool required to make adjustments is a screwdriver.

Demand Adjustment—The demand mechanism is calibrated by adjusting the position and length of the control spring.

Three-wire single-phase meters are identical in appearance with the two-wire. The rated current is that in each outside wire.

Meters For Use With Transformers

These meters are arranged for use with current transformers with 5-ampere secondaries, for current capacities higher than those listed in the tables. The 100-volt meters can be used with voltage transformers with 100-volt secondaries for voltages higher than those listed.

TYPE RO WATTHOUR DEMAND METERS—Continued

METERS WITH 15-MINUTE TIME INTERVAL*

Self-Contained Meters

The style number and list price include self-contained meter only, which does not require either voltage or current transformers. Polyphase meters as listed are for two-phase or for three-wire three-phase circuits and have metal cover.

Single Phase

Volts	Amp.	Kw.	STYLE NO. 60-Cycle Metal Cover	60-Cycle Glass Cover	25-Cycle Metal Cover	25-Cycle Glass Cover	List Price
100	5	.5	190336	190341	206859	206882	$35 30
100	10	1	190337	190342	206860	206883	37 15
100	15	1.5	190338	190343	206861	206884	38 80
100	25	2.5	190340	190345	206863	206886	41 80
100	50	5	225849	225851	225899	225901	48 20
100	75	7.5	225850	225852	225900	225902	51 90
200	5	1	197821	197829	206867	206890	36 65
200	10	2	197822	197830	206868	206891	38 45
200	15	3	197823	197831	206869	206892	40 15
200	25	5	197825	197833	206871	206894	43 50
200	50	10	225869	225871	225919	225921	50 20
200	75	15	225870	225872	225920	225922	53 90
			3-Wire Meters				
100–200	5	1	197526	197533	206875	206898	$36 65
100–200	10	2	197527	197534	206876	206899	38 45
100–200	15	3	197528	197535	206877	206900	40 15
100–200	25	5	197530	197537	206879	206902	43 50
100–200	50	10	225883	225884	225933	225934	50 20

Polyphase
(With Metal Cover)

Volts	Amp.	Kw.	STYLE NO. 25-Cycle	60-Cycle	List Price
100	5	1	218894	219024	$69 65
100	10	2	218895	219025	72 35
100	15	3	218896	219026	74 50
100	25	5	218898	219028	77 60
100	50	10	218900	219030	83 80
100	75	15	218901	219031	88 20
200	5	2	218902	219032	74 10
200	10	4	218903	219033	76 75
200	15	6	218904	219034	78 90
200	25	10	218906	219036	82 00
200	50	20	218908	219038	88 20
200	75	30	218909	219039	92 60
400	5	4	218910	219040	82 00
400	10	8	218911	219041	84 65
400	15	12	218912	219042	86 85
400	25	20	218914	219044	89 95
400	50	40	218916	219046	96 15
400	75	60	218917	219047	100 55

Meters for Use With Transformers

Style number and list price include 5-ampere meter of the voltage listed, for use with transformers, but do not include transformers.

When a meter is desired with register reading directly in kilowatt-hours in the primary circuit, it should be ordered as: "Meter similar to Style No. (give Style No. of 100-volt meter from the following table), except with register for...../5-ampere and...../100-volt transformer;" or "Meter similar to Style No. (give Style No. of 200, or 400-volt meter from the following table), except with register for...../5-ampere transformer." Price of the meter with register as ordered will be the same as for meter listed.

Transformers should be added at regular prices.

Single Phase

Volts	Amp.	STYLE NO. 60-Cycle Metal Cover	60-Cycle Glass Cover	25-Cycle Metal Cover	25-Cycle Glass Cover	List Price
		2-Wire Meters				
100	5	226674	226676	226704	226706	$39 40
200	5	226675	226677	226705	226707	40 75
		3-Wire Meters				
100–200	5	226688	226689	226718	226719	40 75

Prices on 400-volt and 500-volt, 60-cycle and 400-volt, 25-cycle, single-phase meters will be furnished on application.

Polyphase

Volts	Amps.	STYLE NO. 25-Cycle	60-Cycle	List Price
100	5	218918	219048	$73 65
200	5	218919	219049	78 10
400	5	.....	224894	86 00

For self-contained three-phase, four-wire meters of 25-ampere and less, prices on application.

*Meters with 1, 2, 5, or 30-minute interval on special order at same price.

Approximate Dimensions and Weights

	Dimensions in Inches Width	Height	Depth	Weight—Lbs. Net	Boxed
Single Phase	7 1/16	9 11/16	6½	12	20
Polyphase	9¾	12 5/8	[illegible]	25	45

Dimensions shown are for reference only. For official dimensions apply to the nearest district office.

Order by Style Number

TYPE RA RECORDING-DEMAND WATTHOUR METERS

Polyphase

Application

The type RA recording-demand watthour meter in one unit measures both the kilowatt-hours consumed and the integrated demand. It indicates on a four-counter dial the total kilowatt-hours consumed and records in a permanent form the integrated demand over successive predetermined time intervals.

Because of its simplicity and exceptional reliability, it is especially applicable for determining the demand of power installations, particularly where a permanent record of the demand, involving the time and length of occurrence, is wanted.

Capacity—The rated current capacity is that in each wire of the circuit; the rated voltage is that across each phase. The indicating mechanism is arranged so that full scale deflection is 50 per cent overload on the meter.

FIG. 1

DISTINCTIVE FEATURES

1. The type RA is a recording-demand watthour meter, is entirely self-contained and is installed as an ordinary watthour meter and requires no additional apparatus or wiring.

2. It is mounted on a one-piece cast iron base with cover that makes the meter thoroughly dust-proof. The cover can be easily removed and is as easily sealed.

3. The measuring and recording elements are mechanically interconnected; there are no electrical contacts to become inoperative.

4. The recording element is controlled by an exceptionally high-grade clock good for at least 35 days on one winding and having features that make not only for clock accuracy but for reliability of continuous operation.

5. The record paper is of sufficient length to last thirty-six days, and the self-inking feature provides sufficient ink for 35 days, thus reducing the maintenance cost.

6. The measuring element is the standard Westinghouse type OA watthour meter with special gear train.

OPERATION

The type RA recording-demand watthour meter consists of a watthour meter with the usual four-counter register and, in addition, the mechanism for obtaining a graphic record of the demand. The time interval of the meter and the advance of the record paper are controlled by a hand-wound clock mechanism.

FIG. 2

Principle of Operation—Under load, the gear train of the watthour meter advances the counters in the regular manner. At the same time the gear train causes the ink-carrying pen to advance across the record paper in proportion to the energy registered. At the end of a predetermined time interval a stud on the reset wheel releases the pen gear from mesh with the gear train and a balancing weight returns the pen to zero where it is again meshed with the gear train to repeat its advance during the next time interval.

Just before the pen gear is released, the record paper is advanced a sixteenth inch by the operating spring so that the pen makes a distinct and readily observed record of the maximum pen travel, showing both the amount of integrated demand and, by the time calibration printed on the record paper, the time of its occurrence.

Time Interval—The reset wheel, which makes one complete revolution per hour, is arranged for the

TYPE RA RECORDING-DEMAND WATTHOUR METERS—Continued

insertion of four studs. When all four studs are used, the meter has a 15-minute time interval on the integrated demand. With two studs in place, arranged 180 degrees apart, the meter has a 30-minute time interval; and with only one stud, a 60-minute interval. However, each time interval requires its particular gear train for obtaining the proper full-scale record at rated voltage. It is therefore necessary to change the gear train if the time interval is desired changed; this change can be made at installation. Additional gear trains are listed for making this change.

The operating spring causes the paper to advance one-sixteenth inch every 15 minutes. Thus, if the reset wheel is equipped with studs for a 15-minute time interval, the paper is advanced just before the pen is reset (see Fig. 3.) If, however, the reset wheel is set for thirty-minute intervals, the paper will advance one 15-minute space between reset periods, causing an offset mark on the chart at the middle of the 30-minute period (see Fig. 4). This offset mark enables the reading of the integrated demand at 15-minute intervals as well as 30-minute. Similarly, if the reset wheel is set for one-hour intervals, three offset marks indicate the 15-minute demands between each regular one-hour demand record.

Polyphase Meters—The standard type RA meters are all polyphase, having virtually two independent single-phase electrical elements enclosed in the same case, with the watthour register and the demand recording devices in common. As with the polyphase type OA watthour meter, the two torque elements are on the same shaft so that, each exerting its torque on the shaft, the total rotative torque is proportional to the total power in the metered phases. The meter, therefore, when properly connected, records the true power in any two-phase or three-phase circuit, regardless of power factor or the degree of unbalance between phases.

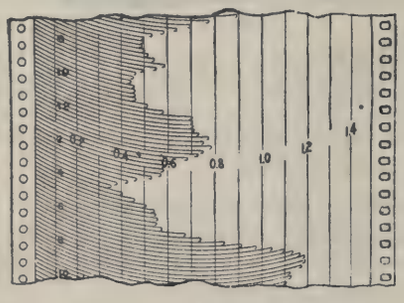


Fig. 3—Made by a 15-Minute-Interval Meter

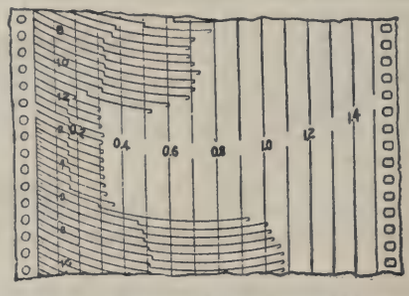


Fig. 4—Made by a 30 Minute-Interval Meter

FAC-SIMILE OF RECORD CHART MADE BY TYPE RA RECORDING-DEMAND WATTHOUR METER

Note that on the chart of Fig. 4 the 15-minute as well as the 30-minute demand is shown.

CONSTRUCTION

The entire meter is mounted on a cast iron base. The cover is of pressed zinc with dead black finish. It is fitted with a dust-proof gasket and the glass windows over the dial and chart are well sealed.

Measuring element—The electrical measuring element consists of the standard type OA watthour meter on its own supporting casting but without cover. Therefore this element can be removed from the case as a unit without changing the calibration.

Clock—A high-grade clock of the latest type and having a watch-type escapement is used. In order that the drive may be at all times positive and constant even though the heavy main spring is nearly unwound, a small helical intermediate spring is interposed. The main spring serves to keep this intermediate spring wound, while the intermediate spring drives the clock escapement with constant torque. An additional heavy operating spring provides power for the advancing of the paper chart and the pen arm reset thus relieving the main spring of this duty and resulting in improved time keeping of the clock.

The paper driving mechanism is a metal drum with pins that engage in perforations in the record paper, driven through gearing by the operating spring. The paper is held on a spindle and is wound off this onto a drum by the driving mechanism.

The record paper for these meters is of stock specially selected for satisfactory records and is accurately ruled, with the hours stamped on one margin. An accurate drive is assured by perforations in the paper in which pins on the driving mechanism engage. The paper is furnished in 18-foot rolls. As it is advanced one-quarter inch per hour, one roll is therefore sufficient for thirty-six days' record.

The pen is of the V-point type that is familiar to operators of graphic recorders. The self-inking device will hold a supply of ink sufficient to last for at least 35 days.

The ink is furnished in liquid form and is especially prepared to give satisfaction with the pen and paper supplied.

Terminals—Studs for rear connection on switchboards up to two inches thick are supplied with all meters. A terminal block is also mounted under the iron base for front connection; the studs are not used when meter is front connected.

POLYPHASE METERS FOR USE WITH TRANSFORMERS

Style number and list price include 5-ampere meter of the voltage listed, two rolls of record paper, and one 2-ounce bottle of ink; but do not include transformers. When the meter is to be used with both current and voltage transformers, the 100-volt meter should be selected. (The multiplier to be used is the product of the transformer ratios).

Transformers should be added at regular prices (see catalogue on "Instruments and Relays").

Volts	Amps.	Kw.	Style Nos. 15-Minute Interval	30-Minute Interval	60-Minute Interval	List Price
			For 25-Cycle Circuits			
100	5	1	258097	258106	258115	$140 00
100*	5	1	276338	276340	276342	155 00
200	5	2	258098	258107	258116	145 00
400	5	4	258099	258108	258117	150 00
			For 40-Cycle Circuits			
100	5	1	258100	258109	258118	140 00
200	5	2	258101	258110	258119	145 00
400	5	4	258102	258111	258120	150 00
			For 60-Cycle Circuits			
100	5	1	258103	258112	258121	140 00
100*	5	1	276339	276341	276343	155 00
200	5	2	258104	258113	258122	145 00
400	5	4	258105	258114	258123	150 00

ACCESSORIES

Amperes	Volts	Description	Style No.	List Price
5	100	Record Paper, per Roll, for 3-phase, 3-wire meters	237204	$0 35†
5	200	Record Paper, per Roll, for 3-phase, 3-wire meters	263096	0 35†
5	400	Record Paper, per Roll, for 3-phase, 3-wire meters	263097	0 25†
5	100	Record Paper, per Roll, for 3-phase, 4-wire meters	280943	0 35†
..	....	Ink for type RA meter, per 2-oz. bottle	256332	0 35†
..	....	Pen for type RA meter,	276387	0 25

EXTRA GEAR TRAINS

For changing the time interval of meters already in use. **Style number** includes gear train as listed. **List price** includes gear train and three studs for changing the time interval on clock mechanism.

Volts	Style Nos. 15-Minute Interval	30-Minute Interval	60-Minute Interval	List Price
100	258369	258372	258375	$8 00
200	258370	258373	258376	8 00
400	258371	258374	258377	8 00
100*	276674	276675	276676	8 00

Order by Style Number

APPROXIMATE DIMENSIONS AND WEIGHTS

	Dimensions in Inches Width	Height	Depth	Weights, Lbs. Net	Boxed
All Style Nos.	10½	13⅞	6¾	30	85

These dimensions are for reference only. For official dimensions apply to the nearest district office.

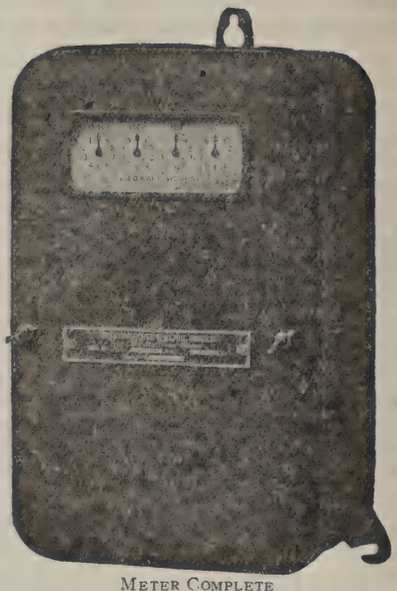
*These meters are equipped with ten terminals, special gear trains, and current coils for three-phase four-wire circuits.

†Orders not accepted for less than ten rolls of paper or for less than ten bottles of ink on one order.

TYPE CW-6 WATTHOUR METERS

FOR DIRECT-CURRENT CIRCUITS

METER WITH COVER REMOVED



METER COMPLETE

The Westinghouse type CW-6 watthour meters are designed in accordance with the latest meter practice and have incorporated in them all the improvements that experience has shown to be desirable.

Construction

The meters are of the commutator type without iron in the magnetic circuit. The spherical armature is closely surrounded by circular field coils. Uniform brush tension at all degrees of wear is secured by making the brush tension dependent entirely upon gravity. Each brush consists of two small round wires held against the commutator by a small adjustable counterweight. Brushes and commutator are made of non-oxidizable material The current winding consists of two flat coils of strap copper connected either in series or in parallel, depending on the capacity. In three-wire meters one of the coils is connected in series with each side of the line. The mounting frame is cast of very hard and tough aluminum alloy, strong and rigid. This frame supports all of the meter mechanism. This construction makes it possible to remove the entire meter as a unit, without disturbing the adjustment.

Bearings—The main bearing of the Westinghouse type CW-6 meters is an improved form of ball bearing, consisting of a one-sixteenth-inch highly polished steel ball between two sapphire cup jewels, one spring mounted and the other in a removable sleeve on the shaft. In operation this bearing has a rolling action that reduces friction and increases the life.

Dimensions and Weights—Overall dimensions: width 7½ inches, height 13 inches, depth 6¾ inches. Approximate net weight 13 pounds, boxed 32 pounds.

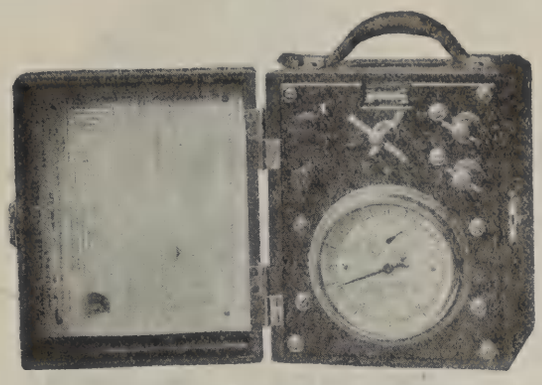
Cap. Amp.	TWO-WIRE METERS 100–120 Volts Style No.	List Price	200–240 Volts Style No.	List Price	500–600 Volts Style No.	List Price	THREE-WIRE* 200–240 Volts Style No.	List Price
5	162548	$ 24 60	162558	$ 27 75	244456	$ 35 70	162568	$ 27 75
10	162549	26 20	162559	31 75	244457	41 25	162569	31 75
15	162550	29 35	162560	37 30	244458	47 60	162570	37 30
25	162551	34 90	162561	42 85	244459	55 55	162571	42 85
50	162552	46 05	162562	54 35	244460	67 45	162572	56 35
75	162553	57 15	162563	65 90	244461	79 35	162573	69 90
100	162554	67 45	162564	77 35	244462	91 25	162574	83 35
150	162555	87 35	162565	99 35	244463	115 10	162575	107 15
300	162556	111 25	162566	127 00	244464	150 80	162576	146 80
600	162557	158 75	162567	178 50	244465	206 35		

*Three-wire meters are for use on circuits of 100-120 volts between neutral and outside wire.

Order by Style Number

PORTABLE STANDARD WATTHOUR METERS

SINGLE PHASE AND POLYPHASE



SINGLE-PHASE METER

Checking service meters with a portable standard watthour meter eliminates the use of a stop watch and makes the calibration very simple. As the number of revolutions made by the meter under test is compared directly with the number of revolutions made by the standard meter in the same time, the result indicates by very simple calculation the condition of the service meter. Moreover, both meters being connected in series, it is not necessary to keep the test load absolutely constant.

Meters of other manufacture may be tested by using the printed instructions and table of constants furnished with each meter.

Case—The meter is mounted in a hard wood case with readily-removable hinged cover and a leather carrying handle. The single-phase meter measures 8½ by 7 by 7½ inches and the polyphase meter 10 by 9 by 12¼ inches.

Bearings—The main (lower) bearing is a ball-and jewel bearing like that of the Westinghouse type OA watthour meter. The upper bearing is a self-oiling guide bearing.

Register—At normal load the pointer on the large dial revolves 25 times per minute and the pointer on the small dial once per minute. The small dial is subdivided into 25 divisions, each corresponding to a revolution of the main meter shaft, or a revolution of the large dial pointer; the large dial is subdived into 100 divisions

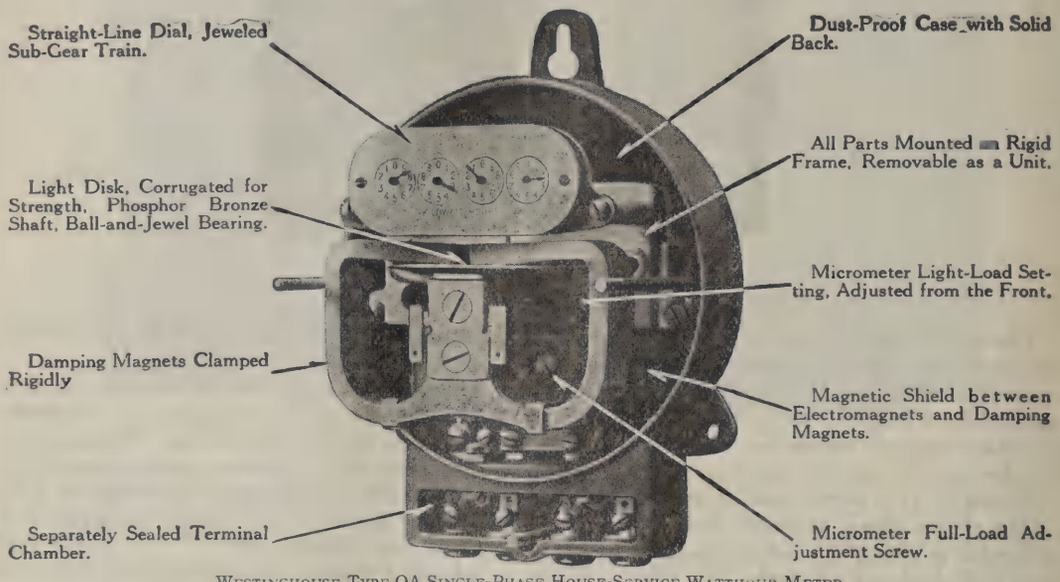
Adjusting Switch—The current and voltage setting is accomplished by means of a drum switch to which voltage and current coil leads are connected.

Calibration—The meter is essentially a service watthour meter with added refinements in workmanship and features tending to make it convenient for testing. Its calibration is guaranteed to be as per data furnished with the meter when it leaves the factory. This calibration is subject to variation, however, like any other meter used for a similiar purpose, due to the rough usuage the meter is bound to receive in transportation and in service.

Style number and list price include meter complete with flexible leads and push-button switch.

Style No. 25 Cycles	Style No. 60 Cycles	Volts	Full Load Amperes	Approx. Wt.—Lb. Net	Approx. Wt.—Lb. Boxed	List Price
			Single-Phase Meters			
199341	149742	100–200	1– 5–10–20–40	15	37	$102 00
199342	151807	100–200	1–10–20–40–80	15	37	114 00
141037	119375	100–200	80–160	15	37	102 00
.....	241810	100–200–400	1– 5–10–20–40	15	37	180 00
			Polyphase Meters			
151809	151808	100–200	1– 5–10–20–40	29	65	198 00
151813	151812	100–200	1–10–20–40–80	29	65	215 00
151819	151818	100–200	80–160	29	65	267 50
.....	199345	100–200–400	1– 5–10–20–40	29	65	335 00
151811	151810	200–400	1– 5–10–20–40	29	65	198 00
151815	151814	200–400	1–10–20–40–80	29	65	215 00
151821	151820	200–400	80–160	29	65	267 50
.....	199346	250–500	1– 5–10–20–40	29	65	198 00
			133-Cycle Single-Phase Meters			
	199343	100–200	1– 5–10–20–40	15	37	102 00

Order by Style Number


Straight-Line Dial, Jeweled Sub-Gear Train.
Dust-Proof Case with Solid Back.
All Parts Mounted on Rigid Frame, Removable as a Unit.
Light Disk, Corrugated for Strength, Phosphor Bronze Shaft, Ball-and-Jewel Bearing.
Micrometer Light-Load Setting, Adjusted from the Front.
Damping Magnets Clamped Rigidly
Magnetic Shield between Electromagnets and Damping Magnets.
Separately Sealed Terminal Chamber.
Micrometer Full-Load Adjustment Screw.

WESTINGHOUSE TYPE OA SINGLE-PHASE HOUSE-SERVICE WATTHOUR METER

Use Westinghouse Type OA Watthour Meters to Serve as Cash Registers on Your System

They are pre-eminently adapted to give maximum possible accuracy, embodying as they do the following distinctive features:

Slow Speed Worm, reducing friction.

Jeweled Bearings in Sub-Gear train, insuring permanent minimum friction.

Double Jeweled Ball Bearings for main shaft, giving unequaled sustained accuracy; Electro-Magnet, accurately proportioned, and safeguarded against change.

Permanent Magnet System, generous in use of material; carefully treated; correct in design.

TYPE BI AUTOMOBILE AMMETERS

DIRECT-CURRENT—2-INCH DIALS—1½-INCH SCALES

Application

These instruments are for use on the automobile dash or cowl when electric generators, motors, and storage batteries for starting, ignition, and lighting are used. They also find ready application on motor boats, yachts, aerial craft, small direct-current switchboards, and for charging batteries.

These instruments are designed with special regard to ruggedness, simplicity, readabilty and appearance.

Principle of Operation

The type BI instrument utilizes the polarized vane construction, comprising a moving soft-iron vane polarized by a stationary permanent magnet and deflected over its scale by the action of a stationary current coil. No springs or moving coil are used, thus resulting in great simplicity and ruggedness. The indications are made dead-beat by means of an efficient damper.

Construction

Mounted in open-faced circular pressed-metal cases arranged with a flange for flush mounting. Terminal studs are for rear connection.

Capacities—Instruments are self-contained in the capacities listed, no external shunts or resistors are required, and are not damaged by momentary short circuits up to 500 amperes.

Finish—Standard case finish is black rubberoid with a bright polished rim, holding the glass.

The dials are of metal, black or white, as desired.

Mounting Accessories—The "mounting details" included in some of the listed styles comprise three standard machine screws and a circular punched metal ring tapped for receiving the screws. These make nuts unnecessary for clamping the instrument to either a metal or wooden dash. Where it is desired to screw directly into the dash the styles listed "without mounting details" should be ordered.

Rear Mounting Flush Type—These instruments are identical to the standard instrument with the exception that there is no hole in the flange mounting. The arrangement for mounting being from the rear of the panel by means of the mounting clamp listed below.

Dimensions—The type BI instrument has a diameter over its flange of approximately 2½ inches and requires an opening in the dash of approximately 2 inches; exact mounting dimensions on request.

Weights—Net 4 ounces, boxed 8 ounces. Individual units can be shipped by mail.

Replacement Offer

The following replacement offer accompanies each type BI instrument herein listed:

"This instrument will be replaced, if damaged, with a new instrument for $1.25 at any time, if returned postpaid to Westinghouse Electric & Manufacturing Company, Newark, N. J."

PRICES

Style number and list price include instrument with or without mounting accessories as specified.

Scale	Style No. Black Dial	Style No. White Nickel Dial	List Price
Ammeters Without Mounting Details			
15–0–15	257775	270436	$3 00
20–0–20	257777	270438	3 00
30–0–30	257779	270440	3 00
Ammeter With Mounting Details			
15–0–15	257776	270437	$3 15
20–0–20	257778	270439	3 15
30–0–30	257780	270441	3 15

Rear-Mounting Flush-Type

Scale	Style No. Black Dial	Style No. White Nickel Dial	List Price
20–0–20	289106	289130	$3 00
30–0–30	289129	289131	3 00

Mounting Clamps

Description	*Style No.	List Price
For Metal Dash	251488	$0 15
For ⅛-inch Wood Dash	251489	15
For ⅜-inch Wood Dash	251490	15
For ¼-inch Wood Dash	251491	15

*The mounting clamp style numbers include necessary nuts and terminal clips for assembling to dash and making connections.

TYPE BX INSTRUMENTS

DIRECT-CURRENT OR ALTERNATING-CURRENT OF ANY FREQUENCY

2-INCH DIALS—2-INCH SCALES

Application

The tendency of recent developments in electrical applications has been to demand instruments of smaller size, increased sensitiveness and greater accuracy. To meet this demand the Westinghouse Company has developed the type BX line of instruments of miniature proportions.

They combine extreme delicacy of action with high sensibility and ruggedness. In addition the design, construction and materials are such that the instruments are permanently accurate.

Type BX instruments may be used for the measurement of small direct currents, such as the filament and plate currents of radio communication sets, or on farm-lighting or other small charging and lighting panels, or in dental, electro-medical, or other applications where space, economy and accuracy are essential.

Principle of Operation

Type BX instruments operate on the D'Arsonval principle. By combining the millivoltmeter with a non-inductive heater and thermo-couple it is made suitable for the measurement of high-frequency alternating currents such as are encountered in radio communication. The same instrument may also be operated on alternating-current circuits of commercial frequency.

Construction

The instrument is of the round open-face type. It can be furnished either flush or projection mounting and is arranged for rear connections.

Finish—The standard finish is white dial, nickel bezel ring, and black marine case. Black dials are furnished for certain styles as noted below.

Accuracy—Type BX instruments are checked throughout their entire range for accuracy. The calibration is correct at any point of the scale within two per cent of full scale reading on direct current and radio frequency current of the frequencies now in use.

Dimensions—Instruments are $2\frac{9}{16}$ inches in diameter over the flange base. The diameter of the body is 2 inches.

Approximate Weights—Net 4 ounces, boxed 8 ounces.

PRICES

Style number and list price include the type BX instrument complete as described.

Scale	Application	Style No. Flush Type	Style No. Projection Type	List Price
	D. C. Ammeters			
1	Small Panels	284918	289144	$11 00
2	Small Panels	284919	289145	11 00
3	Small Panels	284920	289146	11 00
5	Small Panels	284921	289147	11 00
10	Small Panels	284922	289148	11 00
15	Small Panels	284923	289149	11 00
*25	Small Panels	284924	289150	11 00
½–0–1½	Audion Filament Control	289169	289183	11 00
20–0–20	Automobile and Small Panels	284925	289151	11 00
30–0–30	Automobile and Small Panels	284926	289152	11 00
25–0–25	Automobile and Small Panels	284927	289153	11 00
†20–0–20	Automobile and Small Panels	284928	289154	11 00
†30–0–30	Automobile and Small Panels	284929	289155	11 00
†25–0–25	Automobile and Small Panels	284930	289156	11 00
	D. C. Voltmeters			
3	Small Panels	284931	289157	11 00
5	Automobile and Small Panels	284932	289158	11 00
10	Automobile and Small Panels	284933	289159	11 00
16	Automobile and Small Panels	284934	289160	11 00
25	Small Panels	284935	289161	11 00
50	Small Panels	284936	289162	12 00
75	Small Panels	284937	289163	12 00
120	Small Panels	284938	289164	13 00
*150	Small Panels	284939	289165	13 00
†8	Automobile and Small Panels	284940	289166	11 00
†10	Automobile and Small Panels	284941	289167	11 00
†16	Automobile and Small Panels	284942	289168	11 00
	D. C. Milliammeters			
100	Small Panels	289170	289184	11 00
150	Small Panels	289171	289185	11 00
250	Small Panels	289172	289186	11 00
	Radio Frequency Ammeters			
0.6	Radio Sets	289173	289187	20 00
0.8	Radio Sets	289174	289188	20 00
1.0	Radio Sets	272913	289189	20 00
1.5	Radio Sets	289176	289190	20 00
2.0	Radio Sets	289177	289191	20 00
3.0	Radio Sets	289178	289192	20 00
4.0	Radio Sets	289179	289193	20 00
6.0	Radio Sets	289180	289194	20 00
8.0	Radio Sets	289181	289195	20 00
10.0	Radio Sets	289182	289196	20 00

*Larger capacities can be produced with external resistors or shunts.
†Black dial.

INTERIOR VIEW OF TYPE BX RADIO FREQUENCY AMMETER

TYPE EW AUTOMOBILE AMMETERS AND VOLTMETERS

DIRECT-CURRENT—3-INCH DIALS—2⅜-INCH SCALES

Application

For use on the dash or cowl of automobiles on which electric generators, motors, and storage batteries are used for ignition, lighting, and starting. They also find ready applications on motor boats, yachts, aerial craft, small direct-current switchboards, and for charging batteries.

Designed with special regard to ruggedness, simplicity, readability, and attractive appearance.

The voltmeters are particularly suitable for use with generating systems having current regulators; they then give an indication of the state of the battery and also give an indication as to the functioning of the system as a whole.

Principle of Operation

The type EW instrument operates on the D'Arsonval principle, involving a permanent magnet and a moving coil, with spiral current-carrying springs, mounted in pivot and jewel bearings; the movement being rendered dead-beat by winding the moving coil on an aluminum damping frame.

Construction

Mounted in open-faced circular pressed-metal cases arranged with a flange for flush mounting.

Capacities—Instruments are self-contained in the capacities listed.

Accuracy—The instruments have a degree of accuracy entirely adequate for the service for which they are intended, the accuracy being the greatest at the most important operating points of the scale.

Finish—Standard case finish is black rubberoid with a bright polished rim holding the glass.

Mounting Accessories—For wood-dash mounting three machine screws (1⅛-inch long), three nuts, three lock washers, and a mounting ring are required. For metal-dash mounting, the mounting ring is omitted and shorter screws (⅜-inch long) are used.

Dimensions—The instrument has a diameter over its flange of approximately 3¾ inches and requires an opening in the dash of approximately 3 inches.

Weights—Net 12 ounces, boxed 17 ounces.

PRICES

Style number and list price include instrument only—order mounting accessories separately.

Ammeters

Scale	Case Finish	Dial Finish	Style No.	List Price
15–0–15	Black	Black	217588	$9 00
20–0–20	Black	Black	226409	9 00
30–0–30	Black	Black	243355	9 00

Voltmeters

Scale	Case Finish	Dial Finish	Style No.	List Price
3.5–8.5	Black	Black	217589	$9 00
7–17	Black	Black	221876	9 00

Mounting Accessories

For Wood Dash

Description	Style No.	List Price Per 100
Mounting screw (black)	245196	$ 1 90
Mounting nut	119326	1 90
Lock washer for nut	125680	0 18
Mounting ring	214960	12 10

For Metal Dash

Description	Style No.	List Price per 100
Mounting screw (black)	216824	$ 1 90
Mounting nut	119326	1 90
Lock washer for nut	125680	0 18

Order by Style Number

TYPE AW SWITCHBOARD INSTRUMENTS

DIRECT-CURRENT—3 INCHES DIAMETER—2⅜-INCH SCALES

Application

Especially suitable for use on small direct-current switchboard panels, such as battery charging, generator and control panels for marine, dental, telegraph, telephone, and farm lighting equipments.

Principle of Operation

The D'Arsonval type of movement is employed.

Construction

Round open-face, glass cover, with rear mounting studs, stamped metal case and rim.

Finish—Standard finish is dull black.

Ammeters—Type AW ammeters are self-contained up to 15 amperes. Above this capacity external shunts of 50 millivolts drop at full scale are included in style numbers listed. If desired for capacities greater than those listed, the uncalibrated style (which includes shunt leads 8 feet long) should be ordered with a 50-millivolt shunt of proper capacity.

Voltmeters—The voltmeters are self-contained in all the capacities listed.

Duplex Instruments—Consist of two type AW instruments mounted in an attractive dull-black metal case. Standard combination will be made up of any two type AW instruments listed on this page.

Insulation—The insulation of the type AW instruments meet the A. I. E. E. specifications for circuits not over 150 volts.

Accuracy—Type AW instruments are guaranteed to be correct within 2 per cent of full scale at all parts of the scale.

Dimensions—Type AW is 3⅛ inches in diameter over all and projects 1⅞ inch from face of panel; studs suitable for panels up to ¾ inch thick.

Approximate Weights—Net 1½ pounds, boxed 2 pounds.

Ammeters

Scale	Style No.	List Price
*Uncalibrated	246833	9 00
0–1	246815	9 00
0–5	246816	9 00
0–10	246817	9 00
0–15	246818	9 00
0–25	246820	9 00
0–50	246822	12 00
0–75	246826	12 00

Voltmeters

Scale	Style No.	List Price
0–1	246829	9 00
0–5	246830	9 00
0–10	246831	9 00
0–15	246832	9 00
0–25	246833	9 00
0–50	246834	12 00
0–75	246835	12 00
0–150	246836	12 00

Duplex Instruments

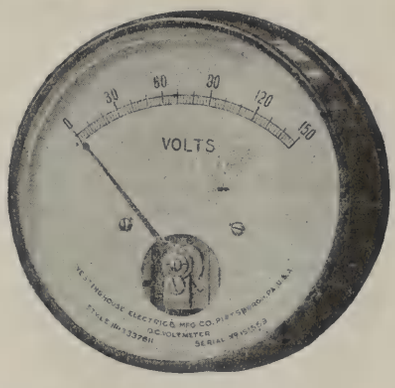
Scale	Style No.	List Price
†	272900	**

*Will be calibrated as desired on order.
†See description. Always specify calibration wanted on each element.
**$22.00 for capacities less than 50 amperes and less than 50 volts. $28.00 for capacities of 50 or 75 amperes and for voltages not exceeding 150 volts. Prices for higher capacities on request.

TYPE AW DUPLEX INSTRUMENT

TYPE FW SWITCHBOARD INSTRUMENTS

DIRECT-CURRENT—5 INCHES DIAMETER—4-INCH SCALES



Application

Type FW instruments are especially suitable for use on small direct-current switchboard panels, such as for isolated plants; battery charging, generator, and control panels for marine, dental, telegraph, telephone, and farm lighting equipments; and for use as speed indicators and temperature indicators when properly calibrated (see pages on "Speed Indicators" and "Temperature Indicators").

Principle of Operation

The D'Arsonval type of movement is employed.

Construction

Round open face glass cover with rear mounting studs.

Insulation meets A. I. E. E. specifications for 600-volt circuits.

Finish—Standard finish is dull black marine case and white dial. Instruments with black dials can be furnished at same price if so ordered. When ordering black dials specify "Similar to Style No..... except to have black dial."

Accuracy—Type FW ammeters are correct within 2 per cent of full scale at all parts of the scale. Type FW voltmeters are correct within 1 per cent of full scale at all parts of the scale.

Dimensions—5⅛ inches diameter; projects $2\frac{5}{16}$ inches from face of panel; studs suitable for panels up to 2 inches thick.

Approximate Weight—Net 2½ pounds, boxed 3½ pounds.

Ammeters—Type FW ammeters up to 75 amperes are supplied with special external shunts mounted on the studs. If desired for capacities greater than those listed, the uncalibrated style (which includes shunt leads 8 feet long) should be ordered with a 50-millivolt shunt of proper capacity.

Duplex Instruments—Consist of two type FW instruments mounted in an attractive dull-black metal case. Standard combination will be made up of any two type FW instruments listed on this page.

Ammeters

Scale	Style No.	List Price
*Uncalibrated	185388	$18 00
0–1	185389	18 00
0–5	185390	18 00
0–10	185391	18 00
0–15	185392	18 00
0–25	185393	18 00
0–50	185394	18 00
0–75	185395	18 00

Voltmeters

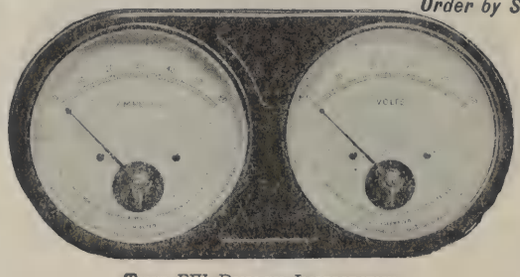
0–5	185397	18 00
0–10	185398	18 00
0–15	185399	18 00
0–25	185400	18 00
0–50	185401	18 00
0–75	185402	18 00
0–150	185403	18 00
0–200	185404	18 00
0–300	185405	18 00
0–600	185406	20 00
0–750	185407	24 00
750–0–750	251365	25 00

Duplex Instruments

Scale		
†	272901	**42 00

*Will be calibrated as desired on order.
†See description. Specify calibration wanted on each element.
**Applies for any current and voltage listed above

Order by Style Number



TYPE FW DUPLEX INSTRUMENT

TYPE SL SWITCHBOARD AMMETERS AND VOLTMETERS

DIRECT-CURRENT—7 INCHES DIAMETER—7-INCH SCALES

Application

Intended for the most general switchboard applications, wherever highest grade instruments are required. Match in appearance the types SM, SI, and SD seven-inch alternating-current switchboard instruments.

Distinctive Features

Scales are approximately seven inches long.

Covers are of flat glass rendering the entire pointer visible; this makes it easy to take readings from a distance and from any angle.

Cases are of soft iron, easily removed, the base remaining on the panel.

Operation

Operate on the D'Arsonval principle, but have a moving coil operating in a single air gap.

Construction

The complete movement is readily removed for repairs. The single air-gap construction makes it possible to remove the moving coil without first removing the pole pieces and without disturbing in any way the magnetic circuit.

Connections—Type SL instruments are furnished regularly for rear connection.

Insulation meets A. I. E. E. specifications.

Finish—Standard finish is dull black marine.

Resistance—The resistance is approximately 50 ohms per volt up to 750 volts. For higher voltages the resistance is 100 ohms per volt.

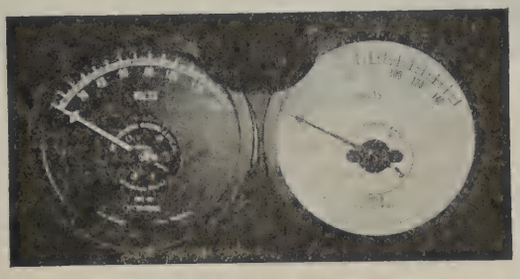
Accuracy—One per cent of full scale at points between ½ and ¾ scale, and average accuracy 2 per cent of full scale at other points.

Dimensions—Overall diameter $7\frac{7}{16}$ inches; depth from switchboard, 4 inches.

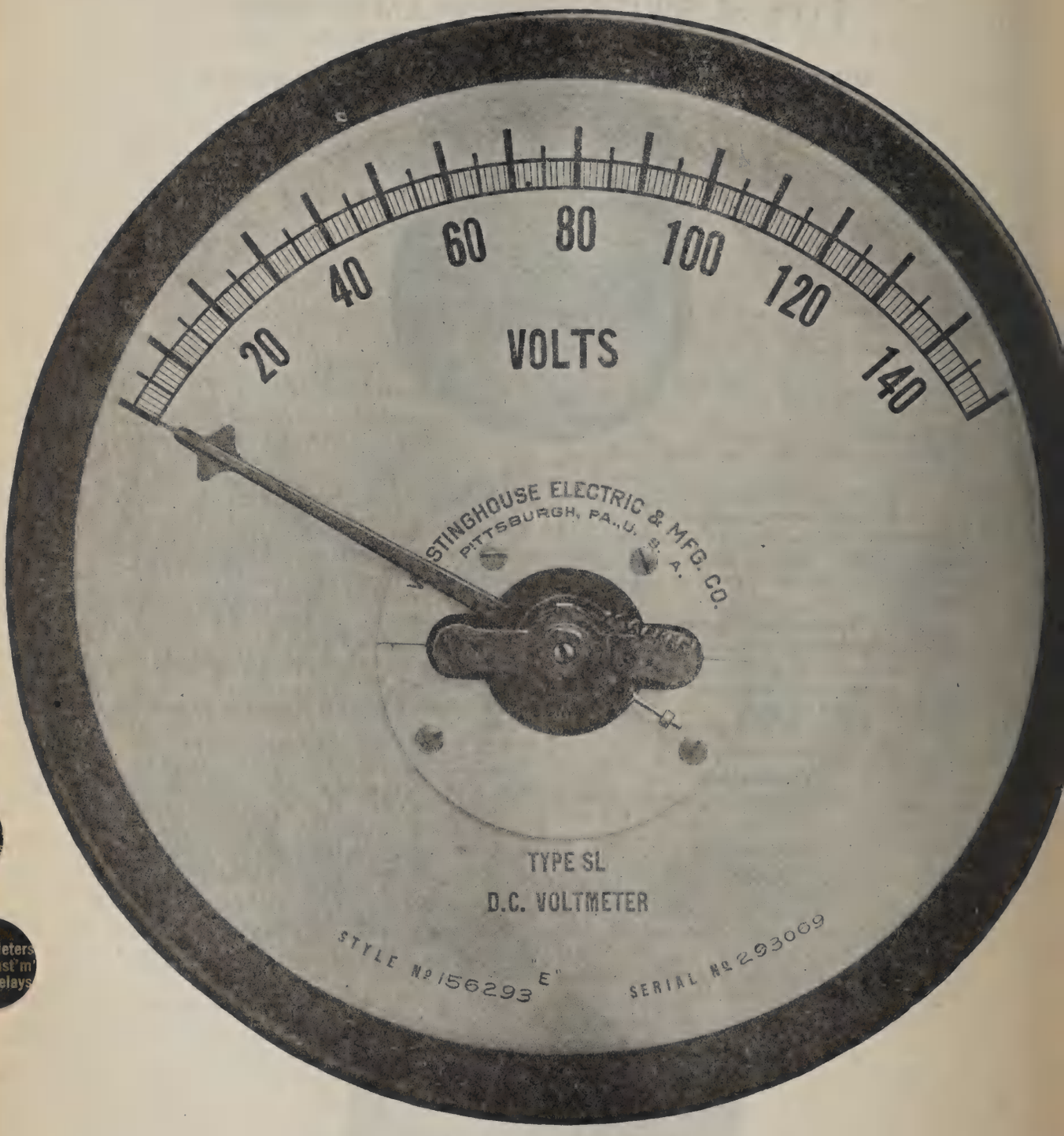
Approximate Weight—11 pounds net, 25 pounds boxed.

Black Dials—Instruments can be furnished when desired with black dial, the figures, scale, and pointer being white. Under many conditions of station illumination this arrangement will be found to add considerably to readability, the principle involved being to illuminate only those parts which are to be observed. When ordering black dial instruments specify "Similar to Style No..... except to have black dials."

Shunts—Type G shunts are used with type SL shunt-type ammeters. For description and prices see page on "Shunts for D. C. Ammeters."



COMPARATIVE ILLUMINATION ON BLACK AND WHITE-DIAL INSTRUMENTS



FULL-SIZE VIEW OF TYPE SL VOLTMETER
ACTUAL DIAMETER 7⅜ INCHES

TYPE SL D. C. SWITCHBOARD INSTRUMENTS—Continued

High-Voltage Instruments—Several Type SL ammeters and voltmeters are listed with special insulation for use on direct-current railway or series arc circuits of voltage up to 4000.

Ammeters†

With the exception of the self-contained styles, type SL ammeters operate from shunts and give full scale deflection with 50 millivolt drop at the terminals of the shunt.

Self-Contained Ammeters

Style number and price include instrument with internal shunt ready to connect.

Calibration Amp.	Maximum Voltage of Circuit	Style No.	List Price
5	750	173047	$30 25
10	750	173048	30 25
15	750	173049	30 75
25	750	173050	30 75
50	750	173051	31 25
75	750	173052	31 25
7	4000	179002	34 50
10	4000	179003	34 50

Shunt-Type Ammeters

Style number and price include instrument complete, without shunt, but with 8-foot shunt leads, ready to connect to circuit. Shunts for these instruments should be ordered separately from pages covering "Shunts for D. C. Ammeters."

Calibration Amp.	Maximum Voltage of Circuit	Style No.	List Price
As desired*	750	156291	$29 50
As desired*	4000	179001	33 75
15	750	156298	29 50
25	750	156299	29 50
50	750	156300	29 50
75	750	156301	29 50
100	750	156302	29 50
150	750	156303	29 50
200	750	156304	29 50
250	750	156305	29 50
300	750	156306	29 50
400	750	156307	29 50
500	750	156308	29 50
600	750	156309	29 50
800	750	156310	29 50
1000	750	156311	29 50
1200	750	156312	29 50
1500	750	156313	29 50
2000	750	156314	29 50
2500	750	156315	29 50
3000	750	156316	29 50

*To be ordered if other capacities than listed are desired.

Voltmeters

The voltmeters require little current to operate them, owing to their high resistance. Above 300 volts capacity, they require external resistors; all others are self-contained.

Style number and price include instrument ready to connect to the circuit.

Calibration Volts	Style No.	List Price
150	156293	$34 00
300	156294	41 00
600	*156295	48 00
750	*156296	50 00
1000	*186381	65 00
1500	*186382	70 00
2000	*186383	80 00
2500	*186384	90 00
3000	*186385	95 00
4000	*186386	100 00

*Includes external resistor.

Differential Voltmeters

Differential voltmeters are furnished for use in paralleling generators. They have the zero in the center of the scale and are arranged to read zero when two equal voltages of the same polarity are applied. Differential voltmeters require external resistors.

Style number and price include instrument and external resistor, ready to connect to the circuit.

Calibration Volts	Style No.	List Price
150	156317	$41 00
300	156318	48 00
600	156319	55 00
750	156320	57 00

Instruments on Special Order

Ground-detector voltmeters, also called "leakage detectors," can be furnished on special order, arranged to read zero when two voltages of opposite polarity are applied. These instruments are also used for indicating unbalanced voltage of three-wire circuits.

Double-reading ammeters and voltmeters with zero at any point of the scale and graduated for readings in both directions, will be furnished on special order.

Pyrometry millivoltmeters for use with thermo-electric couples can be adjusted for 20 to 100 millivolts, full scale. The current required at full scale is .01 ampere. The scale can be calibrated in millivolts or degrees. Prices on request.

Temperature Indicators—Voltmeters arranged as resistance-type temperature indicators, complete with coils or bulbs, can be furnished for reading the temperature of machinery, ovens, etc. Scale can be calibrated in volts or degrees. Prices on request. (See also pages on "Temperature Indicators").

Speed Indicators—See pages on "Speed Indicators."

Frequency Indicators—See pages on "Speed Indicators."

Dust-Proof and Damp-Proof Instruments—Type SL instruments can be supplied on special order with special gaskets, making them dust-proof and damp-proof, as may be required in some installations under severe conditions such as mines and cement mills. Where so supplied an additional list price of **$2.50** should be added to the list price of the standard instrument.

Type TL Instruments—In order to match up present installations of 9-inch instruments, instruments similar to type SL, except to have 9-inch cases can be supplied on special order; price on request.

†Where the ammeter is to be mounted **directly** in front of and **near** vertical bus bar carrying a heavy current, a special instrument should be obtained. Prices and description on request.

FULL-SIZE VIEW OF TYPE SM AMMETER
ACTUAL DIAMETER 7⅜ INCHES

TYPE SM SWITCHBOARD AMMETERS, VOLTMETERS, AND WATTMETERS

ALTERNATING-CURRENT—7 INCHES DIAMETER—14½-INCH SCALES

Application

Intended for the most general switchboard applications, wherever the highest grade, perfectly damped instruments are required. These instruments form a part of a complete line of seven-inch instruments, making it possible to produce a switchboard of harmonious appearance.

Distinctive Features

The scales of the type SM instruments are 14½ inches long.

Cases are of soft iron and can be easily removed, leaving the instrument and base on the switchboard.

Covers are of flat glass, making it possible to read the instrument at a distance and from any angle.

Torque—The exceptionally high torque developed in the instruments makes them extremely sensitive to actual changes in load, as distinguished from momentary fluctuation, which are damped out. They are not affected by temperature changes, or by any variation from normal frequency found in switchboard service.

Operation

Type SM instruments operate on the induction principle, which results in a very simple construction.

Construction

The complete movement is readily removed for repairs. The moving element consists of a light drum and a pointer, both of aluminum, mounted on an aluminum shaft, with removable steel pivots.

Connections—Instruments are furnished regularly only for rear connection.

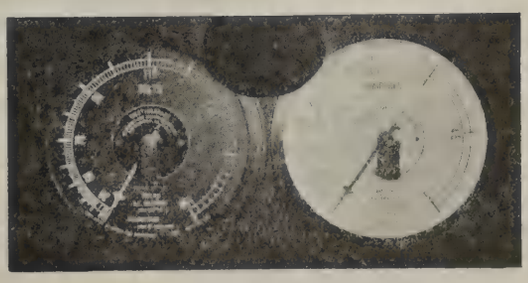
Finish—Standard finish is dull black marine.

Insulation meets A. I. E. E. specifications.

Accuracy—The ammeters and voltmeters are guaranteed to be correct within 1 per cent of full scale at all points of the scale; the wattmeters within 2 per cent.

Dimensions—Overall diameter, $7\frac{7}{16}$ inches; depth from switchboard, 4 inches; polyphase wattmeter requires hole $7\frac{1}{16}$ inches diameter through panel.

Black Dials—Instruments can be furnished, when desired, with black dials, the figures, scale, and pointer being white. Under many conditions of station illumination this arrangement will be found to add considerably to readability, the principle involved being to illuminate only those parts which are to be observed. When ordering black dial instruments



COMPARATIVE ILLUMINATION ON BLACK AND WHITE-DIAL INSTRUMENTS

specify "Similar to Style No.....except to have black dials."

Type TM Instruments—In order to match up present installations of 9-inch instruments, instruments similar to type SM except to have 9-inch cases can be supplied on special order, price on request.

Dust-Proof and Damp-Proof Instruments—Type SM instruments can be supplied on special order with special gaskets, making them dust-proof and damp-proof, as may be required in some installations under severe conditions such as mines and cement mills. An additional list price of **$2.50** should be added to the list price of the standard instrument.

STANDARD SCALES

To secure easy readings and clear scales, the following scales are considered standard, and instruments will be calibrated to these scales only.

Wattmeters

Full Scale	Number of Divisions
10, 100, 1000, etc.	100
12, 120, 1200, etc.	60
16, 160, 1600, etc.	80
20, 200, 2000, etc.	100
25, 250, 2500, etc.	125
30, 300, 3000, etc.	120
40, 400, 4000, etc.	80
50, 500, 5000, etc.	100
60, 600, 6000, etc.	60
80, 800, 8000, etc.	80

Ammeters and Voltmeters

Full Scale	Number of Divisions
10, 100, 1000, etc.	100
12, 120, 1200, etc.	120
15, 150, 1500, etc.	150
16, 160, 1600, etc.	160
20, 200, 2000, etc.	100
24, 240, 2400, etc.	120
25, 250, 2500, etc.	125
30, 300, 3000, etc.	150
40, 400, 4000, etc.	160
50, 500, 5000, etc.	100
60, 600, 6000, etc.	120
75, 750, 7500, etc.	150
80, 800, 8000, etc.	160
90, 900, 9000, etc.	90

VOLTMETERS

Voltmeters should be selected with full-scale marking about 50 per cent greater than nominal voltage of the circuit.

For voltage or frequencies other than listed, the "uncalibrated" voltmeters should be ordered with transformers to suit the conditions. The 135-to-165-volt instruments should be specified ordinarily; but when the secondary voltage of the transformer at full-scale deflection of the instrument falls below this range, the 100-to-135-volt instruments should be specified. All voltmeters have external series resistors.

Style number and list price include voltmeter complete with resistor when necessary. Price of "uncalibrated" voltmeter includes calibration for any standard scale selected, at either 25 or 60 cycles. In ordering "uncalibrated" instruments specify frequency, transformer ratio, and full scale of instrument.

Transformers when required should be ordered separately from pages on "Voltage Transformers."

Approximate Weight—11 pounds net, 25 pounds boxed.

Voltage for Full Scale Deflection	Style No.	List Price
	Calibrated on 25 Cycles	
150	156585	$42 00
300	156587	46 50
600	156589	51 50
750	156591	56 50
	Calibrated on 60 Cycles	
150	156586	42 00
300	156588	46 50
600	156590	51 50
750	156592	56 50
	"Uncalibrated"	
100 to 135	172193	44 00
135 to 165	156584	42 00

AMMETERS

Ammeters should be selected with full-scale markings about 50 per cent in excess of the full load of the circuit. For circuits of more than 8 amperes maximum current or for circuits of any capacity at more than 600 volts, current transformers are required, except for the type SM self-contained ammeters.

The calibrated instruments for operation from current transformers give full-scale deflection with 5 amperes in the coil. They must be used with transformers having a primary rating the same as full-scale marking of the instrument and a secondary rating of 5 amperes.

Style number and list price include instruments complete without transformer. Price of "uncalibrated" instrument includes calibration for any standard scale selected, and at either 25 or 60 cycles. In ordering "uncalibrated" instruments specify style number, frequency, transformer ratio, and full scale of instrument.

Approximate Weight—11 pounds net, 25 pounds boxed.

Order by Style Number

TYPE SM A. C. SWITCHBOARD INSTRUMENTS—Continued

Calibrated Ammeters

(5 Amperes for Full-Scale Deflection)

Scale	25 Cycles Style No.	25 Cycles List Price	60 Cycles Style No.	60 Cycles List Price
5	195979	$33 00	195980	$33 00
10	199335	33 00	199336	33 00
20	194349	33 00	194354	33 00
30	194350	33 00	194355	33 00
40	194351	33 00	194356	33 00
60	194352	33 00	194357	33 00
80	194353	33 00	194358	33 00
120	156610	33 00	156620	33 00
200	156611	33 00	156621	33 00
300	156612	$33 00	156622	$33 00
400	156613	33 00	156623	33 00
600	156614	33 00	156624	33 00
800	156615	33 00	156625	33 00
1000	156616	33 00	156626	33 00
1200	156617	33 00	156627	33 00
1600	156618	33 00	156628	33 00
2000	156619	33 00	156629	33 00

"Uncalibrated" Ammeters

Amperes for Full Scale Deflection	Style No.	List Price
3.5 to 4.5	163088	$34 00
4.5 to 5.5	156572	34 00
5.5 to 6.8	163089	$34 00
6.8 to 8.2	163090	34 00

Self-Contained Type SM Ammeters

Used without transformers on circuits whose maximum voltage does not exceed the values given. Style number and list price include self-contained type SM ammeter complete, calibrated as listed.

Amp.	Max. Volts	Style No. 25 Cycles	Style No. 60 Cycles	List Price
5	4000	174397	174406	$33 00
10	4000	174398	174407	34 00
15	4000	177054	177055	35 00
20	2500	174399	174408	36 00
30	2500	183968	183970	37 00
40	2500	174400	174409	$38 00
60	2500	183969	183971	40 00
80	2500	174401	174410	42 00
120	2500	174402	174411	44 00
160	2500	188693	188694	46 00
200	2500	174403	174412	48 00

WATTMETERS

The wattmeters indicate true energy, regardless of power factor. The polyphase instruments indicate the true energy in a two-phase or a three-phase circuit regardless of unbalance.†

Wattmeters should be selected with full-scale capacity 50 per cent in excess of full load of the circuit and with voltage rating within 25 per cent of the voltage of the circuit. For voltage more than 25 per cent above the voltage listed, voltage transformers are necessary and should be ordered to suit the conditions. For circuits of more than 10 amperes maximum current, or for circuits of any capacity at more than 600 volts, current transformers are required.

All wattmeters have external series resistors for the voltage circuit. Current transformers should be selected with a primary rating 50 per cent in excess of full load of the circuit and a secondary rating of 5 amperes. The 4.5 to 5.5 ampere instruments will be ordinarily required. When an instrument is desired, however, with full-scale capacity differing from the product of the nominal primary ratings of the transformers, the secondary current of the current transformer should be determined for full scale of instrument at normal voltage, and the instruments selected for the proper range of calibration.

Style Number and List Price include wattmeter complete without transformers. Price includes calibration at either 25 or 60 cycles and for any standard full-scale. **In ordering** specify style number, frequency, transformer ratios, and scale desired.

Transformers should be ordered separately from the pages on "Current and Voltage Transformers."

One current transformer is required for single-phase operation, two for two-phase and three-phase three-wire, and three for three-phase, four-wire. One voltage transformer is required for single-phase operation and two for polyphase.

Approximate Weight—Single-phase, 14 pounds net, 30 pounds boxed; polyphase, 22 pounds net, 40 pounds boxed.

Nominal Current Amperes	Nominal Voltage	Style No.	List Price
Single-Phase Wattmeters			
*4.5 to 5.5	110	156988	$ 72 00
8.8 to 11.5	110	156989	74 00
*4.5 to 5.5	220	156993	76 50
8.8 to 11.5	220	156994	78 50
*4.5 to 5.5	440	156998	81 50
8.8 to 11.5	440	156999	83 50
Polyphase Wattmeters			
3.5– 4.5	110	163093	103 50
*4.5– 5.5	110	157024	101 50
5.5– 6.8	110	163094	103 50
6.8– 8.8	110	189696	103 50
8.8–11.5	110	157025	105 50
3.5– 4.5	220	189697	112 50
*4.5– 5.5	220	157029	110 50
5.5– 6.8	220	189698	112 50
6.8– 8.8	220	189699	112 50
8.8–11.5	220	157030	114 50
3.5– 4.5	440	189700	123 00
*4.5– 5.5	440	157034	121 00
5.5– 6.8	440	189701	123 00
6.8– 8.8	440	189702	123 00
8.8–11.5	440	157035	125 00
3.5– 4.5	550	272999	123 00
*4.5– 5.5	550	273000	121 00
5.5– 6.8	550	273001	123 00
6.8– 8.8	550	273002	123 00
8.8–11.5	550	273003	125 00

*Standard instrument. For application of other instruments with special range, see paragraphs above.

†Can also be calibrated specially for use as Reactive Component Meters.

TYPE SD SWITCHBOARD FREQUENCY METERS

ALTERNATING-CURRENT—7 INCHES DIAMETER

Application

For general switchboard application where it is desirable to keep the speed of the prime movers within close limits.

Operation

The instrument, which operates on the induction principle, consists of two voltmeter electro-magnets acting in opposition on a disk attached to the pointer shaft. One of the magnets is in series with a reactor and the other with a resistor, so that any change in the frequency will unbalance the forces acting on the shaft and cause the pointer to assume a new position where the forces are again balanced. The aluminum disk, acted upon by the magnets, is so arranged that when the shaft turns in one direction the torque of the magnet tending to rotate it decreases, while the torque of the other magnet increases. The pointer therefore comes to rest where the torques of the two magnets are equal. This arrangement insures freedom from error due to varying voltage.

The instruments contain no moving wires, iron, or vibrating reeds, and no controlling springs, the controlling forces being entirely electrical.

Construction

Round pattern, 7 inches in diameter, and of same general construction as type SM instruments.

The scales are 5½ inches long with large, open divisions. Normal frequency is usually at the top of the scale, so that any variation can be easily noted. Instruments with double scales, for use on two frequencies, can be supplied on special order.

Damping—The element moves in a magnetic field and therefore has good damping characteristics. Hunting is entirely absent, yet the sensitiveness to changes in frequency is not interfered with.

Accuracy—These frequency meters are not affected by temperature changes or by variations in voltage within 25 per cent of the voltage on which they are calibrated. Accuracy is guaranteed to be within 1 per cent of full scale as shipped.

Finish—Standard finish is dull black marine.

Insulation meets A. I. E. E. specifications.

Transformers—The standard instruments are designed for circuits of 110 volts nominal and can be used on voltage up to 125 volts. For higher voltages, transformers with nominal 110-volt secondary should be used. Resistors for use on 200, 400 and 600-volt circuits without transformers can be furnished as indicated below.

Dimensions—Same as type SM voltmeters.

Approximate Weight—11 pounds net, 25 pounds boxed.

Black Dials—Instruments can be furnished, when desired, with black dials, the figures, scale, and pointer being white. When ordering black dial instruments specify "Similar to Style No. . . . . , except to have black dials".

Type TD Frequency Meters—Similar instruments in cases approximately 9 inches diameter can be furnished on special order to match up existing installations of type TD frequency meters. Price on request.

Style number and list price include 110-volt instrument without transformer.

Frequency	Style No.	List Price
25	157228	$84 50
60	157229	84 50

Resistors

Style No.	List Price
110757 for 220 Volts	$3 50
110756 for 440 Volts	5 00
72458 for 550 Volts	6 50

Order by Style Number

TYPE SI SWITCHBOARD POWER FACTOR METERS
ALTERNATING-CURRENT—7 INCHES DIAMETER

Application

The use of direct-reading power factor meters is necessary on circuits where there is control of power factor or where for other reasons it is desirable to have a continuous indication of power factor. They are quite generally used on panels controlling generators, synchronous converters, condensers, or motors.

Distinctive Features

These instruments have open, distinctly marked scales embracing a complete circle, and are highly damped; scales are marked to indicate the cosine of the angle of lag. They match in size and appearance the types SM, SD and SL instruments.

Operation

Operate on the rotating field principle. In rotating field produced by coils connected to the metered circuits there is pivoted a movable iron vane or armature, magnetized by a stationary coil the current for which is taken from a current transformer in one phase of the circuit. As the iron vane is attracted or repelled by the rotating field, it takes up a position where the zero of the rotating field occurs at the same instant as zero of its own field. Thus its position indicates the phase angle between the voltage and current of the circuit.

In the three-phase instrument the rotating field is produced by three voltage coils spaced 120 electrical degrees apart; and in the single-phase instrument by means of a split-phase winding connected to the voltage circuit.

Construction

The instruments are enclosed in round, dust-proof cases. There are no movable coils or flexible connections and no springs are used to control the movement. The construction is therefore extremely simple and rugged. External fields cannot influence the readings.

Finish—Standard finish is dull black marine.

Insulation meets A. I. E. E. specifications.

Dimensions—Diameter, $7\frac{7}{16}$ inches; depth, 4 inches.

Approximate Weight—11 pounds net, 25 pounds boxed.

Single-phase instruments indicate the power factor of a single-phase circuit, or of one branch of any polyphase circuit. Special calibration is necessary in order to use a single-phase instrument on a three-phase circuit, unless the voltage coil is connected from one line to the neutral. External resistors are furnished with all single-phase instruments.

For two-phase circuits one single-phase instrument should be used.

Three-phase instruments have three internal voltage coils and one current coil. Each three-phase instrument is furnished with three external resistors for the voltage coils.

Transformers—The instruments are furnished regularly for 5 amperes and the voltages listed. For circuits of other voltage or current, transformers are required: Single-phase and three-phase instruments require one current transformer. Single-phase instruments require one voltage transformer; three-phase instruments require two.

Black-dial instruments can be furnished when desired. When ordering black-dial instruments specify "Similar to Style No. . . . . , except to have black dials".

Type TI power factor meters can be furnished to match up with existing installations. Price on request.

Style number and list price include a 5 ampere instrument without transformers.

	Style No.				
	Single-Phase		Three-Phase		List Price
Volts	25 Cycle	60 Cycle	25 Cycle	60 Cycle	
110	157246	157247	272924	272925	$77 50
220	272920	272921	272926	272927	80 50
440	272922	272923	272928	272929	83 50
550	272935	272936	272937	272938	85 00

Instruments can be used on circuits whose normal voltage is 25 per cent greater than voltage listed.

Order by Style Number

TYPE SI SWITCHBOARD REACTIVE FACTOR METERS

ALTERNATING-CURRENT— 7 INCHES DIAMETER

Application

Certain types of synchronous machines such as synchronous converters are designed to operate only at unity power factor; in other words, with minimum idle volt-amperes. Any divergence from this condition greatly increases the heating of the windings. As this heating is a function of the "reactive factor" of the volt-amperes, an ordinary power factor meter indicates this condition somewhat indirectly. Thus with a power factor indication of 95 per cent, which the average operator considers good, there are 31.5 per cent reactive volt-amperes flowing. A direct indication of the reactive factor is thus preferable on all synchronous machines designed primarily for operation at high-power factors.*

Distinctive Features

These instruments have open, distinctly marked scales, and are highly damped. The scales are marked to indicate the sine of the angle of lag.

Operation and Construction

The operation and construction are same as in the type SI power factor meter described on previous page.

Finish—Standard finish is dull black marine.

Insulation meets A. I. E. E. specifications.

Dimensions—Overall diameter, $7\frac{7}{16}$ inches; depth, 4 inches.

Approximate Weight—11 pounds net, 25 pounds boxed.

Single-phase instruments indicate the reactive factor of a single-phase circuit or of one branch of any polyphase circuit. Special calibration is necessary in order to use a single-phase instrument on a three-phase circuit, unless the voltage coil is connected from one line to neutral. External resistors are furnished for all single-phase instruments.

For two-phase circuits one single-phase instrument should be used.

Three-phase instruments have three internal voltage coils and one internal current coil. Each three-phase instrument is furnished with three external resistors for the voltage coils.

Transformers—The instruments are furnished regularly for 5 amperes and the voltages listed below. For circuits of other voltage or current, transformers are required: Single-phase and three-phase instruments require one current transformer. Single-phase instruments require one voltage transformer; three-phase instruments require two.

Black-dial instruments can be furnished, when desired. When ordering black-dial instruments specify "Similar to Style No. . . . . , except to have black dials".

Type TI Reactive Factor Meters—Similar instruments can be furnished to match existing installations of 9-inch reactive factor meters. Price on request.

Style number and list price include 5-ampere instrument without transformers.

	Single-Phase		Three-Phase		
Volts	Style No. 25 Cycles	Style No. 60 Cycles	Style No. 25 Cycles	Style No. 60 Cycles	List Price
110	202750	202751	202756	202757	$77 50
220	202752	202753	202758	202759	80 50
440	202754	202755	202760	202761	83 50
550	272939	272940	272941	272942	85 00

Instruments can be used on circuits whose normal voltage is 25 per cent greater than the voltage listed.

*Reactive Factor Meters should not be confused with Reactive Component Wattmeters on which information will be sent on request.

Order by Style Number

TYPE SI SWITCHBOARD SYNCHRONOSCOPE

ALTERNATING-CURRENT—7 INCHES DIAMETER

Application

Indicate by means of a pointer, which assumes at every instant a position corresponding to the phase angle between the e.m.f.'s of the bus-bars and the incoming machine. Give exact indications, which are impossible with synchronizing lamps and which are a necessity in the paralleling of large generators. Pointer is continuously visible during both the dark and the light periods of the synchronizing lamps.

In installations where a considerable distance separates the control board from the prime movers, it is good practice to provide an additional synchronoscope on the turbine gauge board for the guidance of the turbine operator.

Operation

The principle of operation is the same as for Westinghouse single-phase power factor meters. A rotating field is produced by current from the bus-bars passing through a split-phase winding and two angularly placed coils. In this rotating field is a movable iron vane, or armature, magnetized by a stationary coil connected across the incoming machine. The iron vane takes a position where the zero of the rotating field occurs at the same instant as the zero of the stationary field. Thus its position at every instant indicates the phase angle between the voltage of the incoming machine and that of the bus-bars. As this angle changes, due to difference in frequency, the iron vane with the pointer attached to it rotates, and when synchronism is reached it remains stationary. This principle results in a greater reliability than is possible with moving coil devices.

Construction

Type SI synchronoscopes are of the same general appearance as the type SM instruments. The glass front allows the dial to be thoroughly illuminated and makes the entire pointer visible, so that the indications are clearly discernable at a considerable distance. All Westinghouse synchronoscopes are made single-phase.

Finish—Standard finish is dull black marine.

Insulation meets A. I. E. E. specifications.

Dimensions—Overall diameter, $7\frac{7}{16}$ inches; depth, 4 inches.

Approximate Weight—11 pounds net, 25 pounds boxed.

Transformers—Westinghouse synchronoscopes are designed for circuits of 110 volts nominal and can be used on potentials up to 125 volts. For other voltages, transformers should be selected from pages on voltage transformers. These synchronoscopes take 10 watts per circuit and can be operated from the same transformers as other instruments. It is usual to install one transformer on each generator circuit with a six-point synchronizing plug and receptacle in the secondary circuit of each. For synchronizing plugs see catalogue on "Wiring Devices and Carbon Circuit-Breakers."

Black Dials—Instruments can be furnished when desired with black dial, the figures, scale, and pointer being white. When ordering black-dial instruments specify "Similar to Style No....., except to have black dials."

Type TI Synchronoscopes—Similar instruments in cases approximately 9 inches in diameter can be furnished to match up with existing installations of 9-inch instruments. Price on request.

Style number and list price include single-phase synchronoscope complete, but without transformers or synchronizing plugs or receptacles.

Frequency Cycles	Style No.	List Price
25	157244	$97 50
60	157245	97 50

Order by Style Number

TYPE TG SWITCHBOARD ELECTROSTATIC GROUND DETECTORS AND VOLTMETERS

ALTERNATING-CURRENT—9 INCHES DIAMETER

SINGLE-PHASE GROUND DETECTOR

POLYPHASE GROUND DETECTOR

TYPE TG ELECTROSTATIC GROUND DETECTORS

Application

Ground detectors are desirable on some alternating-current transmission or distributing systems to indicate a ground before it has developed to any serious extent. On a system in which one conductor might become grounded without tripping the circuit-breakers or a similar result, ground detectors are recommended. On high-voltage circuits no other than the electrostatic type of ground detector is practicable.

Limitations—The practical application of ground detectors is limited to overhead lines without a grounded neutral and on which the normal charging current passing into a ground is insufficient to trip a breaker, and to small underground systems.

Operation

The type TG ground detectors are connected to the circuit through condensers, so that the potential at the switchboard is low and safe.

The single-phase ground detector indicates a ground on either side of the system by the movement of a pointer. It is intended for use on single-phase system or in pairs on a two-phase system. Two single-phase instruments can be used on a three-phase system, and the grounded line determined by a comparison of the indications. The moving vane moves away from the fixed vane connected with the line on which a ground occurs.

The three-phase ground detector indicates a ground in any phase, and which phase is grounded. The movable-indicating vane moves away from the fixed vane connected with the grounded line.

Construction

The instruments are enclosed in metal cases with flat glass fronts.

Finish—Standard finish is dull black marine.

Insulation meets A. I. E. E. specifications.

Dimensions—Overall diameter, 9⅝ inches; height on switchboard, 11½ inches including terminal post clearance; depth, 5⅛ inches.

Approximate Weight—12 pounds net, 32 pounds boxed.

Style number and list price include instrument complete with condensers as listed, ready to connect to the circuit.

Volts	No. of Condensers	Style No.	List Price
		Single-Phase	
2200	2	15803	$ 80 00
3500	2	183616	82 00
6600	2	15804	91 00
11000	2	15805	100 00
22000	2	15806	106 00
		Three-Phase	
2200	3	35586	$108 00
3500	3	183615	113 00
6600	3	35587	118 00
11000	3	35588	123 00
22000	3	35589	126 00

By means of special condensers these instruments can be adapted for higher voltages than listed. Prices upon request.

Order by Style Number

TYPE TG ELECTROSTATIC VOLTMETERS

Application

The electrostatic voltmeter is both a voltage indicator for single-phase high-voltage lines, and a ground detector. Its accuracy is insufficient for use as a voltmeter in the usual sense of the term; but for approximate voltage indications it is very serviceable.

Construction

These instruments are similar to single-phase electrostatic ground detectors except that a single reading movement is used with one stationary and one movable vane. The zero is at the left end of a scale graduated in volts. The stationary vane is connected to the line through a condenser, the movable vane and the case being grounded.

Accuracy—The electrostatic voltmeters as shipped are accurate within 5 per cent of full scale voltage.

Style number and list price include instrument complete with condensers.

Voltage To Ground	Full Scale Volts	Style No.	List Price
2200	3000	112882	$65 00
6600	9000	112883	68 00
11000	15000	112884	69 00
22000	20000	112885	71 00

By means of special condensers these instruments can be adapted for higher voltages than listed. Prices upon request.

CONDENSERS

The condenser consists of a brass tube covered with a layer of insulating material and a copper sheath. The inner tube is connected to the line and the outer sheath to a fixed vane of the ground detector. The condenser insulates the instrument from the line but the lead connecting the instrument and condensers must be treated as high-voltage conductors to avoid a disturbance of their electrostatic charge. They cannot be enclosed in metal conduits.

Volts	Approx. Wt., Lb. Net	Boxed	Style No.	List Price
2200	5	11	29897	$12 00
3500	5	11	163699	14 00
6600	5	11	29898	16 00
11000	5	11	29899	18 00
22000	5	11	29900	22 00

Order by Style Number

ELECTROSTATIC GLOW METER

FIG. 1—FRONT VIEW OF GLOW METER

Application

This is a vacuum-tube type of electrostatic potential indicator which may be used for indication of potential on the line, as a ground detector, or as an electrostatic synchronism indicator.

In high-tension switching stations where no wattmeters are used it is often desirable to have an indication of the presence of potential, of a grounded phase, or of the condition of synchronism between two separate high-tension lines. Where no potential transformers are needed for other purposes, it becomes very expensive to provide the above indication. A simple device for securing these indications through the electrostatic discharge of one section of an insulator column has been developed thus obviating the necessity for potential transformers.

Operation

When used as a ground detector or potential indicator the device is connected as shown in figure 3. It will be noticed that one bulb is in parallel with the bottom section of each of the three insulator columns.

When used for synchronizing between a bus and a line or between two lines or two busses the glow meter is connected as shown in figure 4. The phase connections through the top lamp are made such that the lamp will be out at synchronism. The phases to the two lower lamps are crossed so that they will burn at half brilliancy at synchronism. When out of synchronism there will be an apparent rotation which will be an indication as to whether the incoming line is fast or slow.

For switching these instruments small type I oil switches are used, and it is possible to use one glow meter for a number of purposes by providing enough oil switches.

The connecting leads may be run considerable distances if carefully insulated and may be carried into buildings if treated as wiring for 2200 volts. The glow meter should preferably not be mounted on the switch board, but may be mounted above it on a bracket or on the wall or other suitable location.

All indications are that there is no limit to the useful life of the bulb.

Construction

The base on which the apparatus is mounted is of micarta insulation. The indicating device consists of three small bulbs filled with a rare gas which has the property of giving forth a vivid orange-red glow on an extremely small static discharge.

These bulbs are mounted between spring clips and are separated from one another by micarta tubing.

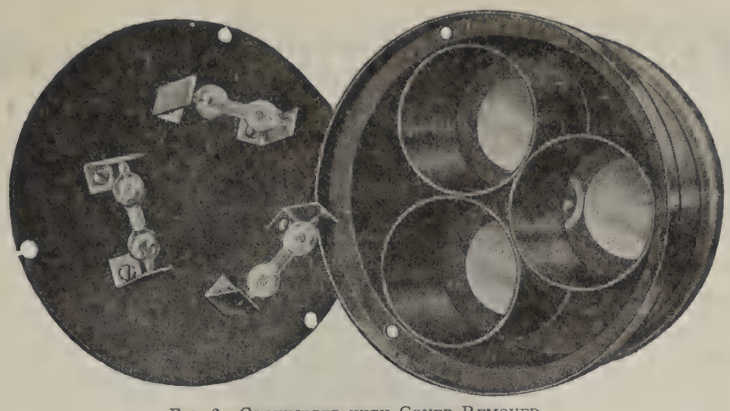


FIG. 2—GLOWMETER WITH COVER REMOVED

Style number and list price cover the instrument complete with case and three bulbs. For lower voltage than listed use the standard condensers as listed under the type TG electrostatic ground detector.

Style No.	Voltage	List Price
289393	22000 to 110,000	**$140 00**

Weights and dimensions—The case is 9 inches in diameter. The net weight is approximately 10 pounds, shipping weight 30 pounds.

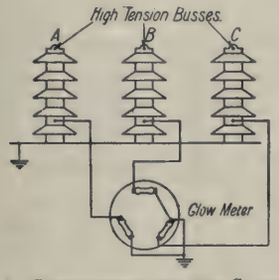


FIG. 3—CONNECTIONS FOR THE GLOWMETER WHEN USED AS GROUND DETECTOR

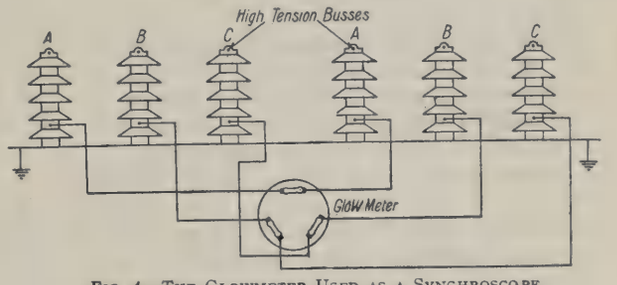


FIG. 4—THE GLOWMETER USED AS A SYNCHROSCOPE

TYPES GL AND GM SWITCHBOARD AMMETERS AND VOLTMETERS

ILLUMINATED DIALS

TYPE GL D. C. AMMETER

Operation and Construction

The type GL direct-current instruments operate on the D'Arsonval principle and type GM alternating-current instruments on the induction principle.

The movements are similar to those of the types SL and SM instruments.

Scales are 15¼ inches long, and are made of translucent material, illuminated from the rear by two 110-volt 6-candle-power tubular lamps.

Finish—Standard finish is dull black marine.

Insulation meets A. I. E. E. specifications.

Accuracy—Type GL voltmeters and ammeters are guaranteed correct within one per cent of full scale at all points. Type GM voltmeters are guaranteed to be correct within 1½ per cent of full scale at all points; ammeters, 2 per cent at all points.

Connections—The instruments are front connected.

Dimensions—Overall height, 12⅛ inches; overall width, 15¾ inches; depth, 3 to 3½ inches; mounting screws suitable for switchboards up to 2 inches thick.

Approximate Weight—21 pounds net, 50 pounds boxed.

Type GL D. C. Ammeters

Ammeters—Shunt leads are furnished with the ammeters but shunts should be ordered separately from pages on "Ammeter Shunts." The ammeters give full deflection with 50-millivolt shunts.

Style number and price include instrument with lamps and shunt leads, calibrated with the shunt ordered.

Description	Style No.	List Price
Ammeter without shunt, scale and calibration as desired	162320	$123 00
Uncalibrated ammeter without shunt for special magnetic field conditions	246343	130 00

Type GL D. C. Voltmeters

The differential voltmeter and the type GL voltmeter above 300 volts require external resistors. All other voltmeters are self-contained.

Differential voltmeters have the zero in the center of the scale and read zero when two equal voltages of the same polarity are applied.

Ground detector voltmeters and double-reading instruments are furnished on special order.

Style number and list price include voltmeter complete.

	VOLTMETER		DIFFERENTIAL VOLTMETER	
Volts	Style No.	List Price	Style No.	List Price
150	162322	$129 00	162326	$135 00
300	162323	132 00	162327	138 00
600	162324	135 00	162328	141 00
750	162325	138 00	162329	144 00

Type GM A. C. Ammeters

Style number and list price include instrument calibrated as desired. Transformers should be ordered to suit conditions, with 5-amperes secondary current at full scale deflection.

Frequency	Style No.	List Price
25 Cycles	166778	$125 00
60 Cycles	166779	125 00

Type GM A. C. Voltmeters

Style number and list price include instrument complete with resistor.

The instrument will be calibrated to order. When desired for circuits of higher voltage or of other frequency than listed, suitable voltage transformers must be used. The secondary of the transformer should be 100 volts at nominal voltage and the scale 50 per cent greater than nominal voltage of the circuit.

	STYLE NO.		
Volts	25 Cycles	60 Cycles	List Price
150	166770	166774	$125 00
300	166771	166775	130 00
600	166772	166776	135 00
750	166773	166777	140 00

Uncalibrated, any frequency, Style No. **166769**, list price $125 00.

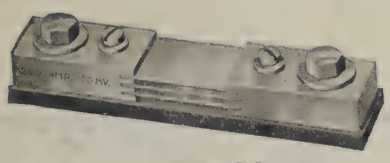
Frosted Tubular Carbon Lamps

Volts*	Watts	Base	Style No.	List Price
110*	30	Edison	99895	On Request

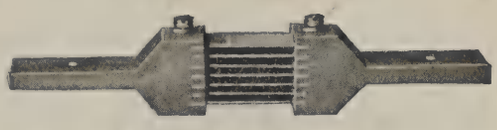
*For 220-volt circuits, reconnect sockets in series. For higher voltages, additional 30-watt carbon lamps can be connected in series on back of switchboard.

TYPE G SHUNTS FOR D.C. AMMETERS

SWITCHBOARD TYPE



200 AMPERE TYPE G SHUNT



500 AMPERE TYPE G SHUNT

The type G shunts are designed for use on horizontal laminated bus bars, but will operate in any position without overheating. The terminal castings above 300 amperes are slotted to receive one ¼-inch copper bar per slot. The sizes ranging from 10 to 300 amperes are mounted on a light micarta strip which takes all strain that might arise from bus-bar distortion, from the terminal lug and manganin plate joint.

The types AW and FW shunts are used only with types AW and FW ammeters respectively and are not separately listed.

Temperature Coefficient

The resistance plates of the type G shunts have a negligible temperature coefficient and thermo-electromotive force, thus avoiding errors due to heating, which may amount to several per cent in other resistor materials.

Temperature Rise

Type G shunts operate at a temperature rise of 30° C. if connected to bus-bars of ample conductivity when carrying two-thirds of their rated current which should correspond to the normal full load rating of the circuit.

Interchangeability

Type G shunts are adjusted for 50 millivolts drop at full rated current, and are interchangeable with other standard makes of the same rating.

Rating

Shunts are rated according to full scale rating of the ammeters which, in general, should be about 50 per cent in excess of the full load current of the circuit. They are intended primarily for Westinghouse ammeters but can be used with any instrument requiring 50 millivolts for full scale deflection.

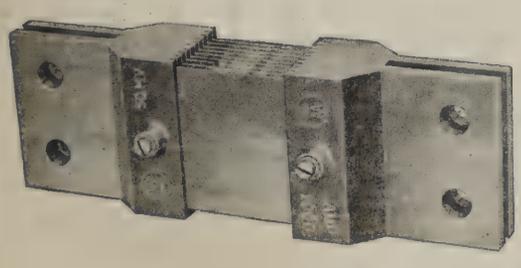
Portable Shunts

Shunts for use with portable instruments are listed on the pages covering the portable instruments. Type G shunts are also suitable for portable service with shunted-type ammeters or millivolt meters requiring 50 millivolts for full scale deflection. The accuracy of the combination is lower than when 100 millivolt shunts and instruments are used, unless the air temperature is between 20 and 30° C., as 50 millivolt instruments have not sufficient resistance to compensate completely for temperature errors.

Style number and list price include shunt complete with instrument-lead connecting screws, but do not include leads or cable terminals. Shunt leads are furnished with all shunted-type ammeters.

PRICES

Capacity Amperes	Style No.	List Price
10	289653	$ 4 50
15	289652	4 75
25	289651	5 00
50	289650	5 50
75	289649	5 75
100	282634	6 00
150	282635	6 50
200	282636	7 00
250	282637	8 00
300	282638	8 50
400	282639	13 00
500	282640	15 00
600	282641	17 00
800	282642	20 00
1000	282643	22 00
1200	282644	24 00
1500	282645	29 00
2000	282646	35 00
2500	282647	50 00
3000	282648	60 00
4000	282649	85 00
5000	282650	110 00
6000	282651	125 00
8000	282652	150 00



1000 AMPERE TYPE G SHUNT

6000 AMPERE TYPE G SHUNT

Order by Style Number

TYPE G SHUNTS FOR D. C. AMMETERS—Continued

OUTLINE DIMENSIONS

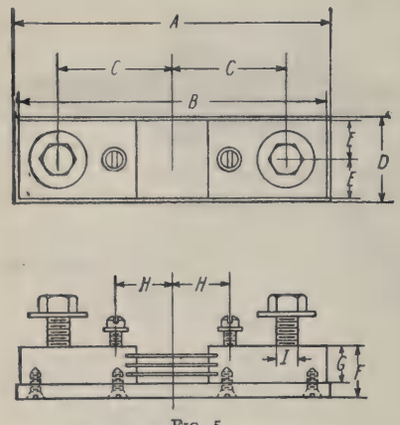


FIG. 5

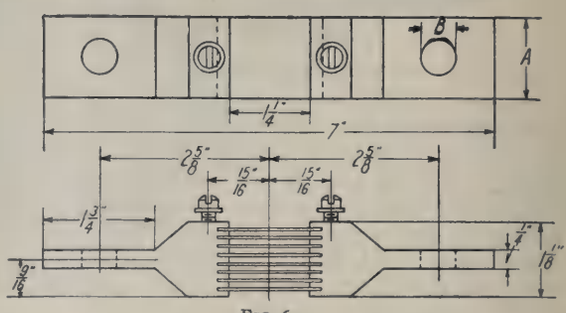


FIG. 6

Style No.	Amps.	Fig.	Dimensions in Inches A	B	C	D	E	F	G	H	I
282634	100	5	4 7/8	4 3/4	1 13/16	1 1/8	1/2	3/4	1/2	1 1/16	1/4
282635	150	5	4 7/8	4 3/4	1 13/16	1 1/8	1/2	3/4	1/2	1 1/16	1/4
282636	200	5	4 7/8	4 3/4	1 13/16	1 1/8	1/2	3/4	1/2	1 1/16	1/4
282637	250	5	5 3/8	5 1/4	2	1 1/2	1/4	7/8	5/8	1	1/2
282638	300	5	5 3/8	5 1/4	2	1 1/2	1/4	7/8	5/8	1	1/2
282639	400	6	1 1/4	1/2	...	...	..	..	..	...	..
282640	500	6	1 1/4	1/2	...	...	..	..	..	...	..
282641	600	6	1 1/2	1/2	...	...	..	..	..	...	..
282642	800	6	2	31/32	...	...	..	..	..	...	..

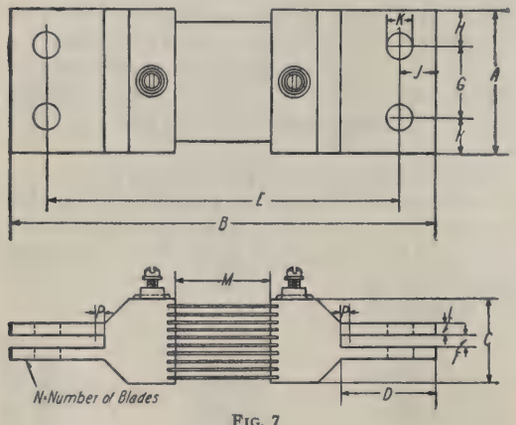


FIG. 7

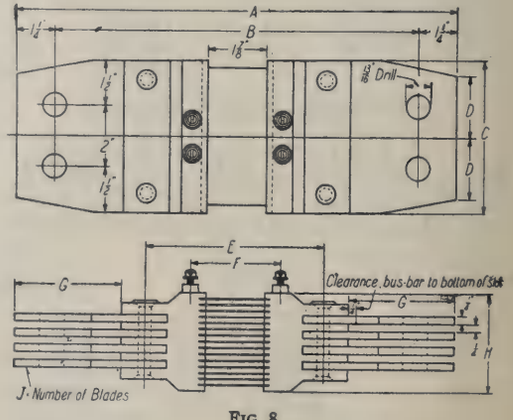


FIG. 8

Style No.	Amps.	Fig.	Dimensions in Inches A	B	C	D	E	F	G	H	J	K	L	M	N	*P
282643	1000	7	3	9	1 3/4	2	7 1/2	1/4	1 1/2	3/4	3/4	11/32	1/4	2	2	1/16
282644	1200	7	3	9	1 3/4	2	7 1/2	1/4	1 1/2	3/4	3/4	11/32	1/4	2	2	1/16
282645	1500	7	3	9	2 1/4	2	7 1/2	1/4	1 1/2	3/4	3/4	11/32	1/4	2	3	1/16
282646	2000	7	4	9	2 1/4	2	7 1/2	1/4	2	1	3/4	11/32	1/4	2	3	1/16
282647	2500	7	4	14 3/8	2 5/8	3 1/2	11 7/8	1/4	2	1	1 1/4	11/32	1/4	1 7/8	3	1/16
282648	3000	7	4	14 3/8	3	3 1/2	11 7/8	1/4	2	1	1 1/4	11/32	1/4	1 7/8	4	1/16
282649	4000	8	26 3/8	11 7/8	5	2	5 7/8	2 7/8	3 1/2	3 1/4	4	..	..	...	..	..
282650	5000	8	26 3/8	11 7/8	5	2	5 7/8	2 7/8	3 1/2	4	5	..	..	...	..	..
282651	6000	8	26 7/8	12 3/8	6	2 1/2	6 1/8	2 3/4	3 3/4	4	5	..	..	...	..	..
282652	8000	8	26 7/8	12 3/8	6	2 1/2	6 1/8	2 3/4	3 3/4	5 1/4	[illegible]	..	..	...	..	..

*P—Clearance distance between bus-bar connections and bottom of shunt slot.

TEMPERATURE INDICATORS
SWITCHBOARD-MOUNTING

Application

Electrical Apparatus—Many of the shutdowns on alternating-current generators are due to insulation breakdowns and examination of the insulation afterwards frequently shows that the failure has been caused by excessive temperature. Therefore, it is desirable, especially in large capacity generators, to know what are the maximum temperatures in the machine so that the load may be controlled in accordance with the safe temperature limits of the insulation.

Three general methods of temperature measurement may be used: by thermometer, by measuring increase in the resistance of the windings, and by embedded temperature detectors. With the first of these, surface temperatures of stationary parts only can be observed. The second method gives only average temperatures of the winding and does not give temperatures of hot spots. It is therefore upon the third named method that the greatest dependance can be placed.

Industrial Uses—Embedded temperature detectors may be used in measuring the temperature of the interior of cotton or tobacco bales, storage coal piles, and similar places where excessive temperature may develop slow burning. However, in such applications it is often desirable to use a portable indicator—see "Portable Potentiometer" described and listed on another page.

There are two **forms of embedded detectors for temperature measurement:** exploring coils, and thermo-couples.

OUTFITS FOR USE WITH EMBEDDED EXPLORING COILS

These give a direct and continuous indication of temperature. A separate source of direct current of constant voltage must be provided.

This method is limited to cases where convenience of direct and continuous indication of temperature are more important than high accuracy.

Operation

The Wheatstone Bridge principle is used. The exploring coil is a resistor, the resistance of which varies with the temperature of the mass surrounding it, and forms the fourth arm of the bridge. The values of the other three resistances of the bridge are such that when the temperature of the exploring coil has reached some predetermined value the bridge is in balance and there is no difference in voltage between points 2 and 4 (Fig. 1). With the exploring coil at any other temperature, there will be a difference in voltage indicated on the voltmeter which is calibrated in degrees. The four arms of the bridge are made equal at the temperature for which greatest accuracy is desired; and at this temperature the indications will be independent of applied control-circuit voltage. The standard temperature is 100° C., but any other temperature may be chosen for balance. The instrument can be calibrated for any temperature that the exploring coils can withstand.

Construction

The exploring coil is made up of a large number of turns of copper wire wound on a strip of mica. The finished coil is about 5 inches long and $\frac{1}{16}$ inch thick and at normal temperature has a resistance of approximately 30 ohms.

Resistors—The bridge resistors are generally mounted in a bridge box back of the switchboard panel.

Impressed Voltage—Any source of direct current of constant voltage will serve.

Style number and list price include outfit with type FW or type SL voltmeter, calibrated with temperature range to suit exploring coil and impressed voltage; but does not include exploring coil, connecting leads, or series resistor. **When ordering** specify temperature range, impressed voltage, and length and resistance of connecting leads, and if exploring coils are not ordered with outfit, specify their exact resistance and temperature coefficient at a specified temperature. If the exploring coils are of another make it must be first determined whether they are of a suitable design for use with Westinghouse instrument characteristics. Where source of direct-current is higher than 20 volts a series resistor must also be ordered, price on request.

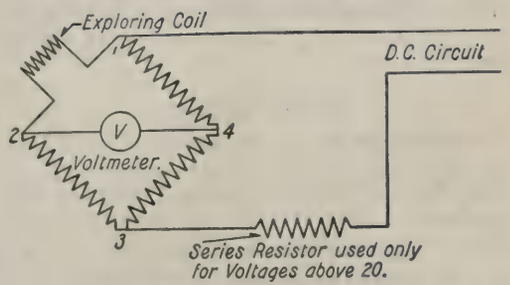


FIG. 1—DIAGRAM OF CONNECTIONS

Description	Style No.	List Price
Outfit with type FW Voltmeter	272957	$45 00
Outfit with type SL Voltmeter	272958	60 00
Exploring Coil		Price on Request

Order by Style Number

TYPE AT TEMPERATURE INDICATOR

OUTFITS FOR USE WITH EMBEDDED THERMO-COUPLES

Distinctive Features—This method balances the e. m. f. of the test couple against that of another couple at known temperature; it thus avoids all errors due to variation in leads, etc., and as it indicates on the "null" or zero-reading principle, very accurate readings can be obtained. Danger of short circuit or open circuit when placed in machine is a minimum. Ease of calibration and checking. Battery voltage need not be constant.

Operation

One thermo-couple is embedded in the mass of which the temperature is to be measured and the other, the "cold" couple, located where its temperature can be easily recorded on a thermometer. An instrument can then be so connected that it will show the difference in voltage between the two couples and therefore the temperature can be easily determined.

In the Westinghouse outfit the instrument is calibrated to read directly the temperature of the test couple.

Construction

Westinghouse thermo-couples are made by welding copper and "advance" (nickel-copper) alloy ribbons together. These ribbons are ordinarily .005 inch thick, .25 inch wide and of any desired length. The couple is insulated with mica and micarta paper to withstand a temperature of at least 150 degrees Centigrade. An inherent characteristic of this couple is that its difference in potential is 42 micro-volts per degree centigrade difference between the two couples. Its use is therefore inherently accurate and dependable under all conditions.

The **Westinghouse type AT temperature indicator** combines in one case all necessary parts except the test couple. It operates on the "potentiometer principle".

The instrument case contains the "cold" couple which is in contact with the bulb of a mercury thermometer, by which the temperature of the cold couple is observed.

A dry cell supplies current to a resistance wire equipped with two sliding contacts. The drop of potential between these contacts is proportional to the current in the wire and to the distance between them. Two pointers which move with the contacts indicate the positions of the two contacts. The scale is calibrated in millivolts and degrees; divisions on the millivolt scale are of equal width, divisions on

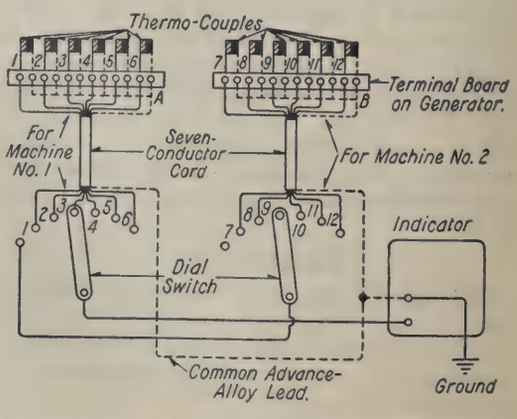


FIG. 2—DIAGRAM OF CONNECTIONS FOR HOT-SPOT TEMPERATURE MEASUREMENTS OF TWO GENERATORS, USING ONE WESTINGHOUSE INDICATOR AND TWO DIAL SWITCHES.

TEMPERATURE INDICATORS—Continued

the temperature scale are spaced according to the e. m. f. law of the couple. A rheostat in the battery circuit is used for adjusting the current exactly to the value that will cause a drop of e. m. f. per degree on the temperature scale equal to the thermo e. m. f. per degree in the couple. Leads from the thermo-couple connect through a sensitive galvanometer to the slide wire contacts of corresponding polarity. If the e. m. f. between the contacts is equal to the thermo e. m. f., there will be no deflection of the galvanometer. If higher or lower, there will be a deflection of the galvanometer in one or the other direction. By changing the distance between contacts, using the galvanometer as a guide, the position at which the slide e. m. f. balances the thermo e. m. f. is easily located.

In practice, the lower pointer is set at the position on the scale corresponding with the temperature of the cold couple and the upper pointer is moved until a balance is obtained as described. Actual temperature of hot couple can then be read directly on the scale.

One galvanometer serves both for measuring the current in the slide wire, in which case it is connected in multiple with a shunt, and for indicating balance when it is connected directly in series with the couple.

Case—The type AT temperature indicator is mounted in a black finished metal case arranged for rear connection. Size of case: $9\frac{3}{16}$ inches wide by $5\frac{7}{8}$ inches high; extends $8\frac{1}{4}$ inches from switchboard.

Wiring—All wiring from the test couple to the indicator must consist of one copper wire and one advance alloy wire.

In ordinary practice, individual copper wire leads are used to connect each individual couple through a dial switch (see following) on the switchboard to the instrument and a common advance alloy lead connects all the couples to the instrument. This side of the circuit is usually grounded in order that no voltage may be carried to the switchboard by failure of the armature coil insulation to the couple, which would allow generator potential on the circuit; also in order that any static disturbance may not affect the accuracy of the instrument. Connecting leads listed can be used up to distances of 300 feet. Cases requiring greater length of lead should be a subject of special negotiation.

Style number and list price include switchboard mounting instrument complete with one test couple.

Description	Temperature Range	Milli-volt Range	Style No.	List Price
Type AT Temperature Indicator	0–150	6.3	227364	$200 00
Type AT Temperature Indicator	0–200	8.4	227365	200 00
Two-Conductor Connecting Leads (one copper and one advance alloy), per foot				25
Seven-Conductor Connecting Leads (six copper and one advance alloy), per foot				85

Approximate Weight of indicator; net, 9 pounds; boxed, 20 pounds.

TYPE AT TEMPERATURE INDICATOR (Top View)

DIAL SWITCH

It is usual to install six thermo-couples in each generator. The leads from these are then brought out to a terminal board on the generator and from there to the switchboard. By installing a dial switch on the switchboard, connection can be made readily from the instrument to any one of the couples.

The dial switch here listed has seven points. Six of these points can be connected to thermo-couple leads and the seventh to a similar dial switch, one being required for each generator. Thus, any number of thermo-couples of one machine or of several can be read at will with one instrument.

Style number and list price include dial switch as described.

Amperes Capacity	Maximum Volts	Style No.	List Price
30	250	273175	$7 00

Order by Style Number

TYPE OA WATTHOUR METERS

SWITCHBOARD SERVICE—SINGLE-PHASE OR POLYPHASE

POLYPHASE

Westinghouse type OA switchboard watthour meters are similar to type OA house-service watthour meters, except designed for switchboard service. These are especially noted for initial accuracy, long life accuracy, low maintenance cost, low losses, ready testing facilities, and other desirable features found in watthour meters of the highest grade.

Construction

All parts of the meter element are mounted on a supporting casting and can be removed from the case as a unit without changing the calibration. The electromagnet punchings are so clamped as to form one piece, and shifting of one part with reference to another is thus obviated. They form a closed magnetic circuit, a feature that insures permanency of calibration.

Bearings—The main (lower) bearing is a highly-polished and hardened-steel ball resting between two sapphire cup jewels, identical with that of the type OA meter.

Case and Cover—The one-piece case is of cast iron. The single joint (gasket fitted) between the case and the cover makes the meters unusually dust proof.

Micrometer adjustment is provided for both full load and light load.

Testing—Extra terminals are provided on the front of the meter under the cover to facilitate checking the meter while in service. These terminals are so arranged and connected by test links that the test meter can be inserted in the circuit from the front of the switchboard, for testing the switchboard meter, without opening the current transformer circuits. By these terminals and links, the switchboard-meter elements can likewise be disconnected from the transformer circuits, the current transformers being short-circuited, and connected to a test load and portable standard watthour meter.

Polyphase meters, when properly connected, indicate the true power in a two-phase three-wire or four-wire, or a three-phase three-wire circuit, regardless of the power factor or the degree of unbalance between phases.

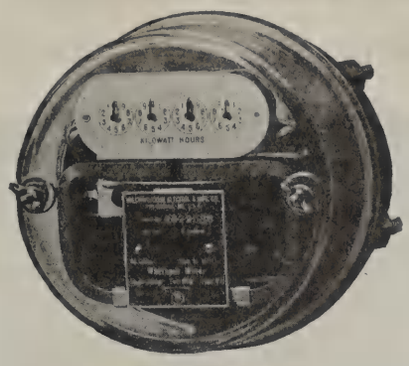
The rated current capacity of the polyphase meter is that in each wire of the circuit; the rated voltage is that across one phase.

Approximate Dimensions—Single-phase, 6⅝ inches diameter by 5½ inches deep. Polyphase, 10½ inches high by 7 inches wide by 5¾ inches deep.

Approximate Weight—Single-phase: 11½ pounds net; 20 pounds. Polyphase: 21 pounds net; 40 pounds boxed.

*For description of House-Service Watthour Meters, see Section 3-A.

TYPE OA SWITCHBOARD A. C. WATTHOUR METERS—Continued



SINGLE-PHASE

SELF-CONTAINED METERS

Style number and list price include meter complete with glass cover as listed, ready for installation.

Capacity Volts	Capacity Amperes	Single-Phase, Two-Wire: Capacity, Kilowatts	Style No. 25-Cycle	Style No. 60-Cycle	List Price	Polyphase: Capacity, Kilowatts	Style No. 25-Cycle	Style No. 60-Cycle	List Price
100	5	0.5	276449	276467	$35 00	1.0	276485	276503	51 00
100	10	1.0	276450	276468	38 00	2.0	276486	276504	55 00
100	15	1.5	276451	276469	40 00	3.0	276487	276505	58 00
100	25	2.5	276452	276470	43 00	5.0	276488	276506	63 00
100	50	5.0	276453	276471	48 00	10.0	276489	276507	72 00
100	75	7.5	276454	276472	51 00	15.0	276490	276508	80 00
200	5	1.0	276455	276473	37 00	2.0	276491	276509	56 00
200	10	2.0	276456	276474	39 00	4.0	276492	276510	60 00
200	15	3.0	276457	276475	41 00	6.0	276493	276511	62 00
200	25	5.0	276458	276476	44 00	10.0	276494	276512	67 00
200	50	10.0	276459	276477	50 00	20.0	276495	276513	77 00
200	75	15.0	276460	276478	53 00	30.0	276496	276514	85 00
400	5	2.0	276461	276479	44 00	4.0	276497	276515	64 00
400	10	4.0	276462	276480	46 00	8.0	276498	276516	67 00
400	15	6.0	276463	276481	48 00	12.0	276499	276517	70 00
400	25	10.0	276464	276482	51 00	20.0	276500	276518	76 00
400	50	20.0	276465	276483	56 00	40.0	276501	276519	86 00
400	75	30.0	276466	276484	60 00	60.0	276502	276520	94 00

METERS FOR USE WITH TRANSFORMERS

These meters are arranged for use with current transformers with 5-ampere secondaries, for current capacities higher than those listed in the preceding table. The 100-volt meters listed below can be used with voltage transformers with 100-volt secondaries for voltages higher than those listed.

Style number and list price include 5-ampere meter of the voltage listed, for use with transformers, but do not include transformers. When a meter is desired with register reading directly in kilowatt-hours in the primary circuit, it should be ordered as: "Meter similar to Style No. (give Style No. of 100-volt meter from the following table), except with register for...../5-ampere and...../ 100-volt transformer;" or "Meter similar to Style No. (give Style No. of 200 or 400-volt meter from the following table), except with register for...../5-ampere transformer." Price for the meter with register as ordered will be the same as for meter listed. Transformers should be added at regular prices.

Capacity Volts	Capacity Amperes	Single-Phase, Two-Wire: Capacity, Kilowatts	Style No. 25-Cycle	Style No. 60-Cycle	List Price	Polyphase: Capacity, Kilowatts	Style No. 25-Cycle	Style No. 60-Cycle	List Price
100	5	0.5	276521	276524	$35 00	1.0	276529	276532	$51 00
200	5	1.0	276522	276525	37 00	2.0	276530	276533	56 00
400	5	2.0	276523	276526	44 00	4.0	276531	276534	64 00

Order by Style Number

TYPE M SWITCHBOARD GRAPHIC INSTRUMENTS

FOR ALTERNATING AND DIRECT-CURRENT CIRCUITS

Application

These instruments make an accurate and permanent record of the electrical quantities involved in power-house operation. Records of kilowatt output are especially important. The load wave indicated by this instrument furnishes a basis for rates to prospective customers whose probable demands for electric power during different hours of the day can be estimated.

For large installations requiring an exceptionally fine record they are unexcelled. The indicating dial makes separate indicating instruments on the same circuit unnecessary.

For type M portable graphic instruments see the fifth page following.

Operation

All instruments operate on the relay principle, the measuring element actuating only contacts and not moving the pen directly. In turn, these contacts energize a device arranged to move the pen. The use of resistances prevents harmful sparking at the contacts, which are made of special alloy.

Details and Construction

The power required for the measuring element is not greater than that for Westinghouse indicating instruments.

The control circuit is generally 110 volts, direct current, 25 and 60 cycles alternating current, the allowable temporary variation of voltage being that ordinarily found in practice, but instruments for other control circuits can be supplied on special order. However, when the direct-current supply is from an exciter circuit controlled by an automatic voltage regulator, causing great fluctuations, alternating-current control should be used.

The record is made by a pen moving in a straight horizontal line at right angles to the motion of the paper, giving a scale having **rectangular co-ordinates.**

The pen is self-feeding and will hold one month's supply of ink. The feed is uniform at all temperatures. The marking point is a hard alloy tube which will not clog, or scratch the paper. A rubber bulb and tube filler is supplied with each instrument.

The motion of the pen and consequently the sensitiveness of the instrument may be regulated easily, and the record made either to show slight variations in the circuit or to slur over these irregularities and form a more even line. The pen can be made to travel full scale in any time from 5 to 30 seconds. This motion is absolutely dead-beat so that the pen will not "overshoot."

The record paper is supplied in a long roll provid-

ing continuous records for any desired period. It is legibly printed in black and is inexpensive. The width is approximately 6¾ inches, the scale being 5¼ inches. Standard rolls are for two months' service at a speed of 2 inches per hour. The standard paper speeds are 1, 2, 4 or 8 inches per hour. Paper for 24 inches per hour can be furnished on application. Each motor-operated instrument has a paper collecting roll of 124 feet capacity; and each solenoid-operated, 32 feet.

The clock, which turns the paper rolls, is of the electric self-winding type and operates from the control circuit at the end of each 2-inch period. It requires no attention and will run for an extra winding period if the control circuit should be open.

If an instrument is desired the speed of which can be adjusted from 8 to 4 or 2 inches per hour, the fact should be stated in the order and a clock suitable for this purpose will be provided with extra sets of gears at an increase in price.

Unless otherwise specified, clock and paper suited to a speed of 2 inches per hour are furnished. This clock is not suitable for operation at higher speed.

Pen-Operating Mechanism—In direct-current ammeters and wattmeters and in power-factor meters, the pen is operated by solenoids energized through the relay contacts. In alternating-current —direct-current voltmeters, alternating-current ammeters and wattmeters, and frequency meters, the pen is operated by a small motor similarly energized through the relay contacts.

The ink furnished with the instruments is of special grade. It is furnished in concentrated form to be added to distilled water, making a writing fluid containing a minimum of solid matter. The ordinary commercial writing inks are not recommended as they cause the pen points to clog.

Mechanical Construction—The construction is strong and compact, no delicate parts being used.

All instruments are designed for switchboard mounting, or wall, and are enclosed in glass cases with removable glass front.

Case—All motor-operated instruments are rear-connected. All solenoid-operated instruments are front-connected and have metal frame glass cover with hinged glass door. If desired, motor-operated types can be furnished with front connections and metal frame glass covers with hinged glass door at an extra list price of **$50.00.**

Accuracy—Ammeters, voltmeters, wattmeters, and frequency meters are guaranteed correct within one per cent of full scale at all points. The instruments are shipped unsealed.

Measuring Elements

The measuring elements of **alternating-current** and **direct-current voltmeters, alternating-current ammeters** and **alternating-current** and **direct-current wattmeters** are of the Kelvin-balance type similar to Westinghouse precision instruments. They are independent of variations in frequency, external fields, temperature, power factor, or wave form. **Polyphase wattmeters** are correct with any degree of unbalancing of phases. **Direct-current ammeters** are of the permanent magnet type with moving coils, and operate from shunts.

Direct-current wattmeters are similar to the alternating-current wattmeters except that the series coils are designed to carry the total current. These instruments obviate the usual difficulties of direct-current switchboard wattmeters, such as: The inconvenience of installing due to heavy currents; the great difficulty of recalibration; the amount of labor involved in removing the instrument when repairs become necessary; the consequent necessity of interrupting the circuit.

The heavy capacity wattmeters have a construction that permits removing the instrument proper from the circuit for repairs, recalibration, etc., leaving the series coil in place upon the switchboard. The measuring element complete, with clock, voltage coil, pen and paper mechanism, is mounted upon a separate base, hung from the series coil. A record of the calibration and strength of the magnetic field produced by the series coil is kept at the Works, so that for repair or recalibration, the measuring element only, without the series coil or case, may be returned.

Dimensions and Weights

The approximate dimensions of all except direct-current wattmeters are: overall width 13¼ inches, overall length 16½ inches, overall depth 9⅝ inches. Outlines of direct-current wattmeters furnished upon application.

Net weight of one instrument, 35 pounds. Boxed weight of one instrument, 170 pounds.

TYPE M SWITCHBOARD GRAPHIC INSTRUMENTS—Continued

The style number and price include instrument with one roll of standard paper, two pens, one filler, one bottle of ink, and one indicating dial and pointer, but without shunts or transformers. Ammeter shunts for direct-current ammeters, or current and voltage transformers for alternating-current instruments, and paper of the proper marking, enable any capacity to be obtained.

Shunts listed on pages on "Direct-Current Ammeter Shunts," are suitable for the direct-current graphic ammeters. One shunt will operate both an indicating and a graphic instrument without error. Shunt leads 8 feet in length are regularly supplied with each direct-current ammeter.

Voltage transformers should have a secondary voltage of 100 volts at the nominal voltage of the circuit.

Current transformers should have a secondary current of five amperes at the maximum reading of the instrument

For further information on voltage and current transformers, see pages on "Current Transformers" and "Voltage Transformers."

A. C. TYPE M GRAPHIC AMMETERS

These instruments have a nominal capacity of 5 amperes and may be used on any frequency, or on a direct-current circuit not exceeding 5 amperes, but cannot be operated from a shunt for higher direct-current ranges. For higher alternating-current ranges, instrument should be operated with a current transformer. The 5-ampere full-scale calibration may be varied from 4 amperes to 7.5 amperes if required to suit current transformer capacities.

Orders should specify the full scale rating desired, according to paper capacity selected, and the ratio of current transformers.

Capacity, Inst. Circuit Amperes	Control Circuit, Volts, D.C. 25 or 60 Cycles	Style No.	List Price
5	110	247007	$200 00
5	220*	247008	200 00

D.C. GRAPHIC AMMETERS

One ammeter shunt is required, but is not included in style number and price. Eight-foot shunt leads are included; prices for extra lengths on request.

Control Circuit Volts	Current	Style No.	List Price
110	D.C.	72312	$235 00
220	D.C.	72313	240 00

A.C. or D.C. TYPE M GRAPHIC VOLTMETERS

Correct at any frequency. For higher alternating-current voltages than those listed, the 90-140-volt range should be selected and operated from a voltage transformer.

Voltmeters may be calibrated with chart starting from zero if desired, using any standard ammeter paper listed. This paper is marked "Graphic Meter" and is thus suitable for use with voltmeters as well as alternating-current ammeters.

Orders should specify the full scale rating desired, according to paper capacity selected, and the ratio of voltage transformers.

Capacity, Inst. Circuit Volts	Control Circuits Volts, D.C. 25 or 60 Cycles	Style No.	List Price
90–140	110	247009	$230 00
180–280	220*	247012	240 00
250–450	110	247013	240 00
360–560	110	277015	250 00
450–700	110	247017	255 00

SINGLE OR POLYPHASE TYPE M GRAPHIC WATTMETERS

These instruments are polyphase wattmeters. For single-phase service the current binding posts are to be connected in series, and the voltage binding posts in parallel. The instruments listed have a nominal capacity of 5 amperes and may be used on any frequency, or on a direct-current circuit not exceeding 5 amperes, but cannot be operated from a shunt for higher direct-current ranges. For higher alternating-current ranges the instruments should be operated in connection with current transformers. The 5-ampere full-scale rating may be varied from 4 amperes to 7.5 amperes to suit current transformers and scale required. For single-phase one current transformer is required. For three-wire three-phase, or for two-phase, two current transformers are required. For three-phase four-wire, or three-phase six-wire, three current transformers are required. For higher voltages than listed, the 110-volt instruments should be operated with voltage transformers, one being required for single-phase, and two for polyphase.

Orders should specify the full scale rating desired, according to paper capacity selected, and the ratios of current and voltage transformers.

Capacity, Inst. Circuit Amps.	Volts	Control Circuit, Volts, D.C. 25 or 60 Cycles	Style No.	List Price
5	110	110	247025	$200 00
5	220	220*	247028	215 00
5	550	110	247029	215 00

*This control covers a combination of any one 220 Volt control as specified on order and 110 Volt D.C., 25 cycle and 60 cycle control.

Order by Style Number

D. C. GRAPHIC WATTMETERS

The paper used is the same as that for alternating-current wattmeters. If the normal voltage multiplied by the desired maximum current rating differs from any listed kilowatt paper capacity, use the nearest capacity paper listed, as the calibration will be made to suit the paper.

Five and Ten-Ampere Capacities—For 5 amperes direct-current use the 5-ampere alternating-curret wattmeter calibrated on direct-current; and for 10 amperes use the same instrument with series coils in multiple. Prices for either capacity will be the same as for the alternating-current wattmeter.

An external resistor is furnished for each voltage circuit.

Meter Capacity Amperes	Meter Capacity Volts†	Paper Capacity,* Kilowatts	Style No.	List Price
		Two-Wire		
25	100–125	2.4	107150	$370 00
25	200–250	5	107151	380 00
25	500–650	12	107152	390 00
50	100–125	5	107153	375 00
50	200–250	10	107154	385 00
50	500–650	25	107155	395 00
100	100–125	10	107156	375 00
100	200–250	20	107157	385 00
100	500–650	50	107158	395 00
200	100–125	20	107159	380 00
200	200–250	40	107160	390 00
200	500–650	100	107161	400 00
400	100–125	40	107162	390 00
400	200–250	80	107163	400 00
400	500–650	200	107164	410 00
600	100–125	60	107165	400 00
600	200–250	120	107166	410 00
600	500–650	300	107167	420 00
800	100–125	80	107168	410 00
800	200–250	160	107169	420 00
800	500–650	400	107170	430 00
1000	100–125	100	107171	420 00
1000	200–250	200	107172	430 00
1000	500–650	500	107173	440 00
1600	100–125	160	107174	445 00
1600	200–250	320	107175	455 00
1600	500–650	800	107176	465 00
2000	100–125	200	107177	460 00
2000	200–250	400	107178	470 00
2000	500–650	1000	107179	480 00
2500	100–125	240	107180	480 00
2500	200–250	500	107181	490 00
2500	500–650	1200	107182	500 00
3000	100–125	300	107183	500 00
3000	200–250	600	107184	510 00
3000	500–650	1600	107185	520 00
4000	100–125	400	107186	535 00
4000	200–250	800	107187	545 00
4000	500–650	2000	107188	555 00
5000	100–125	500	107189	$565 00
5000	200–250	1000	107190	575 00
5000	500–650	2400	107191	585 00
6000	100–125	600	107192	595 00
6000	200–250	1200	107193	605 00
6000	500–650	3000	107194	615 00
8000	100–125	800	107195	635 00
8000	200–250	1600	107196	645 00
8000	500–650	4000	107197	655 00
10000	100–125	1000	107198	675 00
10000	200–250	2000	107199	685 00
10000	500–650	5000	107200	695 00
16000	100–125	1600	107201	765 00
16000	200–250	2300	107202	775 00
16000	500–650	8000	107203	785 00
20000	100–125	2000	107204	805 00
20000	200–250	4000	107205	815 00
20000	500–650	10000	107206	825 00
25000	100–125	2400	107207	855 00
25000	200–250	5000	107208	865 00
25000	500–650	12000	107209	875 00
30000	100–125	3200	107210	900 00
30000	200–250	6000	107211	910 00
30000	500–650	16000	107212	920 00
		Three-Wire		
100	220	20	196679	$390 00
200	220	40	147233	400 00
400	220	80	147234	420 00
600	220	120	147235	430 00
800	220	160	147236	455 00
1000	220	200	147237	470 00
1500	220	320	147238	510 00
2000	220	400	147239	545 00
2500	220	500	147240	575 00

*Where paper of capacity specified is not listed, use paper of .001 or 1000 times the numerical capacity, reading in megawatts or watts. Thus for 2.4 kilowatts use 2400 (watts) paper; for 16,000 kilowatts use 16 (megawatts) paper, etc.

†The control circuit is wound for the same voltage as the voltage circuit of the measuring element.

TYPE M GRAPHIC FREQUENCY METERS

The measuring element is always 110 volts (nominal). One voltage transformer is required on voltages above 110 volts. An external resistor is furnished for the voltage circuit.

Style No. 247031 can also be calibrated for a range of 26-34 cycles, 32-48 cycles, or 42-58 cycles, to conform with paper listed, or for certain other special ranges.

Measuring Element Cycles	Measuring Element Volts	Control Circuit, D.C. or A.C. Volts	Style No.	List Price
21–29	110	110	247031	$275 00
52–68	110	110	247033	275 00

Order by Style Number

TYPE M SWITCHBOARD GRAPHIC INSTRUMENTS—Continued

GRAPHIC POWER FACTOR METERS

Two kinds of paper are listed for these instruments, one recording from 100 percent to 60 per cent power factor, either lagging or leading; the other recording 100 per cent to 10 per cent lagging, and 100 per cent to 80 per cent leading. The instruments will be calibrated for use with either paper, as desired. An external resistor is furnished for the voltage circuit.

Single-Phase

The measuring element is always 5 amperes, 110 volts (nominal). One current transformer is required with each instrument having a capacity above 5 amperes and one voltage transformer on voltages above 110 volts.

Measuring Element Frequency, Cycles	Control Circuit Volts	Control Circuit Current	Style No.	List Price	Measuring Element Frequency, Cycles	Control Circuit Volts	Control Circuit Current	Style No.	List Price
25	110	D.C.	71664	$270 00	60	110	D.C.	71667	$270 00
25	220	D.C.	72321	275 00	60	220	D.C.	72324	275 00
25	550	D.C.	72322	280 00	60	550	D.C.	72325	280 00
25	110	A.C. 25 cycles	72323	270 00	60	110	A.C. 60 cycles	72326	285 00

Two-Phase

Two current transformers are required for all capacities and one voltage transformer for higher voltages than 110 volts.

Measuring Element Frequency, Cycles	Control Circuit Volts	Control Circuit Current	Style No.	List Price	Measuring Element Frequency, Cycles	Control Circuit Volts	Control Circuit Current	Style No.	List Price
25	110	D.C.	71665	$270 00	60	110	D.C.	71668	$270 00
25	220	D.C.	72327	275 00	60	220	D.C.	72330	275 00
25	550	D.C.	72328	280 00	60	550	D.C.	72331	280 00
25	110	A.C. 25 cycles	72329	270 00	60	110	A.C. 60 cycles	72332	285 00

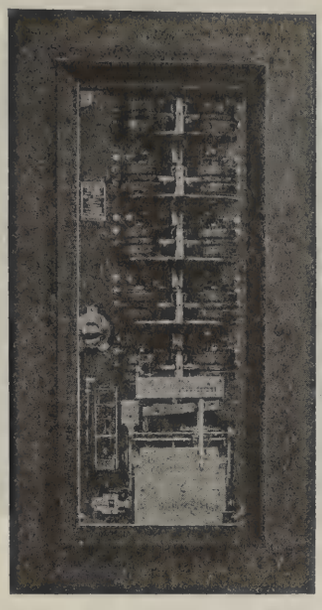
Three-Phase

Two current transformers required for all capacities and one voltage transformer for higher voltages than 100 volts.

Measuring Element Frequency, Cycles	Control Circuit Volts	Control Circuit Current	Style No.	List Price	Measuring Element Frequency, Cycles	Control Circuit Volts	Control Circuit Current	Style No.	List Price
25	110	D.C.	71666	$270 00	60	110	D.C.	71669	$270 00
25	220	D.C.	72333	275 00	60	220	D.C.	72336	275 00
25	550	D.C.	72334	280 00	60	550	D.C.	72337	280 00
25	110	A.C. 25 cycles	72335	270 00	60	110	A.C. 60 cycles	72338	285 00

Order by Style Number

TYPE M TOTALIZING GRAPHIC WATTMETER



FIVE-CIRCUIT TOTALIZING GRAPHIC WATTMETER

Application—Used for measuring the total power in a group of two to twelve independent circuits.

It is possible to record on this instrument the total power in several circuits not in synchronism or of different characteristics such as frequency, transformer ratio, voltage. With the single-circuit graphic instruments this is impossible*.

These instruments can be made for any capacity and frequency and can be used with instrument transformers in service, even though of different ratios. However, an element designed to be operated with certain transformers cannot be used with transformers of other capacities. The calibration is not affected by change of frequency.

Operation—The measuring elements are all mechanically connected to one set of contacts, so that it is the total pull of all the elements that closes and opens the contacts.

The control element is supplied for operation by either direct-current or by alternating-current, as ordered.

Panel—The instrument is supplied on a marble panel, made to fit any switchboard specified, the minimum dimensions being those shown in the table, which will be furnished unless otherwise stated. Black marine finish. Special size, finish, and material of panel should be ordered specially.

Paper—Graphic wattmeter paper is used; the scale capacity selected should be the total capacity of the connected circuits.

Additional Circuits—It is sometimes desirable to provide for future increase in the number of circuits. Extra elements cannot readily be added, but if the instrument is built with the total number of elements which eventually will be required, provision can be made for obtaining good records on the relatively small loads carried at first and later changing the connections so that the higher loads will be within the range of the scale. The possible ratio of maximum to minimum full-scale capacity depends upon the number of circuits and upon their relative capacities.

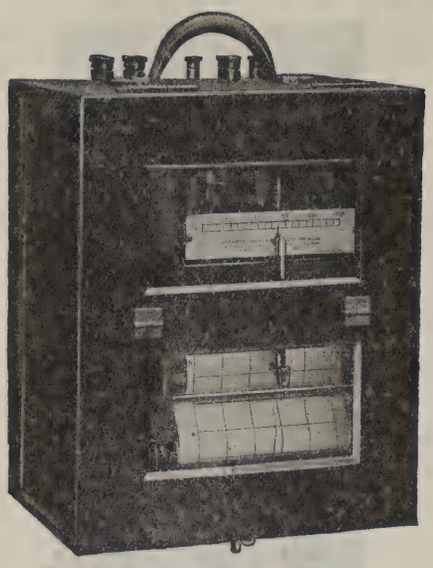
Instructions for Ordering—When ordering, order by style number and specify: Ratio of current transformer of each circuit to be measured. Ratio of voltage transformer of each circuit to be measured. Frequency of control circuit. Voltage of control circuit. Size and drilling of panel, if special. Speed of paper (whether 2, 4 or 8 inches per hour). Any special features desired.

Style number and price include totalizing graphic wattmeter complete with the elements for the number of circuits described.

Number of Circuits	Approximate Dimensions of Panel Inches	Style No.	List Price
2	16 x 2 x 21 11/16	219302	$ 750 00
3	16 x 2 x 24 1/4	219303	1000 00
4	16 x 2 x 27 7/8	219304	1250 00
5	16 x 2 x 31 1/2	219305	1500 00
6	16 x 2 x 35 1/8	219306	1750 00
7	On application	219307	2050 00
8	On application	219308	2300 00
9	On application	219309	2550 00
10	On application	219310	2800 00
11	On application	219311	3050 00
12	On application	219312	3300 00

*In case several feeders or other circuits operate always in synchronism and have equal transformer ratios, the usual single-circuit instrument can be made to record the total power by paralleling the secondaries of the current transformers, and using [illegible] instrument with a series coil of sufficient capacity.

TYPE M PORTABLE GRAPHIC INSTRUMENTS



TYPE M PORTABLE GRAPHIC WATTMETER
THREE PHASE A. C.

Application

There are certain applications of portable graphic instruments where records that are as accurate and reliable as those obtained on large switchboard graphic instruments are necessary. Among these applications are, analysis of motor operation, typical consumption curve of large industrial consumers, and records showing power distribution. All of these require graphic records covering long periods of time, and records that are as accurate as is possible to obtain. The type M portable graphic instruments being an adaptation of our well known switchboard type of instrument, fulfills all of these requirements. The difference between the two is that the switchboard element as a whole is mounted in a portable carrying case. A hand-wound clock is used for speeds up to 4 inches per hour. The electric self-winding type of clock can be supplied to drive the paper at speeds as high as 1 inch per minute, if specified on order.

A. C. Ammeters

These instruments have a nominal capacity of 5 amperes and may be used on any frequency or on a direct current circuit not exceeding 5 amperes, but cannot be operated from a shunt for higher direct current ranges. For higher alternating current ranges, the instrument should be operated with current transformers. The 5-ampere full-scale calibration may be varied from 4 amperes to 7½ amperes if required to suit current transformer capacities.

Order should specify full scale rating desired according to the paper capacity selected, the speed of paper and ratio of current transformer.

Capacity Amperes	Control Circuit Volts, D.,C.,1 25 and 60 cycles	Style No.	List Price
5	110	289426	$330 00

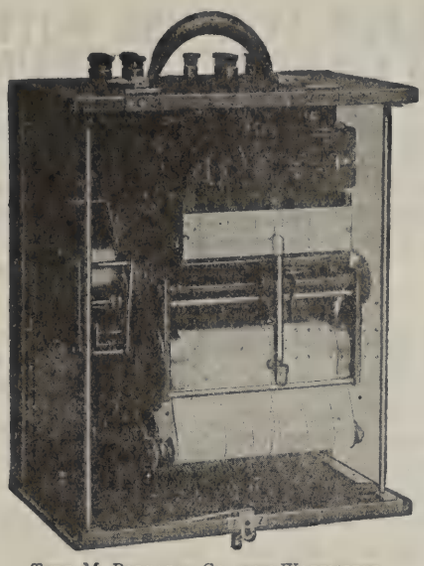
A. C. and D. C. Voltmeters

These instruments are correct at any frequency. For higher alternating current voltages than those listed, the 90 to 140 volt range should be selected and operated from a voltage transformer.

Volt meters may be calibrated with readings beginning from zero if desired, using any standard ammeter paper listed. This paper is marked "graphic meter" and is suitable for use with volt meters as well as ammeters.

Order should specify full scale rating desired according to paper capacity, speed of paper and ratio of voltage transformer.

TYPE M PORTABLE GRAPHIC INSTRUMENTS—Continued



TYPE M. PORTABLE GRAPHIC WATTMETER
WITH COVERS REMOVED

Capacity Volts	Control Circuit Volts D.C., 25 and 60 Cycles	Style No.	List Price
90–140	110	289428	$330 00
180–280	110	289430	330 00
250–450	110	289432	330 00
360–560	110	289434	330 00
450–700	110	289436	330 00

Single and Polyphase Wattmeters

The instruments listed below are polyphase wattmeters. For single-phase service the current binding posts are to be connected in series, and the voltage binding posts in parallel. The instruments listed have a nominal capacity of 5 amperes and may be used on any frequency or on a direct current circuit not exceeding 5 amperes but cannot be operated from shunt for higher direct current ranges. For higher alternating current ranges current transformers should be used. The 5 ampere full scale rating may be varied from 4 amperes to 7½ amperes to suit current transformer and scale required. For single-phase, one current transformer is necessary. For 3-phase, 3-wire or for 2-phase, two current transformers are required. For 3-phase 4-wire, or 3-phase 6-wire, three current transformers are required. For higher voltages than listed, the 110-volt instruments should be operated with voltage transformers, one being required for single-phase and two for polyphase.

Order should specify the full scale rating desired according to paper capacities selected, speed of the paper and the ratio of current and voltage transformer.

If control circuits of other capacity than listed are desired, communicate with nearest District Office.

Amps.	Volts	Control Circuit Volts, D.C., 25 and 60 Cycles	Style No.	List Price
5	110	110	289438	$330 00
5	220	110	289440	330 00
5	550	110	289442	330 00

Dimensions and Weights

The approximate dimensions are; over all width, 13¼ inches, over all length 16½ inches, over all depth, 9½ inches.

Net weight of one instrument is 35 pounds, shipping weight, 170 pounds.

Style Number and List Price include instrument with one roll of standard paper, two pens, one filler, one bottle of ink, one indicating dial and pointer, but without transformers.

Voltage transformers should have a secondary voltage of 100 volts at the nominal voltage of the circuit.

Current transformers should have a secondary current of 5 amperes at the maximum reading of the instrument.

For further information on instrument transformers, see pages on current and voltage transformers.

Order by Style Number

PAPER FOR USE WITH TYPE M GRAPHIC INSTRUMENTS

Standard Paper—Graphic instrument paper is supplied in rolls of 248 feet. A roll is sufficient for 62 days' record at the rate of 2 inches per hour, 31 days at 4 inches per hour, or 15½ days at 8 inches per hour. The prices of standard paper rolls are:

Quantity	List Price
In lots of 9 rolls or less, per roll	$4.00
In lots of 10 to 99 rolls, per roll	3.75
In lots of 100 rolls or more, per roll	3.00

"Blank" paper has ruling same as other styles, the time and capacity numbers being omitted, permitting use of this paper for special purposes. The prices are the same as for standard paper.

Special Paper—All instrument paper is considered special which has markings different from those listed. The "special" paper is intended to cover capacities not covered by "standard", but is not intended for obtaining special markings, numberings, and-so-forth, where the standard paper will answer equally well, nor will special colored ink markings or special length or quality of paper be furnished under terms listed for "special" paper.

Special paper rolls have the same length as standard rolls and will be supplied at an increase of 10 per cent above the prices for standard paper, but will not be furnished in lots of less than 10 rolls.

Ordering Paper—Customers should not wait until their paper is nearly exhausted before ordering more, as delay in filling the order may be unavoidable.

Style numbers listed include one roll of standard paper, marked as indicated.

Standard Paper for A.C. Ammeters

Capacity Amp.	Style No. 2 Inches per Hour	Style No. 4 Inches per Hour	Style No. 8 Inches per Hour	Capacity Amp.	Style No. 2 Inches per Hour	Style No. 4 Inches per Hour	Style No. 8 Inches per Hour
5	121128	121129	121130	500	59085	84727	84748
10	66298	84715	84736	600	66308	84728	84749
20	66299	84716	84737	800	65766	84729	84750
30	120456	120464	120472	1000	66309	84730	84751
32	66300	84717	84738	1200	66310	84731	84752
40	66301	84718	84739	1600	65769	84732	84753
50	120457	120465	120473	2000	66311	84733	84754
60	66302	84719	84740	2400	66312	84734	84755
80	64767	84720	84741	3000	120459	120467	120475
100	66303	84721	84742	3200	66313	84735	84756
120	66304	84722	84743	4000	120460	120468	120476
160	65768	84723	84744	5000	120461	120469	120477
200	66305	84724	84745	6000	120462	120470	120478
250	99839	99840	99841	8000	120463	120471	120479
300	120458	120466	120474				
320	66306	84725	84746				
400	66307	84726	84747				

	No Time Markings	
Blank	20 divisions	84691
Blank	24 divisions	84692
Blank	32 divisions	84693

Standard Frequency Meter Paper

Frequency Range Cycles	Style No. 2 Inches per Hour	Style No. 4 Inches per Hour	Style No. 8 Inches per Hour	Frequency Range Cycles	Style No. 2 Inches per Hour	Style No. 4 Inches per Hour	Style No. 8 Inches per Hour
21–29	110354	110355	110356	42–58	120480	120481	120482
26–34	114840	114841	114842	52–68	110357	110358	110359
32–48	119655	119656	119657				

	No Time Markings
Blank	110360

Standard Power Factor Meter Paper

Power Factor Range Per Cent	Style No.	Feed Rate Inches Per Hour	Power Factor Range Per Cent	Style No.	Feed Rate Inches Per Hour
60–100–60	84687	1	10–100–80	119157	2
60–100–60	59083	2	10–100–80	119158	4
60–100–60	84688	4	10–100–80	119159	8
60–100–60	84689	8	10–100–80	119160	Blank
60–100–60	84690	Blank	.....	.....	.....

Order by Style Number

PAPER FOR USE WITH TYPE M GRAPHIC INSTRUMENTS—Continued

Standard Voltmeter Paper—Alternating or Direct-Current

Capacity, Volts	Style No.			Capacity, Volts	Style No.		
	2 Inches per Hour	4 Inches per Hour	8 Inches per Hour		2 Inches per Hour	4 Inches per Hour	8 Inches per Hour
90–140	59084	84600	84603	360–560	99708	99709	99710
180–280	69902	84601	84604	450–700	69903	84602	84605
250–450	99712	99713	99714	Blank	50 divisions, no time marking.		

NOTE—Special paper can be furnished for reading the primary voltage directly when 90–140-volt instruments are used with transformers on high voltages. However, the use of above paper to indicate the secondary voltage is always recommended instead.

Paper for A.C. and D.C. Wattmeters and D.C. Ammeters

Capacity, Amp. or K. W.	Style No.			Capacity, Amp. or K. W.	Style No.		
	2 Inches per Hour	4 Inches per Hour	8 Inches per Hour		2 Inches per Hour	4 Inches per Hour	8 Inches per Hour
10	66276	84636	84663	600	66290	84651	84678
16	66277	84637	84664	800	63718	84652	84679
20	66293	84638	84665	1000	66291	84653	84680
24	108058	108059	108060	1200	66292	84654	84681
30	120438	120444	120450	1500	120443	120449	120455
32	66278	84639	84666	1600	63720	84655	84682
40	66279	84640	84667	2000	59601	84656	84683
50	66280	84641	84668	2400	66319	84793	84811
60	66281	84642	84669	2500	120442	120448	120454
80	66282	84643	84670	3000	120440	120446	120452
100	66283	84644	84671	3200	63719	84657	84684
120	66284	84645	84672	4000	66294	84658	84685
160	66285	84646	84673	5000	66295	84659	84686
200	66286	84647	84674	6000	65763	84660	88497
240	108064	108065	108066	8000	91244	91245	91246
250	120441	115850	120453	10000	66042	84799	84817
300	120439	120445	120451	12000	59086	84661	88498
320	66287	84648	84675	Blank	84606	20 divisions, no time marking.	
400	66288	84649	84676	Blank	84607	24 divisions, no time marking.	
500	66289	84650	84677	Blank	84608	32 divisions, no time marking.	

Zero-Center Paper for A. C. and D. C. Wattmeters and D. C. Ammeters

Capacity, Amp. or K. W.	In. per Hour	Style No.	Capacity, Amp. or K. W.	In. per Hour	Style No.	Capacity, Amp. or K. W.	In. per Hour	Style No.	Capacity, Amp. or K. W.	In. per Hour	Style No.
4–0–12	2	209914	600–0–600	2	138186	1500–0–3000	2	238127	4000–0–4000	2	130623
10–0–40	2	241279	800–0–800	2	171188	1600–0–3200	8	120193	6000–0–6000	2	133829
50–0–200	2	139962	800–0–800	8	108201	2000–0–2000	2	140086	6000–0–12000	2	98801
120–0–120	4	201658	800–0–1600	4	126529	2000–0–2000	8	239295	6000–0–12000	4	108474
160–0–160	2	252687	1000–0–1000	2	209837	2000–0–6000	2	258882	5000–0–45000	4	242575
200–0–600	2	214978	1000–0–4000	2	231530	2000–0–6000	4	197027	8000–0–8000	2	162658
300–0–300	2	91331	1500–0–1500	2	224721	2000–0–12000	2	250122	10000–0–5000	2	188115
400–0–1600	4	173804	1500–0–1500	4	247375	2400–0–2400	2	98798	10000–0–5000	4	171187
500–0–500	2	153706	1500–0–1500	8	163134	3200–0–3200	2	104167	12000–0–12000	2	252592

NOTE—For higher capacities, use paper graduated in higher units: thus, for 50,000 kilowatts, use 50 megowatt paper. For low capacities, use paper listed and read in watts instead of kilowatts; thus, for 5 kilowatts, use, 5000 paper, etc.

SPARE PARTS

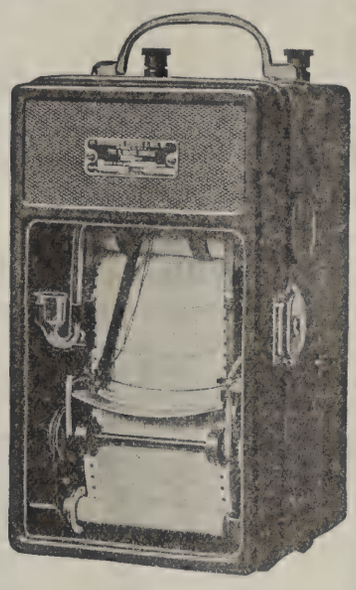
Style No.	Description	List Price
122429	Capillary reservoir pen	$ 2 50
122430	Holder for above pen	0 25
72449	Rubber pen filler	0 50
108067	Green ink in concentrated form, to be added to one quart of distilled water. Postage prepaid	0 25
219079	Pen cleaning wires	05 doz. net

Clock and clock parts for speeds of 1, 2, 4, 8 or 24 inches per hour direct-current or alternating-current control can be supplied. When requesting quotations, state the present speed and control circuit and new speeds or new control circuit desired, also style number of instrument with which they are to be used.

Order by Style Number

TYPE U GRAPHIC AMMETERS AND VOLTMETERS

SWITCHBOARD AND PORTABLE



Application

Intended for purposes where graphic instruments that are easily operated, light in weight, comparatively low in price, and reasonably accurate, are required. Type U instruments permit central stations to secure at a reasonable cost, records, which would otherwise not be taken on account of the expense.

Arc Light Circuits—A graphic chart showing the actual time the arc lamps are in operation each night and the actual current supplied to the lamps will settle any disputes with municipal authorities.

Service Voltage—An instrument on the service end of each feeder provides a record of actual conditions. The type U voltmeter is light, easily set up, and transferred from one feeder to another, thus furnishing a number of records at minimum expense.

Customers' Load Curves—A type U graphic ammeter is the simplest means for obtaining the load curve of a prospect's or customer's plant, from which maximum demand, load factor, and diversity factor can be quickly determined. A type U three-wire ammeter is particularly useful for this purpose on three-wire loads.

Station Curves—Mounted on the station or substation switchboard, type U instruments will give records of the variation in current and voltage.

Settling Disputes—During recent years graphic instruments have come into extensive use in settling disputes with customers. The records often disclose the use of power at unexpected hours. The type U instrument, because it can be installed easily and quickly is particularly adapted for such service.

Other Uses—There are innumerable uses for a graphic instrument of this character. Locating leaks and theft of current, determining most economical hours for operating generators of various sizes, checking up the distribution of load between units, and many other uses will suggest themselves to every central station man.

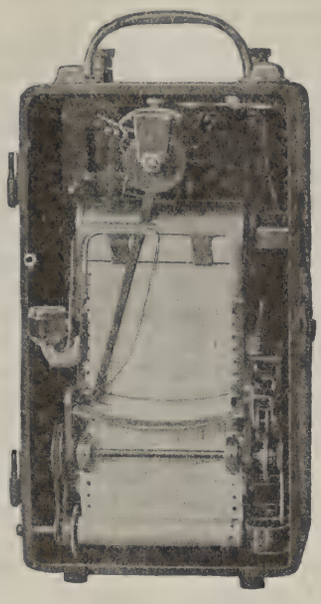
Operation

The instrument consists of a solenoid and core acting on an arm that carries the recording pen, and a continuous strip of paper moved uniformly by a clock mechanism. To overcome the slight friction of the pen on the paper, the solenoid is made powerful in its action. Its action is controlled by a heavy spring, which minimizes inaccuracies due to slight errors in leveling. The energy consumed by the voltmeter, including its external resistor, is 25 watts. The energy consumed by the ammeter is 7 watts, thus adapting it for use with ordinary current transformer for currents higher than the current rating of the instrument.

Accuracy—It should be noted that the purpose of the records divides the accuracy requirements of graphic instruments naturally into two classes. For some applications, accuracy is the prime requisite, and extreme accuracy can be maintained only by a rather expensive instrument. There are many purposes, however, where simplicity of parts and ease of manipulation, such as in type U instruments, are more important than extreme accuracy, and instruments designed on this basis result in considerably lower cost.

Adjustments—Simple spring adjustment is provided to set the zero on the ammeters. On the voltmeters, which are made with suppressed zero, this

TYPE U GRAPHIC AMMETERS AND VOLTMETERS—Continued



WITH COVER REMOVED

adjustment varies the readings above the middle of the scale. For the lower half of the scale an additional adjustment is provided in the form of a counterweight, pivoted on a separate shaft, which is picked up by the main movement and serves to keep the scale more nearly uniform at the lower end.

Construction

Dashpot—A dashpot damps the action of the instrument on fluctuating current or voltage. On circuits not subject to excessive fluctuations the oil can be left out of the dashpot.

Case—The instrument is contained in a metal case having a glass window for observing the movement of the pen. The standard instrument is adapted for either switchboard mounting or portable use. The hinged handle makes it convenient to carry the instrument about and the lug can be used for hanging the instrument on a wall for temporary testing or while being stored in the instrument room.

The lug and handle are detachable and are removed when the instrument is mounted on a switchboard. Three mounting studs are supplied and the base has the necessary drilling and tapping for these studs.

The pen is of the V-point type familiar to operators of graphic recorders.

A glass ink reservoir, which holds a supply of ink sufficient for three weeks or more of ordinary use, feeds the ink into the pen as used.

The ink is furnished in liquid form, specially prepared for use with the pen and paper supplied. A small clip inside the instrument case serves to hold the ink phial, Style No. 174005, so that the ink is always on hand when wanted.

The record paper is furnished in 16-foot rolls, ruled for a speed of one inch per hour; and the 32-foot rolls, for a speed of two inches per hour. A roll is sufficient for 8 days record. The time markings are half inch apart and the capacity markings agree with the calibration of the instrument used. The paper is 3¼ inches wide, scale 2½ inches .

The paper driving mechanism is a metal drum driven through gearing by a standard eight-day clock mechanism. The clock is of key-wound type with balance wheel escapement. Under normal conditions winding once a week is sufficient, but winding twice a week is recommended to insure against stoppage. The standard rate of drive is one inch per hour but instruments for two inches per hour can be supplied on order at the standard price. A two-inch-per-hour mechanism is also listed for changing instruments already in use.

Insulation meets A. I. E. E. specifications.

Standard Type U Graphic Instruments

The instruments are insulated for a maximum of 750 volts.

Voltmeters have suppressed-zero scales to obtain large divisions in the part of the scale used. An external resistor is furnished with each.

Ammeters are made up to and including 80 amperes. Direct-current ammeters for higher currents cannot be furnished, but alternating-currents of any magnitude can be measured by means of the 5-ampere ammeter with a current transformer.

High-Voltage Ammeter—The specially-insulated ammeter is for connection in arc circuits or other

TYPE U GRAPHIC AMMETERS AND VOLTMETERS—Continued

high-voltage lines. The case is made of insulating material instead of metal. The cover can be locked to prevent unauthorized persons from opening it. As long as the cover remains closed this ammeter may safely be handled while connected to a circuit operating at any voltage up to 7000 volts. Interior metal parts have standard 600-volt insulation between them and the coil, and should not be handled while the instrument is connected to a high-voltage circuit. There will generally be opportunities to wind the clock and to attend to the pen and chart while the circuit is open.

Three-wire ammeters record the total current in both outside wires of a three-wire system. They are useful in obtaining a record of the total load on a three-wire installation, but are recommended for use on direct-current circuits only. For three-wire alternating-current circuits the 5-ampere two-wire instrument with a three-wire current transformer is preferable. (For three-wire current transformers see pages on "Current Transformers".)

Instruments with Zero Center—As type U instruments are not polarized, it is impossible to furnish them with zero center

Portable Testing Outfit—This outfit consists of a portable split-type current transformer, Style No. 117508, (see page on portable instrument transformers) and a 5-ampere type U graphic ammeter, Style No. 205889, and provides a convenient means of measuring currents up to 250 amperes in an overhead line, without opening the circuit.

The transformer connections can be made for obtaining full-scale reading on either 125 or 250 amperes primary. These outfits can be calibrated for use on 40 cycles or higher frequencies, but are not recommended for 25-cycle circuits. The instrument is calibrated for use with the transformer, and a correction curve is furnished. No curve is furnished with an instrument to be used with transformer in customer's possession unless the transformer is returned to the factory for the test. By the use of this curve an accuracy within five per cent can be obtained, this being sufficient for giving a good idea of load conditions.

Overall Dimensions

Width	5⅝
Height	9⅞
Depth	5 7/16

PRICES

Style number and list price include instrument complete with five rolls of paper and a two-ounce bottle of ink. The standard instrument is equipped with a one-inch-per-hour paper-driving mechanism. For the two-inches-per-hour mechanism order "Similar to Style No.....", except with two-inches per-hour paper-driving mechanism." Style number and list price on uncalibrated instruments include calibration of instrument as ordered. Specify frequency and scale marking when ordering.

Type U Graphic Voltmeters

Uncalibrated* Nominal Volts	Uncalibrated* Style No.	Calibrated on Direct Current Scale	Calibrated on Direct Current Style No.	Calibrated on 60-Cycle Alternating Current Scale	Calibrated on 60-Cycle Alternating Current Style No.	List Price
110	173204	90–130	190383	90–130	190379	$ 85 00
220	173205	180–260	190384	180–260	190380	90 00
440	173206	360–520	198721	360–520	198723	95 00
550	179555	450–650	198722	450–650	198724	100 00
110 } 220 }	199096†	90–130 } 180–260 }	199098†	90–130 } 180–260 }	199097†	95 00

Type U Graphic Ammeters

Uncalibrated* Capacity, Amperes	Uncalibrated* Style No.	Calibrated on Direct Current Scale	Calibrated on Direct Current Style No.	Calibrated on 60-Cycle Alternating Current Scale	Calibrated on 60-Cycle Alternating Current Style No.	List Price
			Two-Wire			
5	205889‡	...	.....	....	.....	$ 95 00
5	173207	0–5	190385	0–5	190381	90 00
10	179556	0–10	190386	0–10	190382	90 00
20	179557	0–20	198718	0–20	198715	95 00
40	179558	0–40	198719	0–40	198716	95 00
80	179559	0–80	198720	0–80	198717	100 00
			Three-Wire			
..	.....	0–5	179560	....	.....	110 00
..	.....	0–10	179561	....	.....	110 00

*Uncalibrated instruments will be calibrated as desired for use on 25-cycle and odd-frequency alternating-current circuits.

†These are combination instruments, having two voltage ranges. The two ranges are obtained by taking out an extra tap on the series resistor. Paper should be used of a voltage range to correspond to the connection used. Unless otherwise ordered three rolls of 90–130-volt range and three of 180–260-volt range paper will be supplied with each instrument.

‡Specially wound for use with split-type Testing Transformer. Price includes instrument with necessary calibration curve but does not include the transformer.

Order by Style Number

TYPE U GRAPHIC AMMETERS AND VOLTMETERS—Continued

High-Voltage Ammeters

Capacity, Amperes	Maximum Volts	Style No.	List Price
10	7000	241314	$110 00

Portable Testing Set

Scale, Amperes	Description	Style No.	List Price
125 or 250	Consists of Ammeter, Style No. 205889, and Transformer Style No. 117508	199363	$160 00

Type U Graphic Instrument Paper

VOLTMETER — Style No.			AMMETER — Style No.		
Scale	1-inch per hour	2-inches per hour	Scale	1-inch per hour	2-inches per hour
0–50	247562	247563	0–5	167817	192927
90–130	157916	188706	5.4–7.8	269643	.....
100–160	247156	.....	0–10	174415	199102
120–180	247566	247567	0–15	247570	247571
180–260	173209	199099	0–20	174416	199103
0–300	247564	247565	0–25	247572	247573
240–360	247568	247569	0–30	247574	247575
360–520	173210	199100	0–40	174417	199104
450–650	173211	199101	0–60	247576	247577
.....	.....	.....	0–80	174418	199105

	List Price per Roll	
	1-inch per hour	2-inches per hour
Lots of less than 50	$0 20	$0 40

Quantity Shipments Rolls	Additional Discounts
50–99	5%
100–499	10%
500–999	20%
1000 or more	30%

Ink for Type U Graphic Meter

Description	Style No.	List Price
¼-Ounce Phial of Ink	174005	$0 30
2-Ounce Bottle	180199	0 50
8-Ounce Bottle	180201	2 00
1-Pint Bottle	180202	4 00
Ink Reservoir	183081	0 75
Pen Complete with Pen Arm	180794	0 50

2-Inches-Per-Hour Paper-Driving Mechanism

For Changing Drive on Type U Graphic Instruments Already in Use

Style number and price include mechanism complete ready to install in instrument.

Description	Style No.	List Price
Gear Train	199210	[illegible] 00
Pinion	199211	30

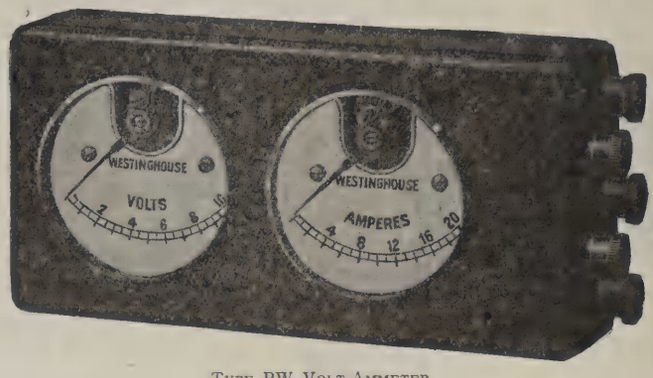
Wick yarn for pen feed **$0.01** net per foot.

Approximate Weights—Voltmeter, including resistor, 10½ pounds net, 13½ pounds boxed; ammeter, 9¼ pounds net, 12¼ pounds boxed.

Order by Style Number

TYPE PW PORTABLE INSTRUMENTS
FOR DIRECT-CURRENT CIRCUITS

TYPE PW VOLTMETER



TYPE PW VOLT-AMMETER

Application

These are direct reading instruments for automobile equipment testing, battery testing, and all purposes where an accurate instrument of pocket size is desirable. They operate on the D'Arsonval principle, having a moving coil and a permanent magnet.

Automobile Service—Style Nos. 184003, 184011, 184012, 227580, and 230168 are particularly recommended for use in testing electric lighting and starting equipments for automobiles.

CARRYING CASE

Construction

Complete movement is mounted as a unit readily removed for repairs by taking off the cover and removing the two screws on the side of the movement, which can then be lifted out or replaced as a unit. This makes repairing possible without disturbing the alignment of the magnetic circuit. The full length of the pointer shows on the dial, thus making the instruments easy to read. The instrument will withstand shocks such as it will be subjected to in ordinary use without affecting the accuracy.

Cases are morocco-leather-covered wood with heavy glass over dials.

Damping—The light metal frame on which the moving coil is wound moves through the air-gap of the permanent magnet and makes the reading inherently dead-beat.

Scale—Scale is made of metal and subtends an arc of 90 degrees, giving large open divisions which are uniform throughout.

Accuracy—Instruments are adjusted at the Works to be correct at all points of the scale, and when used with proper care, an accuracy within 1 per cent of full scale value may be expected. The scales are individually marked by hand. Millivoltmeters with corresponding shunts will have the same accuracy.

Size—Cases of the single type PW portable instruments are 3¾ inches by 4⅜ inches, 2 inches thick. The volt-ammeter cases are 3¾ by 7½ inches, 2 inches thick.

TYPE PW AMMETERS

Type PW ammeters have the shunts contained in the case. For higher capacities than those for which the ammeters are listed, self-contained instruments are not recommended. For such service a millivoltmeter should be used with a separate shunt of the proper capacity.

Scales	Approx. Wt., Lb. Net	Approx. Wt., Lb. Boxed	Style No.	List Price
0-1 and 0- 5 amperes	1	2	184008	$17 00
0-2 and 0-10 amperes	1	2	184009	17 00
0-4 and 0-20 amperes	1	2	184010	17 00
0-5, 0-20 and 0-200 amperes (including shunt Style No. 186871 and one pair shunt leads)	3	4	184011	36 00

TYPE PW MILLIVOLTMETERS

These instruments are for use with portable shunts in making current measurements. The shunts used should have 100 millivolts drop at full load.

Scales	Approx. Wt., Lb. Net	Boxed	Style No.	List Price
0-100 millivolts* (includes one pair leads)	1	2	184002*	$17 00

*Can be marked in amperes to agree with any 100-millivolt external shunt desired, at extra list price of $1.00.

TYPE PW VOLTMETERS

Scales	Approx. Wt., Lb. Net	Boxed	Style No.	List Price
0-2.5 and 0-10 volts	1	2	184003	$16 00
0-2½, 0-10 and 0-125 volts	1	2	184004	18 50
0-12 and 0-120 volts	1	2	184005	18 00
0-15 and 0-150 volts	1	2	184006	18 00
0-3, 0-15 and 0-150 volts	1	2	184007	18 50

TYPE PW VOLT-AMMETERS

A type PW volt-ammeter consists of a voltmeter and an ammeter, or a voltmeter and a millivoltmeter, mounted together in one case. This enables taking simultaneous readings of current and voltage, an operation that is not possible on volt-ammeters of the single instrument type operated by a key or push-button.

Scales	Approx. Wt., Lb. Net	Boxed	Style No.	List Price
Calibrated as desired*	1½	3	184013*	$32 00
0-2½ and 0-10 volts 0-5, 0-20 and 0-200 amperes (includes shunt Style No. 186871 and one pair shunt leads)	3½	4½	184012	46 25
0-2½, 0-10 and 0-125 volts 0-4 and 0-20 amperes	1½	3	184014	32 00
0-3, 0-15 and 0-150 volts 0-3, 0-30 and 0-300 amperes (including shunt Style No. 197040 and one pair shunt leads)	3½	4½	221811	50 50
0-10 and 0-20 volts 0-20 and 0-400 amperes (including shunts Style Nos. 227581 and 227582 and one pair shunt leads)	4	6	227580	44 25
0-10 and 0-20 volts 0-20 and 0-400 amperes (including shunts Style Nos. 227581 and 227582, one pair shunt leads and leather carrying case Style No. 227583)	4½	6½	230168	50 50
0-10 volts, 0-100 millivolts (includes one pair leads)	1½	3	184015	32 00

*Calibrated to order for any one voltage range not above 150 and any one current range not above 20 amperes. The ammeter scale can also be furnished marked as a millivoltmeter, or else marked in amperes to agree with any external separate shunt specified in order. For capacities above 20 amperes a separate 100-millivolt shunt must be used.

SHUNTS

For shunts to use with type PW millivoltmeters see list of type PL portable shunts listed on another page of this catalogue. Any shunt having 100 millivolts drop at full load may be used. In addition, the following portable shunts have been provided as especially suitable for use with type PW instruments.

Capacity, Amperes	Approx. Wt., Lb. Net	Boxed	Style No.	List Price
5–20–200†	2	3	186871	$19 50
3–30–300†	2	4	197040	20 50
20	½	1	227581	7 75
400†‡	2	4	227582	10 25

†The 200, 300, 400 ranges are for intermittent service only, as for testing starting motors of automobiles.
‡One terminal for bolting on terminal of automobile starting motor.

CARRYING CASES

Description	Approx. Wt., Lb. Net	Boxed	Style No.	List Price
Leather carrying case for one type PW ammeter or voltmeter and shunt Style No. 186871 or 197040 and shunt leads, or for one volt-ammeter only	½	1½	197922	4 00
Leather carrying case for one type PW volt-ammeter, shunt Style No. 186871 or 197040 and shunt leads	½	1½	197923	5 00
Leather carrying case for one type PW volt-ammeter, two shunts, Style Nos. 227581 and 227582, and shunt leads	½	1½	227583	8 00

LEADS

One lead for use with ammeter and shunts, (two required for instrument)	..	..	196665	2 00

Order by Style Number

TYPE PL PORTABLE INSTRUMENTS
FOR DIRECT-CURRENT CIRCUITS

TYPE PL PORTABLE VOLTMETER

Application

These are direct-reading portable instruments that meet the demand for high-grade, compact, and easily readable instruments for general testing work. They operate on the D'Arsonval principle, including a moving coil and permanent magnets. They differ, however, from other instruments using this principle, in having a single air-gap through which the moving coil, pivoted at one edge, swings.

Construction

The complete movement is attached to a mounting plate of Bakelized Micarta and is easily removed for repairs. The removable insulating face-plate protects the pointer and scale and makes a dust-proof joint with the case. Single air-gap construction makes it possible to remove the moving coil without removing the pole pieces and thus without disturbing in any way the magnetic circuit, so that the strength of the magnetic field is not changed. The weight of the moving element is low because the eccentrically pivoted coil tends to counter-balance the pointer so that the counter-weight required is small, and the pivot jewels are therefore preserved from wear. The movement and pole pieces are completely surrounded by the permanent magnets, thus greatly reducing the effect of external fields.

Cases—Instruments are mounted in polished wood carrying cases. They have hinged covers that are easily removable and flexible sole-leather handles.

Damping—The light metal frame on which the moving coil is wound moves through the air-gap of the magnets and makes the reading inherently deadbeat. This very important feature enables readings to be taken quickly, and prevents violent fluctuations from injuring the pointer or the moving element.

Scale—Scale subtends an arc of 100 degrees, and is 6½ inches long, giving large, open divisions, which are of uniform length throughout. A mirror extending the entire length of the scale prevents parallax in reading.

Accuracy—These instruments are adjusted at the works to be exactly correct at all points of the scale and when used with proper care an accuracy of ½ per cent of full scale at any point of the scale may be expected. Millivoltmeters when used in the 100-millivolt capacity with corresponding shunts will have the same accuracy.

Finish—All visible metal parts are finished in bright nickel, mounted on a polished black face-plate.

Size—Cases of the type PL portable instruments are 6¼ inches by 6¼ inches, 4 inches high, which is exceptionally small considering the length of scale.

TYPE PL AMMETERS

Type PL ammeters have the shunts contained in the case. For higher capacities than those for which the ammeters are listed, self contained instruments are not recommended, because of possible temperature errors. This applies to all ammeters of this class. For such service, a millivoltmeter should be used, with separate shunt of the proper capacity.

The self-contained ammeters are marked with one scale divided so that even readings are obtained for both capacities. Two sets of figures are used, one for each capacity.

The standard scale divisions and markings for the various capacities are shown in the table on the page following.

Style number and list price include self-contained ammeter as described.

Current Ranges, Amperes	Approx. Wt., Lbs. Net	Boxed	Style No.	List Price
0-0.5 and 0-2.5	5	12	165402	$70 00
0-1 and 0-5	5	12	165403	70 00
0-2 and 0-10	5	12	165404	70 00
0-4 and 0-20	5	12	165405	70 00
0-6 and 0-30	5	12	165406	70 00
Milliammeters				
0-0.02	4	10	168170	70 00
0-0.05	4	10	168171	70 00
0-0.10	4	10	168172	70 00

TYPE PL VOLTMETERS

Style number and list price include voltmeter complete as described.

Voltage Ranges	Approx. Wt., Lbs. Net	Boxed	Style No.	List Price
0-3 and 0-150	5	12	165407	$75 00
0-15 and 0-150	5	12	165408	75 00
0-150 and 0-300	5	12	165409	75 00
0-150 and 0-750	5	12	165410	80 00
0-300 and 0-750	5	12	219355	80 00
0-15, 0-150 and 0-750	5	12	214480	85 00

Two-range voltmeters listed above can be supplied with three ranges at an addition to the list price of $10.00.

Resistors can be supplied for voltages higher than those listed.

All the voltmeters listed have a uniform resistance of approximately 100 ohms per volt capacity. Special voltmeters of higher sensitiveness can be furnished at extra cost. Each voltmeter has a push-button switch for making and breaking the circuit.

TYPE PL MILLIVOLTMETERS

These instruments are for use with portable shunts in making current measurements. Instruments and shunts of 100 millivolts drop make possible more accurate measurements than the 50-millivolt combinations.

The scales of millivoltmeters are marked in millivolts unless otherwise specified and ampere readings are obtained by multiplying the reading in millivolts by the amperes-per-millivolt of the shunt.

Style number and list price include millivoltmeter complete without shunts. Style Nos. 165411 and 165412 can be marked in amperes instead of millivolts if desired, to suit any of the shunts of corresponding drop.

Scale, Millivolts	Approx. Wt., Lbs. Net	Boxed	Style No.	List Price
50	4	10	165411	$70 00
100	4	10	165412	70 00
20 and 100	4	10	165413	70 00
50 and 250	4	10	165414	70 00
50 and 500	4	10	165415	70 00

TYPE PL VOLT-AMMETER

The type PL volt-ammeter is a combined voltmeter and millivoltmeter for current measurements. It has three binding posts. The measuring element is connected directly between two binding posts and through a suitable resistor to the third post for voltage measurements. As a millivoltmeter it is for use with a 100-millivolt shunt.

Volt-ammeters have two scales, one reading volts and divided into 150 divisions as in the voltmeter, and the other divided into 100 divisions to read millivolts. The second scale can be made to read directly in amperes if desired.

Style number and list price include instrument complete as described, without shunts. The volt scale will be calibrated for any voltage from 3 to 300 volts. The ampere scale will be marked for 100 millivolts unless otherwise ordered, and can be used with any capacity of shunt of the proper drop.

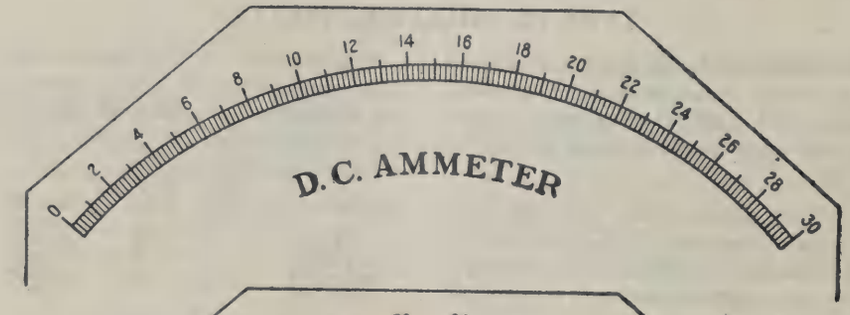
Approx. Wt., Lbs. Net	Boxed	Style No.	List Price
5	12	165416	$80 00

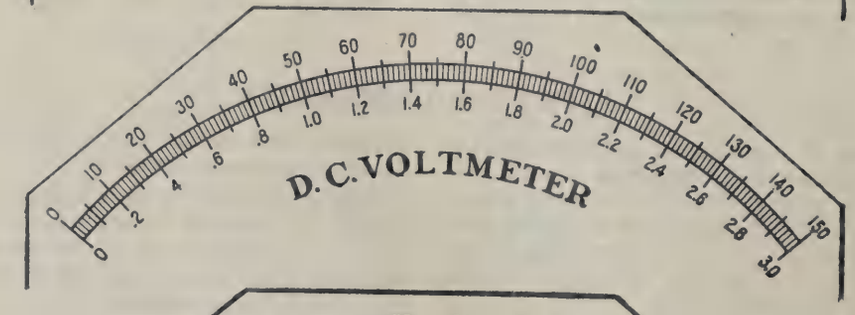
TYPE PL D. C. PORTABLE INSTRUMENTS—Continued

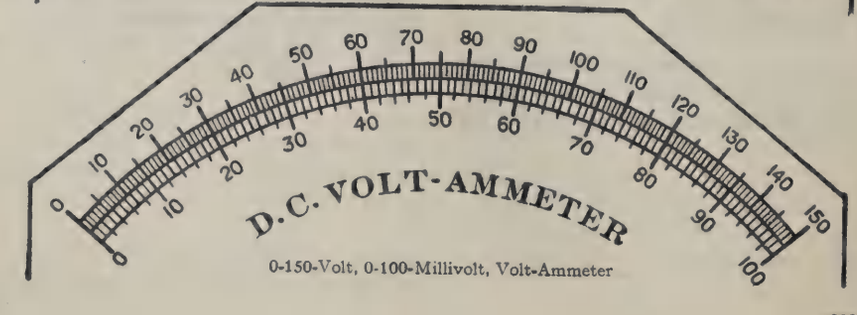
TABLE OF SCALE MARKINGS – TYPE PL METERS

Style No.	Capacity	Divisions Main	Int	Sub	Total	Marking
Milliammeters						
168170	20 Milliamp.	10	2	5	100	0 2 4 6 8 10 12 14 16 18 20
168171	50 "	10	2	5	100	0 5 10 15 20 25 30 35 40 45 50
168172	100 "	10	2	5	100	0 10 20 30 40 50 60 70 80 90 100
Ammeters						
165402	5 & 2.5 Amp.	5	4	5	100	0 1 2 3 4 5 1.5 2 2.5
165403	1 & 5 "	5	4	5	100	0 1 2 3 4 5
165404	2 & 10 "	10	2	5	100	0 1 2 3 4 5 6 7 8 9 10
165405	4 & 20 "	4	5	4	80	0 5 10 15 20
165406	6 & 30 "	6	5	4	120	0 5 10 15 20 25 30
Voltmeters						
165407	3 & 150 Volts	15	2	5	150	0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150
165408	15 & 150 "	15	2	5	150	0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150
165409	150 & 300 "	15	2	5	150	0 20 40 60 80 100 120 140 160 180 200 220 240 260 280 300
165410	150 & 750 "	15	2	5	150	0 50 100 150 200 250 300 350 400 450 500 550 600 650 700 750
219355	300 & 750 "	15	2	5	150	0 50 100 150 200 250 300 350 400 450 500 550 600 650 700 750
214480	15,150 & 750 "	15	2	5	150	0 50 100 150 200 250 300 350 400 450 500 550 600 650 700 750
Millivoltmeters						
165411	50 M-v.	10	2	5	100	0 5 10 15 20 25 30 35 40 45 50
165412	100 M-v.	10	2	5	100	0 10 20 30 40 50 60 70 80 90 100
165413	20 & 100 M-v.	10	2	5	100	0 10 20 30 40 50 60 70 80 90 100
165414	50 & 250 M-v.	10	2	5	100	0 25 50 75 100 125 150 175 200 225 250
165415	50 & 500 M-v.	10	2	5	100	0 50 100 150 200 250 300 350 400 450 500
Volt-Ammeters						
165416	Any single capacity Voltmeter Scale may be used as the upper scale of Volt-Ammeters. Any single capacity Ammeter Scale may be used as the lower scale of Volt-Ammeters.					

REPRODUCTIONS OF TYPICAL SCALES (REDUCED TO ⅔ FULL SIZE).







0-150-Volt, 0-100-Millivolt, Volt-Ammeter

TYPE PL PORTABLE LABORATORY INSTRUMENTS
FOR DIRECT-CURRENT CIRCUITS

TYPE PL LABORATORY VOLTMETER WITH COVER REMOVED

Type PL laboratory large-size instruments are particularly valuable where a long-scale semi-portable instrument is required. Like the regular size type PL instruments, they operate on the D'Arsonval principle, which renders them free from residual error.

Construction

The type PL laboratory instruments have the same general construction as the regular size type PL instruments.

Damping—The light metal frame on which the moving coil is wound moves through the air-gap of the magnets and makes the reading inherently deadbeat. This very important feature enables readings to be taken quickly, and prevents violent fluctuations from injuring the pointer or the moving element.

Scale—Scale subtends an arc of 100 degrees and is 11½ inches long, giving large, open divisions, which are of uniform length throughout. A mirror extending the entire length of the scale prevents parallax in reading.

Accuracy—These instruments are adjusted at the works to be exactly correct at all points of the scale and when used with proper care an accuracy of ½ per cent of full scale at any point of the scale may be expected. Millivoltmeters when used in the 100-millivolt capacity with corresponding shunts will have the same accuracy.

Finish—All visible metal parts are finished in bright nickel, mounted on a polished black face-plate. Case is polished wood.

Size—Cases of the type PL portable laboratory instruments are 12 inches by 13¾ inches, 4⅝ inches high.

Scale Marking

Voltmeters—The type PL laboratory voltmeters are calibrated as ordered, for any capacity of from 3 to 750 volts. Resistors can be supplied for voltages higher than those listed. All the voltmeters have a uniform resistance of approximately 100 ohms per volt capacity. Special voltmeters of higher sensitiveness can be furnished at extra cost. Each voltmeter has a push-button switch for making and breaking the circuit.

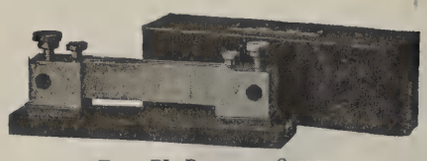
Millivoltmeters—These instruments are for use with portable shunts in making current measurements. Instruments and shunts of 100 millivolts drop make possible more accurate measurements than the 50-millivolt combinations.

Style number and list price include instruments calibrated as ordered. The voltmeter will be calibrated as specified in order for any capacity from 3 to 750 volts, and the millivoltmeter for any capacity from 25 to 500 millivolts.

Instrument	Approx. Wt., Lb. Net	Boxed	Style No.	List Price
Voltmeter	[illegible]	18	165487	$159 00
Millivoltmeter	7	17	165488	159 00

Order by Style Number

TYPE PL PORTABLE SHUNTS



TYPE PL PORTABLE SHUNT

The type PL portable shunts are for use with type PL millivoltmeters and volt-ammeters. They are made of manganin, a material with minimum temperature coefficient and thermo-electromotive force. The resistance of each is accurately adjusted and, as the shunts have the same full-load drop, they are interchangeable—the terminals are generously proportioned. Unless otherwise stated each shunt is mounted in a portable box. The voltage drop in the shunts at full load is 100 millivolts, insuring high accuracy in readings.

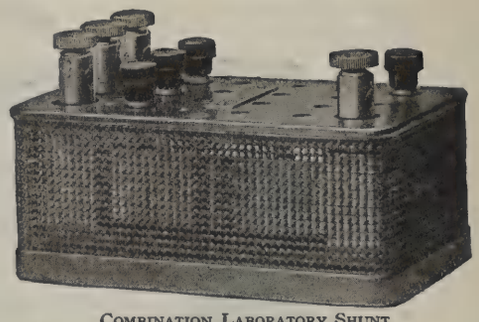
Combination Laboratory Shunts—Combination shunts including three shunts mounted in a single box with suitable terminals are listed for laboratory or semi-portable use. Combinations of any three shunts in capacities up to 200 amperes each can be furnished.

Switchboard Type H 50-Millivolt Shunts listed on another page can also be used with millivoltmeters having 50-millivolt range.

Type PL Portable Shunts 100 Millivolts

Style number and list price for shunts of capacities up to 1000 amperes include 100-millivolt shunt complete in polished wood case. *Shunts of capacities above 1000 amperes are finished in line with switchboard-shunt practice and do not have carrying cases.*

Capacity, Amperes	Approx. Wt., Lb. Net	Boxed	Style No.	List Price
1	1	1½	170224	$16 00
5	1	1½	139618	16 00
10	1	1½	139619	16 00
20	1	1½	139620	18 00
50	1¾	2¾	139621	20 00
100	2½	3¾	139622	20 00
200	3¾	5¾	139623	25 00
500	7½	11	139624	32 00
1000	12½	19	139625	42 00
1200	16	22	272948	45 00
1500	19	25	272949	50 00
2000	25	30	272950	60 00
2500	31	38	272951	70 00
3000	38	50	272952	75 00
4000	43	56	272953	100 00
5000	54	70	272954	120 00
6000	63	85	272955	150 00
8000	72	105	272956	200 00



COMBINATION LABORATORY SHUNT

Combination Laboratory Shunts 100 Millivolts

Capacity, Amperes	Approx. Wt., Lb. Net	Boxed	Style No.	List Price
5–20–100	5	7	168094	$57 50
5–20–200	5	7	185293	68 00
10–50–200	5	7	168095	72 00

Combination Carrying Case

Combination Carrying Case—This wooden case has room for one shunt of 1000, 800, or 500 amperes and 5 shunts each 200 amperes or less. Special shunt units without cases are listed for use with this combination carrying case. These shunt units are similar to the regular type PL portable shunts except they are not mounted in a separate box.

Style number and list price include carrying case only.

Description	Style No.	List Price
Carrying Case for Shunts	167587	$20 00

Shunt Units for Combination Carrying Case—100 Millivolts

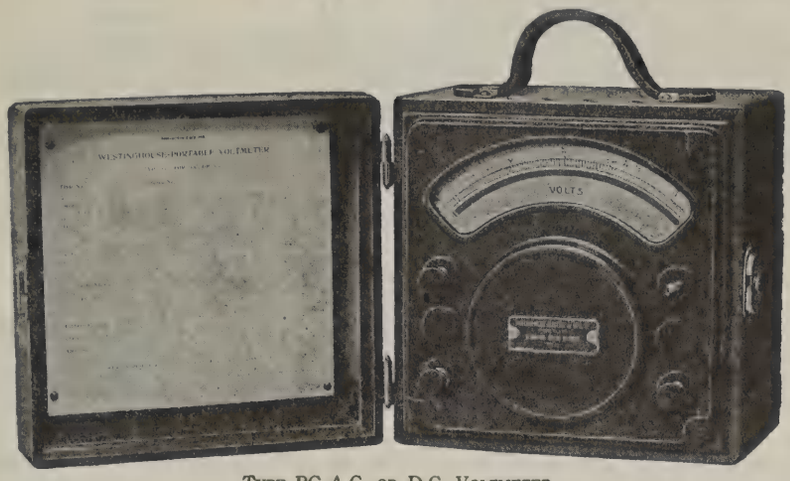
Capacity, Amperes	Approx. Wt., Lb. Net	Boxed	Style No.	List Price
5	1	1½	167588	$4 50
10	1	1½	167589	5 00
20	1	1½	167590	5 50
25	1¼	1¾	167591	6 00
50	1½	2½	167592	8 00
100	2½	3½	167593	12 00
200	3½	5	167594	16 00
500	6	8	167595	25 00
800	8	10	167596	31 00
1000	10	15	167597	35 00

TYPE PL PORTABLE SHUNT UNIT

Order by Style Number

TYPES PC AND PD PORTABLE INSTRUMENTS

A. C. OR D. C. AMMETERS, VOLTMETERS, AND WATTMETERS IRON LOSS VOLTMETERS, POWER FACTOR METERS FREQUENCY METERS



TYPE PC A.C. OR D.C. VOLTMETER

Application

These are high-grade direct-reading instruments for general testing and labratory work where especially high accuracy is desired, particularly on alternating-current.

The permanence of calibration of these instruments, when handled with reasonable care, makes them very desirable as standards for calibrating other instruments, including portable standard watthour meters.

Type PC ammeters, voltmeters, wattmeters, and power factor meters operate on the electro-dynamometer principle, and type PD frequency meters on an adaptation of the induction principle. The perfectly damped character of the indications enables readings to be taken quickly and accurately, and makes these instruments very desirable in measuring fluctuating loads.

Construction

The movement is mounted as a unit and can be removed complete after taking off the face-plate. The face-plate makes a dust-proof joint with an inner aluminum mounting plate. The moving element is light but not delicate.

Cases—The instruments are mounted in hardwood carrying cases with hinged covers that are easily removable, and flexible sole-leather handles.

Damping—Unexcelled damping features, eliminate unnecessary wear on bearings, and effect of rough handling.

Scale—The scale covers an arc of 90 degrees, giving large, open divisions. The scale for the wattmeters is wider at the lower end to give high accuracy for the low readings, and for the voltmeters wider at the middle, where readings are most frequently made. A mirror extending the entire length of the scale prevents parallax in reading.

Accuracy—The instruments are free from temperature, frequency, and wave shape errors. They are adjusted at the works to be exactly correct at all points of the scale, and are guaranteed to be correct within the following percentage of full scale: voltmeters, ammeters and wattmeters, ¼ per cent; power factor meters, 1 degree; frequency meters, ½ per cent.

Finish—The terminals are finished in bright nickel. The face-plate is of polished black composition, and the case is polished hard wood.

TYPE PC AMMETERS

Type PC ammeters are entirely self-contained. The main current to be measured passes through two stationary coils and an inductive shunt, all connected in series; moving coil is connected across the shunt. As the readings of this instrument on commercial frequencies are as accurate as on direct current, it will be found of great value as a "transfer standard".

Style number and list price include instrument complete as described. Made in double capacity only.

Current Ranges, Amperes	Style No.	List Price
2½–5	272962	$145 00
5–10	272963	150 00

Approximate Weight—8½ pounds net, 20 pounds boxed.

TYPE PC VOLTMETERS

A contact switch operated by a button on the front of the instrument is provided on each voltmeter. The listed voltmeters are entirely self-contained, all necessary resistors to obtain the calibrated scale readings being contained in the case, which is well ventilated. The double-scale instruments have the terminals plainly marked.

Voltmeters for lower voltages than those listed or with special ranges can be supplied on special order, prices on request.

Approximate weight: net, 8½ pounds; boxed, 20 pounds.

Style number and list price include voltmeter complete with internal resistors for the voltage listed.

Scales, Volts	Style No.	List Price
0– 75	182963	$100 00
0– 75 0–150	169518	105 00
0–150 0–300	169519	110 00
0–150 0–600	272959	115 00
0–300 0–600	219315	115 00
0–300 0–750	219316	120 00

TYPE PC POWER FACTOR METERS

The power factor meters are direct reading and operate on the moving coil principle. Two forms are made: for single or two-phase circuits, and for three-phase circuits.

The moving element has two voltage coils fixed at right angles to each other, and the stationary current coils are parallel to the axes of the moving coils. The currents in the voltage coils differ from each other in phase, and depend for their phase relation to the current in the stationary coils, on the phase of the voltage of the circuit. Any difference in phase between the voltage and current of the circuit, therefore, changes the relative torques of the two coils of the moving element, which determines the position that the moving element and pointer will assume. In the single-phase instrument the difference in phase between the currents in the moving coils is produced by a split-phase arrangement, and in the three-phase instruments by connecting to two phases of the circuit.

The single-phase power factor meter can be used on a single-phase circuit or on one phase of a two-phase circuit, but cannot be used in one phase of a three-phase circuit unless provision is made for obtaining phase relations at the instrument equivalent to the phase relations of current and voltage in a single-phase circuit. It can be calibrated specially for use on three-phase three-wire circuits but it then becomes essentially a three-phase instrument and cannot be used on single-phase circuits. The instrument has two scales, one for 25 cycles and the other for 60 cycles. The three-phase instruments are suitable for any frequency.

Style number and list price include self-contained power factor meter complete for 5-ampere circuit. For larger capacities a portable current transformer should be used.

These instruments can be used on circuits within 25 per cent below, or 50 per cent above rated voltage.

Frequency, Cycles	Phase	Nominal Voltage	Style No.	List Price
25–60	1*	100	177036	$125 00
Any	3*	100	177039	110 00

Approximate Weight—Net, 9 pounds; shipping, 21 pounds.
*For two-phase circuits use single-phase instrument on one phase.

TYPE PD FREQUENCY METERS

Type PD frequency meters indicate by means of a scale and pointer. They operate on the induction principle, and consist of two voltmeter electromagnets acting in opposition on a disk attached to the pointer shaft. One of the magnets is in series with a resistor, and the other with an inductor, so that any change in the frequency will unbalance the forces acting on the shaft and cause the pointer to assume a new position, where the forces are again balanced. The aluminum disk, acted upon by the magnets, is so shaped that, when the shaft turns, the torque due to one magnet varies, while the torque due to the other magnet remains constant. The pointer therefore comes to rest where the torques of the two magnets are equal. This arrangement insures freedom from error, due to varying voltage. The scale is calibrated to indicate the number of cycles directly.

The instruments contain no moving wires, moving iron, or vibrating reeds, and no controlling springs, the controlling forces being entirely electrical, and thus the calibration is permanent.

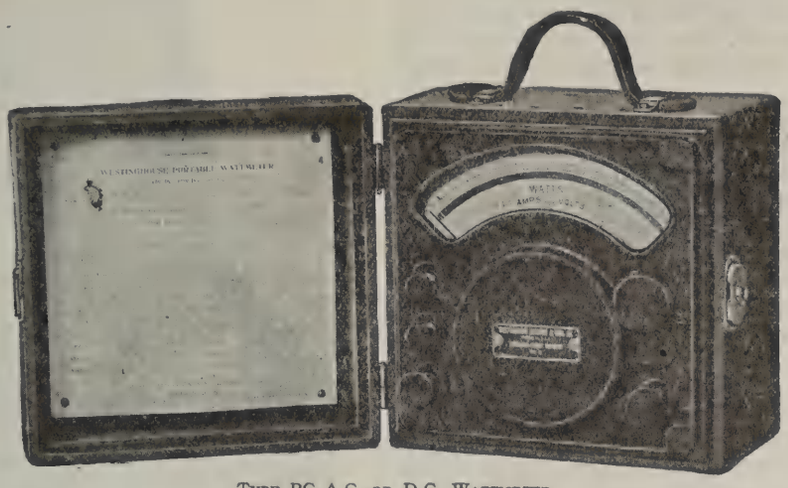
Style number and list price include self-contained frequency meter complete for 90 to 130-volt circuits. For other voltages, a portable transformer having 100-volt secondary should be used.

Frequency	Voltage	Style No.	List Price
20 to 45	90–130	177034	$100 00
45 to 75	90–130	177035	100 00

Approximate Weight—Net, 9 pounds; shipping, 21 pounds.

Order by Style Number

TYPE PC WATTMETERS



TYPE PC A.C. OR D.C. WATTMETER

The listed wattmeters are entirely self-contained, all resistors necessary for the rated voltage ranges being contained in the case. The wattmeters that have double current or double voltage range are provided with a switch operated by a knob on the face-plate, which makes series or parallel connection of coils when the knob is turned to the proper position. Only two current and two voltage binding posts are, therefore, necessary. Special instruments can be supplied with sufficient overload capacity to give full scale deflection on 20 per cent power factor.

The polyphase wattmeter when properly connected, indicates the true power in a two-phase three-wire or four-wire,* or a three-phase three-wire or four-wire circuit. They are useful in polyphase testing, as one instrument indicates the total power and it is not necessary to take separate readings in two phases and add or subtract them. They can be used for single-phase as well as polyphase testing, either by connecting only one element in circuit or by connecting the two current coils in series and the two voltage coils in multiple on the single-phase line. With the latter connection, the instrument reads twice the actual load. If transformers are required, the polyphase instrument connected single phase operates from the same transformers that would be used with a single-phase instrument.

Style number and list price include self-contained wattmeter complete.

Maximum Voltage	Current Capacity, Amp.	Scales	Style No.	List Price
Type PC Single-Phase Wattmeters				
150 300	1 2	100 W. 200 W. 400 W.	182972	$140 00
150 300	2.5 5	250 W. 500 W. 1000 W.	182973	140 00
150 300	5 10	500 W. 1000 W. 2000 W.	182974	145 00
150 300	10 20	1000 W. 2000 W. 4000 W.	182975	150 00
150 300	20 40	2 Kw. 4 Kw. 8 Kw.	182976	160 00
150 300	30 60	3 Kw. 6 Kw. 12 Kw.	182977	160 00
150 600	5 10	500 W. 1000 W. 2500 W. 5000 W.	272960	160 00
300 600	5 10	1000 W. 2000 W. 4000 W.	219313	160 00
Type PC Polyphase Wattmeters				
150 300	Amp. per Phase 2.5 5	500 W. 1000 W. 2000 W.	196555	$210 00
150 300	5 10	1000 W. 2000 W. 4000 W.	196556	210 00
150 600	5 10	1000 W. 2000 W. 5000 W. 10000 W.	272961	225 00
300 600	5 10	2 Kw. 4 Kw. 8 Kw.	219314	225 00

Approximate Weight—Single-phase: net, 9 pounds; boxed, 20 pounds; polyphase: net, 14 pounds; boxed, 30 pounds.

*When used on interconnected two-phase four-wire circuits, these instruments require two voltage transformers for any voltages as there are only three voltage terminals, one being common to each element. The transformers are necessary for the purpose of insulating the two-voltage circuits from the main conductors so that the common connection can be made at the instrument. Special polyphase wattmeters arranged for direct connections to all phases without transformers (within capacity) can be supplied for use on two-phase circuits, prices of which will be given on request; two standard single-phase instruments can also be used.

Order by Style Number

TYPE PC IRON-LOSS VOLTMETER

This instrument is for use with a wattmeter for determining the iron loss in distributing and power transformers on the basis of sine wave voltage and normal frequency, when the testing is done on a circuit of any wave shape and approximately normal frequency.

The iron loss in a transformer varies with the wave shape and frequency. Guarantees are, therefore, based on sine wave and a normal frequency; but the standard conditions are difficult to obtain in practice.

The iron-loss voltmeter consists of a type PC wattmeter movement connected in series with the winding on an iron core, and so compensated that it measures the iron loss in the core. It is calibrated in "volts" on a circuit of pure sine wave voltage. Any circuit that makes the instrument read a certain "voltage", therefore, produces the same iron loss as would a pure sine wave of that voltage. The instrument does not indicate the voltage of the circuit, but the voltage of a pure sine wave of normal frequency that would cause the same iron loss in the transformer as the wave of voltage of the testing circuit.

In application the iron-loss voltmeter is connected across the terminals of the transformer under test in the same manner as an ordinary voltmeter. A wattmeter is also connected in the circuit in such a way as to measure the total input of both the transformer and the iron-loss voltmeter. The voltage of the circuit is then adjusted by any convenient means until the iron-loss voltmeter reads the normal voltage of the transformer. The total power input is read on the wattmeter and the watts input of the iron-loss voltmeter is read on its watt scale, the difference being the normal iron loss of the transformer.

TYPE PC IRON-LOSS VOLTMETER

Style number and list price include complete instrument.

Voltage	Frequency, Cycles	Approx. Wt. Lbs. Net	Boxed	Style No.	List Price
125–250	60	20	50	185074	$200 00

RESISTORS* FOR VOLTMETERS, WATTMETERS, AND THREE-PHASE POWER FACTOR METERS

Resistors are listed that adapt any of the voltmeters or wattmeters for use on voltages up to 600, and the three-phase power factor meters for voltages up to 400. Above these voltages and for single-phase power factor meters on voltages above 150, voltage transformers should be used when measuring alternating current. For voltmeters that are to be used on direct-current circuits of higher voltages, special resistors can be furnished.

Rated Ohms	For Voltmeter Style No.	For Wattmeter Style Nos.	For Power Factor Meter Style No.	Changes Voltage From	Changes Voltage To	Style No.	List Price
550 1650	182963	....	.....	0– 75	0–150 0–300	207389	$34 00
1100 3300	169518	....	.....	0–150	0–300 0–600	207390	42 00
2000 6000	.....	169520 to 169526 182965 to 182970	.....	150	300 600	182971	34 00
4000	169519	169527 to 169533 182972 to 182977	.....	300	600	207391	28 00
2000 2000	.....	....	177039	100	200	†207392	38 00
4000 4000	.....	196555 to 196556	..... 177037 or 177039	300 100	600 400	‡178554	42 00

*These resistors are not interchangeable; each must be adjusted for the particular instrument with which it is used. When ordering new resistors for instrument already in service, state the exact resistance of instrument. A record of the original resistance will be found on the instruction card in cover. If the instrument has never been readjusted and is in good condition this information can be copied from card.

†This resistor includes two separate 2000 ohm resistors in one box.

‡This resistor includes two separate 4000 ohm resistors in one box.

Transformers—For voltages or currents higher than those for which instruments are listed, instruments for 100 volts and for 5 amperes should be used with voltage and current transformers selected from the pages of this catalogue on "Instrument Transformers".

Transportation of Portable Instruments

Experience has shown that portable instruments shipped by freight are subjected to such rough handling that there is an appreciable tendency toward change in calibration or actual damage.

It is strongly recommended that all shipments of portable instruments be made by express and they will be so shipped in all cases where method of shipment is not specified by the purchaser. Where the purchaser specifies shipment by freight the Westinghouse Company will accept no responsibility for errors found in calibration.

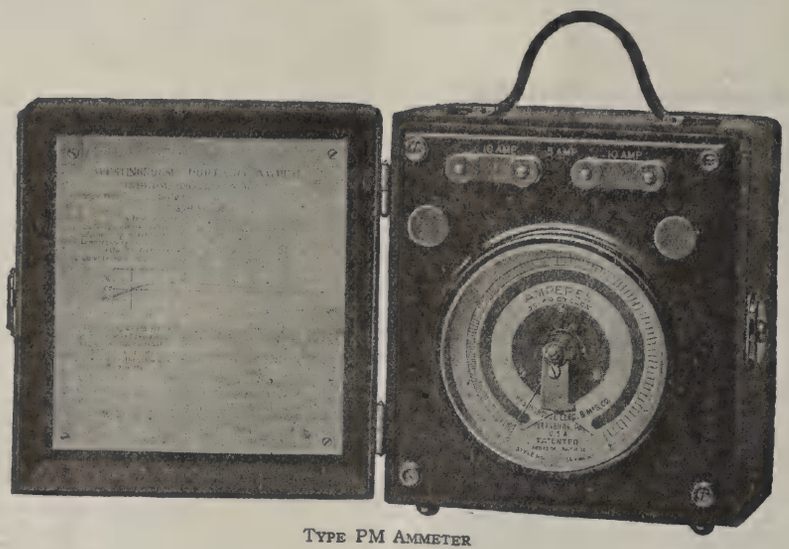
Over-All Dimensions—Inches

Type PC Voltmeter.....7¾ x 7¾ x 6 1/16
Type PC Wattmeter (Single-Phase).....7¾ x 7¾ x 6 1/16
Type PC Wattmeter (Polyphase).....7¾ x 7¾ x 9½
Type PC Iron Loss Voltmeter.....7¾ x 7¾ x 12
Type PC Power Factor Meter.....7¾ x 7¾ x 6 1/16
Type PD Frequency Meter.....7¾ x 7¾ x 6 1/16

TABLE OF SCALE MARKINGS - TYPES PC AND PD METERS

Style No.	Capacity	Divisions Main	Int.	Sub	Total	Marking
						Type PC Voltmeters
182963	75 Volts	15	2	5	150	0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75
169518	75-150 Volts	15	2	5	150	0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75
169515	150-300 "	15	2	5	150	0 20 40 60 80 100 120 140 160 180 200 220 240 260 280 300 0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150
						Type PC Wattmeters
169520	100 Watts	10	2	5	100	0 10 20 30 40 50 60 70 80 90 100
169521 169527	200 "	10	2	5	100	0 20 40 60 80 100 120 140 160 180 200
182965	100-200 "	10	2	5	100	0 20 40 60 80 100 120 140 160 180 200 0 10 20 30 40 50 60 70 80 90 100
169528	400 "	8	2	5	80	0 50 100 150 200 250 300 350 400
182972	100-200-400 Watts	10	2	5	100	0 40 80 120 160 200 240 280 320 360 400 0 20 40 60 80 100 120 140 160 180 200 0 10 20 30 40 50 60 70 80 90 100
169522	500 Watts	10	2	5	100	0 50 100 150 200 250 300 350 400 450 500
182966	250-500 "	10	2	5	100	0 50 100 150 200 250 300 350 400 450 500 0 25 50 75 100 125 150 175 200 225 250
169523 169529	1000 "	10	2	5	100	0 100 200 300 400 500 600 700 800 900 1000
182967	500-1000 "	10	2	5	100	0 100 200 300 400 500 600 700 800 900 1000 0 50 100 150 200 250 300 350 400 450 500
182973	250-500-1000 Watts	10	2	5	100	0 100 200 300 400 500 600 700 800 900 1000 0 50 100 150 200 250 300 350 400 450 500 0 25 50 75 100 125 150 175 200 225 250
169530	2000 Watts	10	2	5	100	0 200 400 600 800 1000 1200 1400 1600 1800 2000
182968	1000-2000 "	10	2	5	100	0 200 400 600 800 1000 1200 1400 1600 1800 2000 0 100 200 300 400 500 600 700 800 900 1000
182974	500-1000-2000 Watts	10	2	5	100	0 200 400 600 800 1000 1200 1400 1600 1800 2000 0 100 200 300 400 500 600 700 800 900 1000 0 50 100 150 200 250 300 350 400 450 500
169524	2500 Watts	10	2	5	100	0 250 500 750 1000 1250 1500 1750 2000 2250 2500
182969	2000-4000 "	8	2	5	80	0 500 1000 1500 2000 2500 3000 3500 4000 0 250 500 750 1000 1250 1500 1750 2000
182975	1000-2000-4000 Watts	10	2	5	100	0 400 800 1200 1600 2000 2400 2800 3200 3600 4000 0 200 400 600 800 1000 1200 1400 1600 1800 2000 0 100 200 300 400 500 600 700 800 900 1000
169525 169531	5 Kw.	10	2	5	100	0 .5 1 1.5 2 2.5 3 3.5 4 4.5 5
182970	3-6 "	12	2	5	120	0 .5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 0 .25 .5 .75 1 1.25 1.5 1.75 2 2.25 2.5 2.75 3
182976	2-4-8 "	8	2	5	80	0 1 2 3 4 5 6 7 8 0 .5 1 1.5 2 2.5 3 3.5 4 0 .25 .5 .75 1 1.25 1.5 1.75 2
169526 169532	10 "	10	2	5	100	0 1 2 3 4 5 6 7 8 9 10
182977	3-6-12 "	12	2	5	120	0 1 2 3 4 5 6 7 8 9 10 11 12 0 .5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 0 .25 .5 .75 1 1.25 1.5 1.75 2 2.25 2.5 2.75 3
169533	20 "	10	2	5	100	2 4 6 10 12 14 16 18 20
						Type PC Power Factor Meters
	80% Leading 40% Lagging	8	2	5	80	80 90 100 90 80 70 60 50 40
						Type PD Frequency Meters
177034	20 to 30 Cycles	10		5	50	20 25 30
177035	45 to 75 "	6	5	2	60	45 50 55 60 65 70 75

TYPES PM AND PR PORTABLE AMMETERS
FOR ALTERNATING-CURRENT CIRCUITS



TYPE PM AMMETER

Application

These are direct-reading instruments for general alternating-current testing and laboratory work. Exceptionally long, open scales and perfectly damped character of the indications, enable readings to be taken quickly and accurately, and make these instruments very desirable for measuring fluctuating loads or for general testing.

Distinctive Features

Permanent accuracy, light but strong moving element, high torque, no moving wires or connections, freedom from effects of external fields, damping by permanent magnets, and excellent readability.

Compared to moving-iron instruments, these instruments offer many advantages such as freedom from stray fields, and longer scales. The long scales permit of fewer instruments for a complete equipment for any given range of testing.

Operation

These instruments operate on the induction principle. Simple construction and accessibility of all parts have been made prime features in their designs.

TYPE PM INSTRUMENTS

Construction

Case and Cover—Mounted in polished wood carrying cases having hinged covers, which are easily removable, and flexible sole-leather handles. By withdrawing four screws and removing a connection strap on the face-plate the sides and face of the case can be removed, leaving the measuring element mounted on the base in good position for inspection or repairs.

Scales—Scale subtends an arc of 300 degrees, giving large, open divisions that are clearly readable from 10 per cent to full scale. Mirror extending the entire length of the scale prevents parallax in reading.

Simplicity—The use of the induction principle results in a very sinple construction. The moving element is light but not delicate.

Damping—Perfect damping is obtained with minimum weight of movement. A sudden application of full load will not cause the pointer to overswing. In addition, heavy damping has the effect of eliminating unnecessary wear on bearings, and mechanical shocks.

Accuracy and Permanence—The exceptionally high torque developed makes these instruments extremely sensitive to permanent changes in load as distinguished from momentary fluctuations, which are damped out. They are not affected by temperature changes, and a curve accompanying each instrument gives corrections for frequencies between 20 and 65 cycles. The absence of pivot wear, insured by the light moving element and the design and materials used in the bearings, enables the instruments to retain their high initial accuracy for a long period of service.

These instruments are guaranteed to be accurate within ½ per cent of full scale.

Torque and Weight of Movement—Extremes of weight in the movements have been avoided. The ratio of torque to weight is exceedingly high.

Finish—The terminals and connection straps are finished in bright nickel. Metal parts close to the dial are finished in black nickel to avoid glare. The face-plate is of polished black composition.

Size—The cases of the type PM ammeters are 6¾ inches by 7¾ inches by 4¾ inches high.

Range in Calibration—Each instrument has two scales with a ratio of 1 to 2, and the calibration is equally correct for either scale.

Scale Marking

The scale marking is so divided that the division marks give even readings. Thus, the 40-ampere instrument has eight main divisions, five intermediate divisions, and four sub-divisions, or a total of 160 divisions; each sub-division is .25 ampere. Owing to the condensation of the scales at the zero end, a number of the sub-divisions are omitted, usually about 10 per cent. The main (numbered) divisions of the scale are, however, given down to zero.

The standard scale divisions and markings for the various capacities are shown in the table below.

Type PM Ammeters

Style number and list price include self-contained instrument in a polished box with removable cover. Style Nos. 169511 and 169512 may be used in connection with current transformers having 5 amperes secondary current for full-scale deflection.

Current Ranges, Amperes	Frequency, Cycles	Approx. Wt., Lb. Net	Approx. Wt., Lb. Boxed	Style No.	List Price
0– 1 and 0– 2	20 to 65	8	20	169510	$75 00
0– 2½ and 0– 5	20 to 65	8	20	169511	75 00
0– 5 and 0– 10	20 to 65	8	20	169512	75 00
0–10 and 0– 20	20 to 65	8	20	169513	80 00
0–20 and 0– 40	20 to 65	8	20	169514	85 00
0–30 and 0– 60	20 to 65	8	20	169515	85 00
0–40 and 0– 80	20 to 65	8	20	169516	90 00
0–60 and 0–120	20 to 65	8	20	169517	90 00

Order by Style Number

TABLE OF SCALE MARKINGS—TYPE PM AMMETERS

Style No.	Capacity	Divisions Main	Int.	Sub.	Total	Marking	Color of Ink
169510	1 & 2 Amp.	10	2	5	100	0 .2 .4 .6 .8 1.0 1.2 1.4 1.6 1.8 2.0 / 0 .2 .4 .6 .8 1.0 1.2 1.4 1.6 1.8 2.0	Black / Red
169511	2.5 & 5 "	10	2	5	100	0 .5 1 1.5 2. 2.5 3. 3.5 4 4.5 5 / 0 .5 1 1.5 2 2.5 3 3.5 4 4.5 5	Black / Red
169512	5 & 10 "	10	2	5	100	0 1 2 3 4 5 6 7 8 9 10 / 0 1 2 3 4 5 6 7 8 9 10	Black / Red
169513	10 & 20 "	10	2	5	100	0 2 4 6 8 10 12 14 16 18 20 / 0 2 4 6 8 10 12 14 16 18 20	Black / Red
169514	20 & 40 "	8	5	4	160	0 5 10 15 20 25 30 35 40 / 0 5 10 15 20 25 30 35 40	Black / Red
169515	30 & 60 "	12	2	5	120	0 5 10 15 20 25 30 35 40 45 50 55 60 / 0 5 10 15 20 25 30	Black / Red
169516	40 & 80 "	8	5	4	160	0 10 20 30 40 50 60 70 80 / 0 10 20 30 40 50 60 70 80	Black / Red
169517	60 & 120 "	12	2	5	120	0 20 40 60 80 100 120 / 0 10 16 30 40 50 60	Black / Red

TYPE PR INSTRUMENTS

The type PR ammeters fill the demand for instruments where low first cost is of more importance than very high accuracy. The mechanism is similar to that of the type PM, the difference consisting in the omission from type PR of some of the refinements. The main differences are: Pivots permanently attached to movement instead of removable; cases made from cast aluminum, black japanned finish, without hinged cover, not sealed.

Accuracy—The accuracy of type PR ammeter is guaranteed to be within 1 per cent of full scale.

Size—The cases of the type PR ammeters are 6 inches by 7 inches by 3¾ inches.

TYPE PR AMMETER

Type PR Ammeters

Style number and list price include self-contained instrument in metal case without cover. Style No. 172569 may be used in connection with current transformers having 5-ampere secondary current for full scale deflection.

Full Scale Capacity, Amperes	Frequency, Cycles	Approximate Wt., Lb. Net	Boxed	Style No.	List Price
As desired	25 to 60	7⅞	11	172569	$45 00
5	25 to 60	7⅞	11	219146	45 00
10	25 to 60	7⅞	11	219147	45 00

For transformers for use with these instruments see pages on "Portable and Switchboard Current and Voltage Transformers."

TYPE PR PORTABLE TESTING OUTFITS

TYPE PR PORTABLE TESTING OUTFIT

Application

These outfits provide a convenient means of measuring currents from 75 amperes up to 250 amperes in an overhead line or in station wiring without opening the circuit. These values are lower than could be measured with a standard instrument and split-type transformer.

Construction

The outfit consists of a portable split-type current transformer, Style No. 117508, a type PR portable ammeter, a set of leads 10 feet long and a leather carrying strap.

The split-type current transformer is made with a clamp at one side and a hinged joint at the other so that the two halves can be opened up, slipped over the cable, and clamped together tightly. By means of binding posts on the transformer, connections can be made for obtaining full scale readings on either 125 or 250 amperes primary.

Insulation—The split-type current transformer is insulated for use on 2300-volt circuits, it being assumed that for higher voltages they will be used over cable having sufficient insulation for the protection of the operator and instrument.

Accuracy

The transformer and instrument are calibrated together so that fairly accurate readings are made without corrections. The transformer is not suitable for use with a wattmeter or watthour meter and cannot be used with an ammeter that has not been calibrated with it. The ammeter as included in the set cannot be used alone or with any transformer other than the one with which it is calibrated.

Style number and list price include type PR ammeter, portable transformer Style No. 117508, leads 10 feet long, and leather carrying strap.

Frequency, Cycles	Full Scale Capacity, Amperes	Opening for Conductor, Inches	Approximate Wt., Lb. Net	Shipping	Style No.	List Price
60	125 or 250	1¾ x 1⅞	28½	48	172571	$110 00

Order by Style Number

PRECISION INSTRUMENTS
FOR A. C. OR D. C. CIRCUITS

STYLE NO. 35248, VOLTMETER

STYLE NO. 35243, AMMETER

Application

These instruments are for use as calibration standards for watthour meters, switchboard and portable instruments, and for general laboratory work. They possess the highest degree of accuracy compatible with portability and simplicity of mechanical and electrical features and enable making rapid and accurate measurements on both alternating-current and direct-current work.

Operation

These instruments operate on the principle of the Kelvin Balance, the mechanical construction being suitably modified to render them portable and to obviate the necessity for accurate leveling. The stationary and moving coils of the measuring element are astatically arranged. The frictional factor is practically eliminated by supporting the movable coils on a ball-bearing consisting of a highly polished steel ball seated between two cupped sapphire jewels.

Scales and Adjustments

These instruments are of the zero reading type, the index pointer indicating 0 when the deflecting pointer indicates the value of electrical quantity. Approximate adjustment of the deflecting pointer may be made by the knurled head on top, and final adjustment accurately secured through a continuous worm operated by the adjusting rod and thumb screw at the side.

The scales are graduated on a silvered dial, with large and open divisions, which form equal parts of the entire circumference of a circle about 5 inches in diameter.

The ammeter and voltmeter deflections are proportional to the square of the quantity measured. The wattmeter deflections are directly proportional to the watts passing. The voltmeters and ammeters are provided with two scales, one divided into equal divisions which may be read with a vernier, the other divided into divisions proportional to the square root of the deflection and hence proportional to the voltage or current. The latter scale is used for taking readings when only ordinary accuracy is necessary. For extreme accuracy readings are taken on the evenly divided scale and the square root obtained from a table furnished with the instrument and this multiplied by the constant. With 1000 ohms in the potential circuit of the voltmeter this constant is 10, thus reducing the amount of calibration necessary to a minimum.

These instruments are calibrated in the standardizing laboratory of the Westinghouse Electric & Mfg. Company, and a certificate furnished with each instrument gives the various constants and the calibration curve of the instrument.

Recalibration—The Westinghouse Electric & Mfg. Company will check these instruments for a period of five years from the date of original purchase without any expense to the purchaser, except the transportation charges.

PRECISION AMMETERS

Precision ammeters are applicable to cases requiring a greater accuracy than that of the usual type of portable ammeter or dynamometer. Ammeters listed are self-contained.

Maximum Current Capacity	Style No.	List Price
1 ampere	35242	$310 00
5 amperes	35243	310 00
10 amperes	35244	310 00
0.5–1 amperes	60179	360 00
2.5–5 amperes	60180	360 00

PRECISION VOLTMETERS

Each voltmeter outfit consists of a low reading milliammeter, used in connection with a known resistance. The instrument will give full scale deflection on 0.15 of an ampere, and has a resistance of exactly 100 ohms. Therefore, when used with external resistor, Style No. 35249, it will measure up to 150 volts, and to proportionate voltages with other resistors.

Style number and list price do not include external resistor. External resistors must be used for all voltages.

Scale	Style No.	List Price
150 volts	35248	$310 00

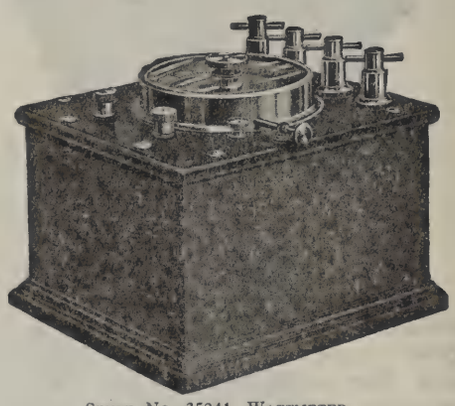
PRECISION WATTMETERS

Resistance—The resistance of the potential coil in these instruments is exactly 100 ohms, and they may be used with suitable external resistance on potentials up to 2500 volts.

Range—For use in calibrating watthour meters, Style No. 35241 is furnished covering three current-ranges of a maximum capacity of 5, 20 and 100 amperes. With 1000 ohms in the potential circuit, and 100 volts on a non-inductive load this instrument will give full scale deflections on 2.5, 20 or 100 amperes. To obtain the maximum capacity of the 5-ampere coil on 100-volt circuits, an external resistance of 2000 ohms should be used. With a resistance in the potential circuit for 100 volts these instruments will accurately measure quantities ranging from 10 to 10,000 watts and proportionate values at other voltages.

Style No. 66371 is a self-contained instrument. The current coils are similar to those in Style No. 35241, but it has in addition a resistance of 2000 ohms total mounted on the outside of the case, making the resistor and instrument a single unit.

Style number and list price do not include external resistors, which must be used for all voltages, except Style No. 66371, which is self-contained for 150-300 volts.

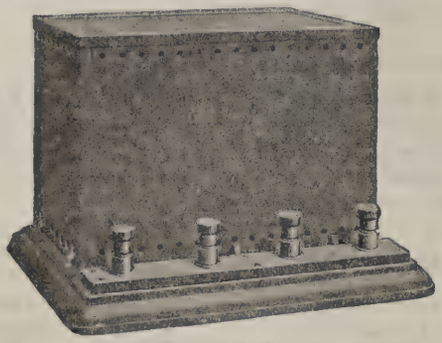


STYLE NO. 35241, WATTMETER

Maximum Current Capacity	Style No.	List Price
2 amperes	35233	$410 00
5 amperes	35234	410 00
10 amperes	35235	410 00
25 amperes	35236	410 00
50 amperes	35237	410 00
100 amperes	35238	410 00
200 amperes	35239	465 00
500 amperes	35240	465 00
0.5–5 amperes	54972	465 00
2.5–10–50 amperes	54973	515 00
5–20–100 amperes	35241	515 00
5–20–100 amperes self-contained	66371	575 00

RESISTORS FOR PRECISION VOLTMETERS AND WATTMETERS

The precision resistors are for use with precision voltmeters and the potential circuits of precision wattmeters. Up to and including the 6000 ohm size, they are made up in several sections giving steps of 1000 ohms each, which is the value used for a normal potential of 100 volts.



STYLE NO. 35250, RESISTOR

Sub-Division—The first section of each box has a sub-division of 100 ohms to allow for the resistance of the instrument coils, the total resistance being used when the boxes are connected in series.

Resistance Ohms	Sections Ohms	Normal Working Voltages For Total Resistance	Style No.	List Price
1000	100–900	100	35249	$105 00
2000	100–900–1000	200	35250	145 00
4000	100–900–1000–2000	400	35251	205 00
6000	100–900–1000–2000–2000	600	35252	260 00
9900	9900	1000	*35253	330 00
19900	9900–10000	2000	†35254	565 00

*Not divided in sections.

†Divided into two sections, one of 9900 ohms for use on circuits of 1000 volts and one of 10000 ohms, which is the additional resistance required for circuits of 2000 volts.

PORTABLE POTENTIOMETERS

FOR "HOT SPOT" TEMPERATURE MEASUREMENTS

Application

Same as the switchboard potentiometer listed on another page, except arranged for portable service. Is the most accurate means of measuring the temperature of the hottest parts in electrical machines.

Industrial Uses—The potentiometer is coming into wide use for measuring temperatures in other than electrical apparatus. With the thermo-couples embedded in bales of cotton or tobacco in course of curing, in storage coal piles, and in similar places, the temperature of the interior of the piles can be determined without disturbing them. The portable instrument lends itself especially to these industrial applications because it is not often convenient to carry the leads from such location to a central point at which the switchboard instrument could be mounted.

As a Millivoltmeter—The potentiometer is calibrated in millivolts as well as in degrees and can therefore be used within its capacity as a millivoltmeter. As it operates on the slide-wire-potentiometer principle, with proper connections it can be used for any testing for which the slide wire potentiometer can be used.

Distinctive Features

Readings are made directly in degrees; couples are simple, inexpensive, and mechanically strong; there is no appreciable time lag in making measurements; there are no errors due to change of resistance.

Construction

The portable potentiometer is essentially the same as the switchboard instrument described on another page.

Case—The potentiometer is mounted in polished hardwood case with hinged cover that is easily removable, and flexible sole-leather handle. Size of case: 8 inches wide by 9¼ inches long; 6 inches high.

Wiring—All wiring from the couples to the potentiometer must consist of one copper wire and one "advance" (nickel-copper) alloy wire.

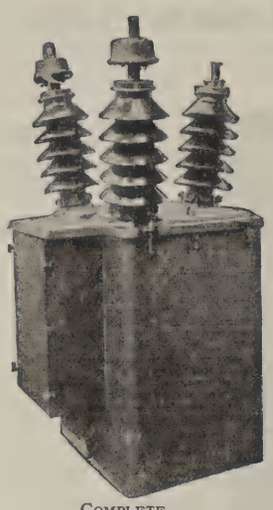
Style number and list price include portable potentiometer complete with one test thermo-couple having leads 6 feet long.

Description	Temperature Range, Degrees C.	Millivolt Range	Style No.	List Price
Potentiometer	0–150	6.3	227362	$200 00
Potentiometer	0–200	8.4	227363	200 00
Extra Thermo-Couple, including 6 feet of leads and terminal clips			232014	3 50
Additional leads, per foot additional length			.....	25

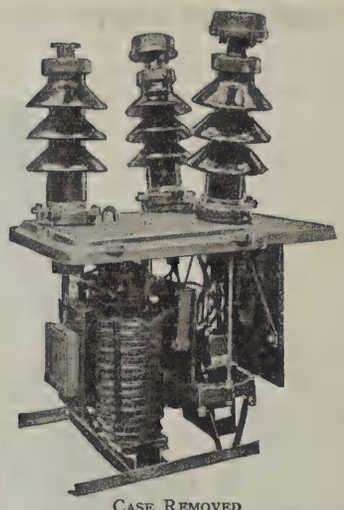
Approximate Weight of Potentiometer—Net, 8½ pounds, boxed, 20 pounds.

Order by Style Number

OUTDOOR METERING EQUIPMENTS



COMPLETE



CASE REMOVED

Application

For supplying service from high-voltage transmission lines, where the expense of a substation is not warranted, these metering equipments are furnished enclosed in weatherproof casings.

Construction

Each equipment consists of a standard polyphase watthour meter, two current transformers, a polyphase voltage transformer, and three choke coils to protect the transformer windings against high-frequency disturbances; all enclosed in a sheet steel case with cast iron cover. The sheet steel case is subdivided into two compartments, one of which is filled with oil in which the transformers and choke coils are immersed, while the other serves to enclose the meter and meter panel. On the meter panel are also mounted two fuses to protect the voltage circuit of the meter and two calibrating links located in the current circuit of the meter. The meter may be read or checked upon opening the hinged door which covers the entire front of the meter compartment. The arrangement is such that the entire outfit, including meter panel, can be raised out of the tank without disconnecting meter leads.

Connections—Three primary outlet terminals supported on the cover provide the necessary primary connections. A large handhole is provided in the cover of the metering equipment to facilitate connection or disconnection of the outlet terminals.

Style number includes outfit complete except watthour meter and oil. **List price** includes outfit complete with oil and watthour meter, Style No. 224369, calibrated as desired. **When ordering** specify style number of outfit, normal voltage, primary-current capacity,* style number of watthour meter (Style No. 224369), calibration desired on watthour meter, and gallons oil.

POLYPHASE 60-CYCLE EQUIPMENTS

Capacity: Current transformers 50 voltamperes; compensated for 25 voltamperes.
Voltage transformers 200 voltamperes; compensated for 15 voltamperes.

Primary Volts 110 Volts Secondary		Approx. Dimensions, In.		Gal. Oil	Approx. Wt., Lbs.		5 to 50 Amperes				100 to 200 Amperes		
							Style No.‡				Style No.‡		
Normal	Maximum Continuous	Floor Space	Ht.		Without Oil Net	Boxed§	5, 10 Amperes	10, 20 Amperes	25, 50 Amperes	List Price‡	50, 100 Amperes	100, 200 Amperes	List Price‡
11,000	12,000	28x41	44	42	1100	1350	272493	272494	272495	$925 00	272496	272497	$950 00
13,200	14,400	28x41	44	42	1100	1350	272498	272499	272500	975 00	272501	272502	1000 00
11,000 or 22,000	24,000	29x41	56	45	1385	1650	272503	272504	272505	1175 00	272506	272507	1200 00
22,000	24,000	29x41	54	43	1400	1700	272508	272509	272510	1150 00	272511	272512	1175 00
33,000	35,000	35x44	60	70	1710	2100	272513	272514	272515	1575 00	272516	272517	1600 00
44,000	47,000	46x50	83	153	2530	3000	272518	272519	272520	2375 00	272521	272522	2400 00
66,000	70,000	50x60	100	270	2600	3100	272523	272524	272525	3275 00	272526	272527	3300 00

Two or Three-Phase Four-Wire Service—Equipments listed above are not suitable for two-phase four-wire or three-phase four-wire service; equipments for this service can be supplied on special order, prices on request.

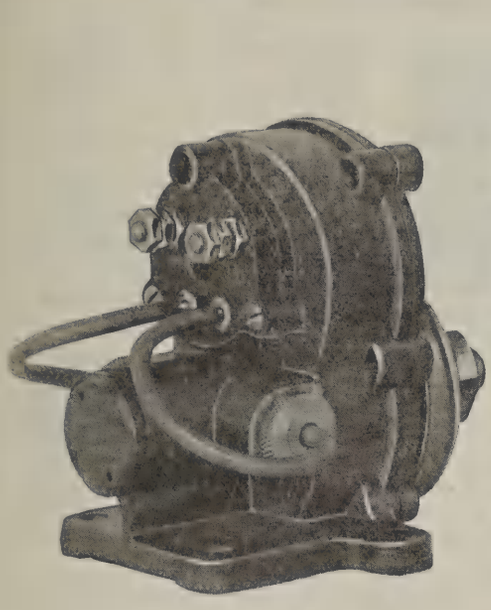
Voltage Below 11,000—For outfits for voltages below **11,000**, see pages on "Outdoor Switching and Metering Equipment".

*The current transformers have two primary windings which can be connected in series or parallel to give the lower or higher current rating listed. Order should specify which current rating is desired so proper connection and meter calibration can be made at the works.

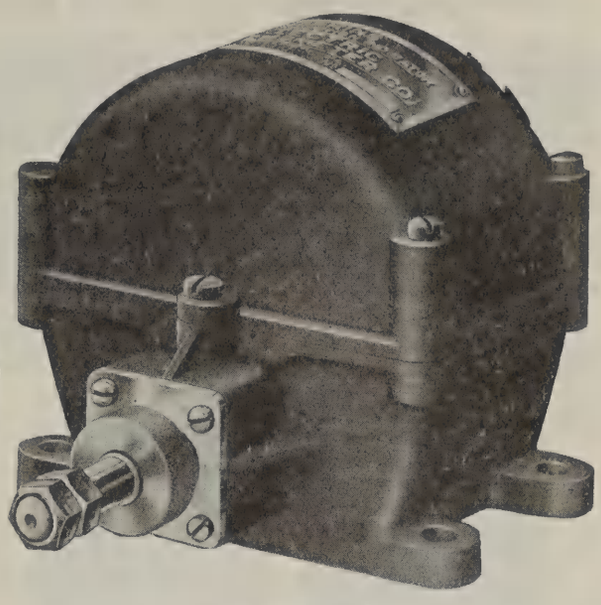
§Equipments are regularly shipped in their tanks without oil—oil is shipped separately and weighs approximately 7 pounds net per gallon and 8½ pounds gross per gallon. On receipt at destination equipments should be filled with clean dry oil immediately.

‡See "style number and list price include" above

ELECTRICAL SPEED INDICATORS



SMALL MAGNETO GENERATOR



LARGE MAGNETO GENERATOR

Application

Electrical speed indicators are used for indicating the speed of rotating machinery, where the location of the indicator prevents the use of mechanically driven indicators or so-called speedometers. Calibration may be made in revolutions per minute, feet per minute, cycles per second, percentage fast or slow, copies per minute on newspaper presses, or in general wherever quantity indicated is a function of the speed.

When applied in railway service the magneto, if mounted on car trucks, must be protected from excessive vibration by some form of spring suspension to be devised by the purchaser. For operation on cars it is usual to belt the magneto pulley to the car axle.

Operation and Construction

The speed indicator consists of a magneto generator and a direct-current instrument. The magneto is belted to a pulley or shaft of the apparatus of which the speed is desired. The voltage of the magneto is proportional to its speed so that it is possible to calibrate the instrument to indicate the speed directly in any unit required. The instrument can be mounted away from the magneto.

The magneto operates normally at 1000 revolutions per minute and pulley ratio should be selected accordingly; when necessary the speed producing full scale reading on the instrument can vary between 900 and 1000 rpm. The magneto generator is arranged for mounting with base either vertical or horizontal on wall, floor or ceiling.

Two forms of magneto are provided. Small magneto, Style No. 289367, is for general use in connection with testing outfits, small machinery, etc., where small size and low cost are desired and the refinements of the large magneto are not necessary. Large magneto, Style No. 289368, is desired particularly for use with heavy machinery, such as marine work, locomotives, etc., the case being dust proof and moisture proof.

No provision is made for mounting the magneto other than the holes in the base. The local conditions of installation vary so widely that it is best to have this taken care of at the time of installation. Outlines of the magnetos and pulleys will be furnished upon application. The mounting should be such as to allow proper space for pulleys and belt.

Overall dimensions—Small magneto base $3\frac{5}{8}$ inches wide, shaft length $4\frac{1}{16}$ inches, height $3\frac{15}{16}$ inches, center line of shaft $1\frac{15}{16}$ inches above bottom of base. Large magneto base $6\frac{1}{8}$ inches wide, shaft length $8\frac{3}{4}$ inches, height $5\frac{9}{16}$ inches, center line of shaft $1\frac{3}{8}$ inches above bottom of base.

The indicator may be any d'Arsonval voltmeter such as type BX, AW, FW, SL, GL or PL voltmeter or a type M d-c graphic ammeter wound for use as a voltmeter. Add $2.50 to the list price of the standard 25-volt type BX, AW or FW voltmeter, type M d-c ammeter or 150-volt type SL, GL or PL voltmeter for calibration as speed indicator.

MAGNETO GENERATORS

Style number and list price include magneto only without pulley or instrument.

Description	Approximate Weight, Pounds Net	Approximate Weight, Pounds Shipping	Style Number	List Price
Small magneto	4	8	289367	$ 75 00
Large magneto	13½	18	289368	170 00

MAGNETO PULLEYS

The magnetos are generally arranged to be driven by belts. The following standard pulleys are suitable for use with flat belt ⅝-inch wide. Special pulleys can be supplied if necessary, but with the range of operating speed of the magneto it is usually practicable to select a driving pulley, which in connection with one of the magneto pulleys listed, will give a satisfactory pulley ratio. Driving pulleys are essentially part of the machinery the speed of which is to be measured, and therefore on account of variation in requirements of mounting applications can best be made locally by the user.

Diameter Inches	Description	Approx. Net Wt., Lbs.	Style Number	List Price
2	Pulley for small generator	1	289885	$4 00
2½	Pulley for small generator	1	289886	4 50
3	Pulley for small generator	2	289887	5 00
4	Pulley for small generator	2	289888	6 00
2	Pulley for large generator	1	289889	4 00
2½	Pulley for large generator	1	289890	4 50
3	Pulley for large generator	2	289891	5 00
4	Pulley for large generator	2	289892	6 00

BELTS

The following endless rubber belts are recommended:

Description	Style Number	List Price
⅝x⅛-inch rubber belt, 24 inches circumference	289893	$1 25
⅝x⅛-inch rubber belt, 26 inches circumference	289894	1 50
⅝x⅛-inch rubber belt, 37 inches circumference	289895	2 00

INFORMATION FOR ORDERING

When entering order specify the following:

(A) Type of instrument required as a separate item, giving scale markings.

(B) Style of magneto.

(C) Resistance or length and section of connecting wire to be used.

(D) Diameter of driving shaft if belt is direct on shaft, or diameter of driving pulley.

(E) Magneto pulley.

(F) Belt.

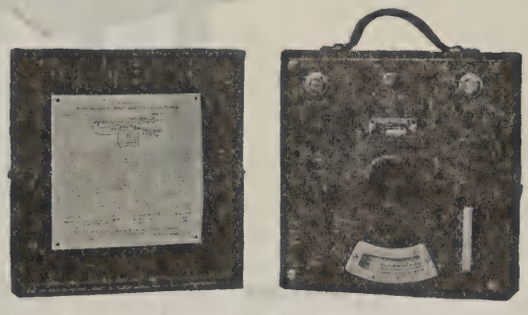
Order by Style Number

PORTABLE FAULT LOCALIZERS

The portable fault localizer is used for locating grounds in a power feeder. It is an application of the wheatstone bridge with all the necessary apparatus contained in one portable case wired or connection to the circuit to be tested.

Its use assumes that the cable is grounded at only one point and that a parallel conductor of the same length and resistance as the faulty cable is available.

PORTABLE FAULT LOCALIZER COMPLETE WITH GALVANOMETER



PORTABLE LOCALIZER WITHOUT GALVANOMETER

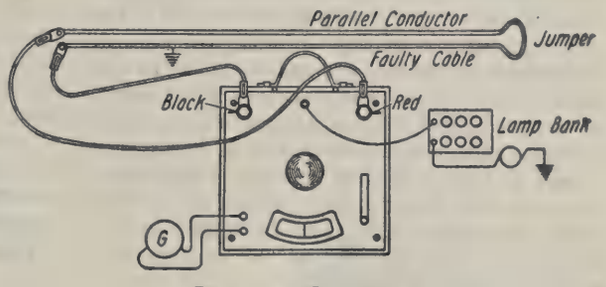


DIAGRAM OF CONNECTIONS

Operation—After all electrical connections to the defective feeder have been removed and before the fault localizer has been connected to the cable, the cable is tested by means of a temporary connection through a lamp bank or battery for the grounded conductor. If the lamps do not burn brightly, a high resistance ground is indicated and should be broken down by applying a sufficiently high voltage.

The fault localizer is connected as shown in the diagram, Fig. 3, and the dial revolved by means of the knob in the middle of the localizer until the galvanometer does not show any deflection when the key is closed. The reading of the instrument then shows the percent of length of the feeder from the point where the test is being made to the location of the ground, assuming the total length of the feeder to be 100 percent; the red scale indicating that the ground is on the conductor connected to the binding post marked red, and the black scale indicating to the binding post marked black.

Direct current only is used in these tests.

Advantages—Ease of adjustment; position of the ground read directly off the dial in terms of percent of length of defective cable.

Construction—The fault localizer consists of a polished wooden case which contains all the parts necessary for the test except the source of direct-current supply, the lamp bank or other load, and the leads to the cables. Style No. 214185 however, does not have the galvanometer or galvanometer leads, and is listed for use with a separate galvanometer.

Galvanometer—Galvanometer, Style No. 216719, which is also supplied with fault localizer Style No. 216718 is a highly sensitive galvanometer with "unipivot" bearing which does not require to be leveled to take readings. It can be used for general testing wherever a portable galvanometer of its sensibility is desired, and can be easily removed from the case of Style No. 216718 when this is desired.

The following are its constants:

Resistance—5-ohms.

Full scale reading—.00036 amperes.

Sensibility—.00001 amperes per division.

PRICES

Style number and price include the fault localizer complete as described.

Style No.	Description	Approx. Overall Dimensions Inches	Approx. Wt., Lb. Net	Approx. Wt., Lb. Shipping	List Price
214185	Without galvanometer	9⅝x10¼x3⅜	5	12	$100 00
216718	With galvanometer and leads	14⅜x10¼x3⅜	9	15	150 00
216719	Galvanometer only	4¼x 5⅛x2¾	3	5	50 00

HARMONIC ANALYZERS

Application

By the use of this wave-form analyzer any periodic function can be investigated mechanically and resolved into its harmonic components so that its equation can be immediately written out. The variations of force, displacement, velocity, or acceleration can be analyzed and, since they are all related, the physicist or engineer can derive any or all of the others by differentiation or integration of the very simple sine or cosine terms of the equation of one of them. Waves of sound, temperature, magnetic flux, pressure, flow, torque, etc., can be easily investigated and their equations used to obtain functions of other related or dependent physical quantities.

By simple changes in adjustment, the apparatus can also be used to draw the harmonic components in their proper phase positions and to their proper amplitudes.

Uses in Electrical Measurements—The harmonic equation of electrical wave forms offers the most convenient means of expression, and allows quick and accurate calculations of engineering problems in which are involved questions of the paralleling of generators, possible cross currents and circulating currents in rotary converters, transformer connections, transmission line regulation, telephone troubles, and so forth.

This harmonic analyzer is the only instrument that can be used to obtain both a quick and accurate analysis of a voltage or current wave direct from the oscillogram. Analyses that were formerly long and tedious calculations that required a day's time and even then were only approximatetions, can by this apparatus be obtained accurately in an hour.

Operation

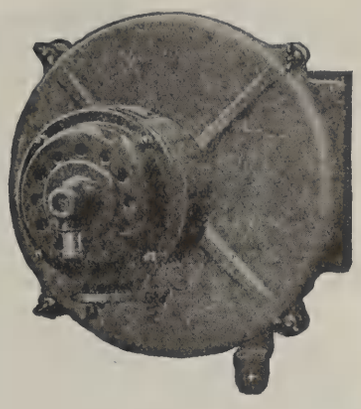
This apparatus extracts the components of the equation of the periodic function, one at a time and in any order desired. Without any knowledge of the principles of the apparatus, an accurate and complete analysis can be made in a few minutes by following a few simple directions which accompany the analyzer. More complete information on operation and construction of the harmonic analyzer is given in Westinghouse Leaflet 3975.

Circular Oscillograph Record—Analyses are made by the analyzer from curves in circular (polar) coordinates. These curves can be obtained directly from the circuit under test by the use of the Westinghouse "Circular-Oscillogram Attachment" (see following page) used with a standard oscillograph, or by plotting from the oscillograph record obtained in rectangular coordinates by the standard oscillograph a curve in circular coordinates. From the curves in circular coordinates, templates in bristol board are cut; these are used directly on the analyzer. The film record obtained by the circular oscillogram attachment is transferred by photographic printing to a sheet of sensitized paper; this is attached firmly to the bristol board and cut into the template.

Description	Approx. Wt., Lb. Net	Boxed	Style No.	List Price
Harmonic Analyzer*	250	300	219087	$650 00
Polar Planimeter	2	3	219088	30 00

*Style number and list price of harmonic analyzer do not include polar planimeter which must be ordered separately.

CIRCULAR-OSCILLOGRAM ATTACHMENT



Application

This attachment is adapted for use with the standard oscillograph for obtaining circular oscillograms. By a very slight remodeling of the standard oscillograph, the attachment can be used interchangeably with the regular rectangular film-holder, enabling the operator to take rectangular or circular oscillograms at will.

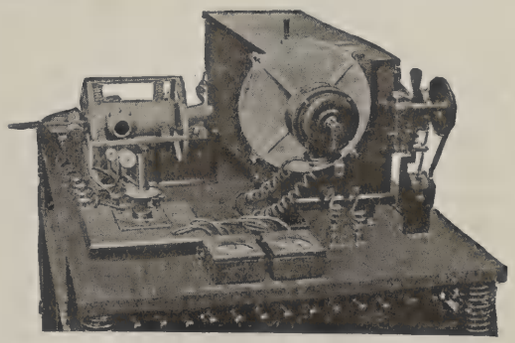
Use of Circular Oscillograms—When electrical investigations and calculations are to be made of a periodic function, they can generally be simplified and are often more accurate if the oscillograms are taken in circular coordinates. A single cycle is several times as long when taken on circular oscillograms as when on rectangular, and this extension of the time scale and the geometric form of the curve allow more accurate subdivisions and more simple and accurate calculations of phase angles, harmonic analyses, root-mean-square values, power in watts, power factors.

The circular oscillograms obtained by the use of this attachment are in the correct form for use on the Harmonic Analyzer described on previous page, not requiring plotting from rectangular coordinates to circular.

Operation

The oscillograph is adjusted as when taking oscillograms in rectangular coordinates, and the pictures are taken by exposing the circular film running at synchronous speed in front of the slot of the oscillograph. Each film holder is equipped with a small two-pole self-starting synchronous motor for driving the film in synchronism with the circuit being tested.

Driving the film at synchronous speed enables the cycle to be traced repeatedly, often allowing the use of a concentrated filament incandescent lamp instead of the troublesome arc lamp. It also enables several exposures to be made on the same film, in proper phase relation, to the same or different scale, and referred to the same or different zero circles; and therefore complete tests of any complicated single-phase or polyphase conditions can be made on a single film with a single oscillograph element and without the least confusion of the several periodic curves.



CIRCULAR-OSCILLOGRAM ATTACHMENT SHOWN MOUNTED ON STANDARD OSCILLOGRAPH

Description	Approx. Wt., Lb. Net	Approx. Wt., Lb. Boxed	Style No.	List Price
Circular-Oscillogram Attachment Complete with Synchronous Motor	17	25	219159	$70 00
One dozen sensitized films, 10 inches diameter, ⅜-inch hole	1½	2	239784	13 00
One dozen sensitized template boards,* 10 inches by 10 inches	3	3½	240171	5 00

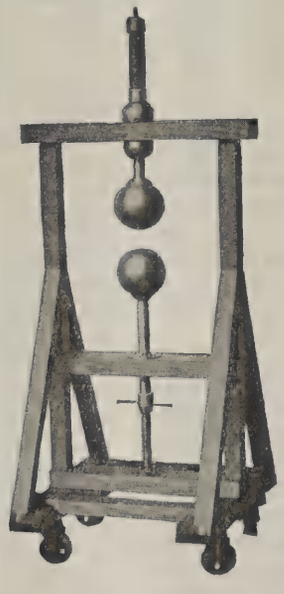
*Consists of sheet of sensitized paper stapled to a sheet of bristol board ready for printing and cutting out the template.

Order by Style Number

HIGH-VOLTAGE MEASURING DEVICES

In high-voltage testing, a voltmeter connected to the primary of the testing transformer and calibrated in terms of the testing voltage, is satisfactory where accuracy is not essential or where the kilovolt-ampere capacity of the load is negligible. These conditions, however, are rarely ever fulfilled in service when making high-voltage tests and more accurate methods are necessary. The Westinghouse Company offers two devices of the latter class, the spherical-spark-gap voltmeter and the crest voltmeter, both recommended by the A. I. E. E. (For insulation testing transformers and equipments see catalogue on "Feeder-Voltage Regulators and Transformer Apparatus.")

SPHERICAL-SPARK-GAP VOLTMETERS



The spherical-spark-gap voltmeters are constructed of two non-arcing metal spheres mounted vertically in suitable wooden frame work. As these spheres are formed in dies and are accurately machined and polished, they are very much more accurate than spun spheres. The lower sphere is at ground potential while the upper sphere is connected to the line through a resistor. Suitable micrometer adjustment is provided so that the separation of the spheres may be accurately determined.

All sizes, 125 to 500 millimeters inclusive, are of the same type of construction as shown in the illustration. The 50 millimeter size is built horizontally, and on account of its light weight is portable without the necessity of castors.

The following are the voltage ranges of the standard sizes:

Diameter of Sphere Millimeters	Range in Kilovolts	List Price
50	10- 75	$ 425 00
125	30-160*	1000 00
250	60-280*	1500 00
375	70-350	2000 00
500	80-400*	2750 00

*Range recommended by A. I. E. E. Rules for 1915.

CREST-VOLTMETER OUTFITS

The crest-voltmeter outfit is used with the condenser-type bushing of a testing transformer. It is standard Westinghouse practice to furnish condenser-type bushings with all testing transformers having voltages of 75,000 and higher and by special arrangement, transformers with voltages as low as 30,000 may be equipped with the condenser bushing.

Westinghouse transformers now in service, equipped with a condenser bushing, can be used by changing the bushing slightly.

Operation

The principle upon which this device operates is that the average value of the half wave of the charging current in a condenser bushing, which charging current flows into and out of the bushing when the latter is subjected to a voltage strain, is proportional to the crest of the voltage wave. The charging current is rectified by means of small mercury bulbs and measured by a sensitive direct-current milli-ammeter that is calibrated in terms of the high-voltage alternating-current voltage. The deflection of the instrument is proportional to the maximum value of the voltage wave; and, since the instrument is a direct-current instrument, all the scale divisions are approximately equal. This makes it possible to read low voltages on the scale with the same accuracy as the higher voltages, a very important and desirable feature in insulation testing.

The readings of the crest-voltmeter are not affected by the electrostatic capacity of the testing load, by changes in the amount of the testing load, or by atmospheric conditions; they are, however, affected by the frequency of the supply circuit and for this reason a frequency meter is supplied. The readings of the crest-voltmeter vary directly with the frequency so that a correction can easily be made for any variation in frequency from that for which it is calibrated.

The readings are theoretically correct for all voltage waves having not more than one maximum and one minimum value per cycle, and are practically correct for all other commercial wave-shapes.

Construction

The complete equipment of the crest-voltmeter outfit consists of a small slate panel mounted on pipe framework, as shown, and upon the panel is mounted a frequency meter, a direct-reading highly sensitive milli-ammeter specially calibrated to read crest voltages, two small rectifier bulbs, and a change-over switch.

This device can be furnished, as stated above, for voltages of from 30 kilovolts up. The normal voltage is determined by the normal voltage of the transformer with which it is to be used. Prices will be furnished on request.

Instruction Card 166-B

INSTRUMENT GUARANTEE

Serial No._____ Type_____ _____meter

All material used in manufacturing this instrument is of the kind and quality which our Engineers advise to be best adapted for the purpose to which it is applied.

We guarantee this instrument to be free from defects in workmanship or material.

We further guarantee the accuracy of the calibration to be within an error equal to.....of the full scale capacity at all points on the scale provided the instrument is installed and used in accordance with the practice of the Company's Engineering Department.

Our liability under this guarantee is limited to repairing free of charge any instrument returned to our Works within a year after date of purchase, transportation prepaid, if upon investigation we find the fault to be due to defective workmanship or material.

WESTINGHOUSE ELECTRIC & MFG. COMPANY
East Pittsburgh, Pa.

NEWARK WORKS
NEWARK, N. J.

Per_____

Dated_____**191**___

TYPES CO OVERLOAD AND CR REVERSE-POWER RELAYS With Adjustable Definite-Minimum Inverse-Time Limit

FOR ALTERNATING-CURRENT CIRCUITS

TYPE CO OVERLOAD RELAY

The necessity for continuity of service, together with the complications of modern transmission and distributing systems, has produced a demand for apparatus to localize instantly any disturbance due to a fault on a system. This localization can be accomplished best by controlling the circuit-breakers on the system with relays that have a dependable time-selective action combined with inverse-time-element functions. The operation of the circuit-breakers will then be governed accordingly as the line disturbances are of a permanent or of a temporary nature, and the defective line only will be disconnected.

Due to lack of proper selective action under short-circuit conditions with most types of relays on the market, and the necessity of promptly restoring service, many systems have installed auxiliary feeders for emergency use. Thoroughly reliable relays on the system will permit the use of such emergency feeders for regular service, thus increasing the load that can be handled at the comparatively small expense of proper relays instead of the comparatively large expense of additional circuits. The saving in copper loss by the use of these emergency feeders for regular load will in many cases finance the installation of proper relays.

APPLICATION

Type CO overload relays have both the time selective action and the inverse-time-element function. They are in general used on individual outgoing feeders or transmission lines, for distribution feeders, motor protection, and differential protection of transformers.

Type CR reverse-power relays have the functions of the type CO and are selective with respect to direction of power. The minimum reversal is 80% of the normal load. This latter function, together with the time-selective feature on both relays, adapts them, singly or together, to confining a disturbance on an alternating-current system to a small area.

DISTINCTIVE FEATURES

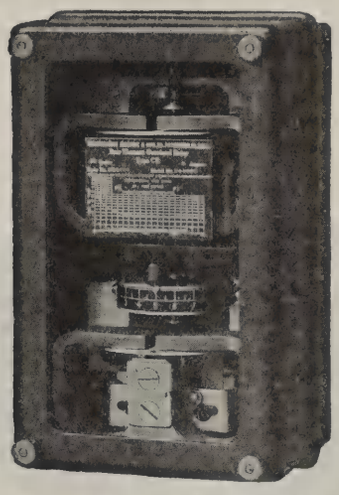
1. Can be quickly set for desired value.

   Setting is accomplished by means of adjustments on face of the relay. The setting is positive. No stop-watch, ammeter, rheostat, or other apparatus is necessary.

2. Simple adjustment.

   Inexperienced operators can adjust them. If emergency requires change in the setting, the load dispatcher can have the changes made instantly by telephoning to the operators on duty at the various points—no need to send an experienced relay man around.

TYPES CO OVERLOAD AND CR REVERSE-POWER A. C. RELAYS—Continued



TYPE CR REVERSE-POWER RELAY

3. Large range of adjustment.

These relays can be set to operate on minimum currents of ½ to 1½, 4 to 12, or 4 to 16 amperes, according to style of relay. The definite-minimum time of closing under short-circuit conditions can be adjusted from instantaneous to 2 seconds. Special relays can be furnished to give up to 4 seconds, although the 2-second relays allow of more accurate setting.

4. Have time-selective inverse-time-element and definite-minimum-time functions.

The time-selective function enables the relays controlling circuits in series to be set that they will each operate at different times. The inverse-time-element enables the relay to operate more quickly on large currents than on small ones. And combined with these functions, is a definite-minimum tripping time below which the relays cannot trip on any current. (See curves on faceplates of relays.)

5. Can be set to operate as a definite-time device instead of inverse-time.

6. Individually tested and the calibration curve hand-drawn on the name plate.

This makes it possible for the engineer or operator in charge to make sure that all the settings are as they should be. The settings can be checked in a minute's time—no testing required for checking.

7. Have watthour-meter accuracy and permanence of calibration.

Their accuracy is permanent and so reliable that relays controlling circuits in series can be set as close as ½ second apart, and still act selectively, even on extremely high currents. With some circuit-breakers, settings as low as ⅛ second have given perfect results.

8. Proper combinations of types CO and CR relay on a circuit will give selection in tripping of circuit-breakers never before obtained.

9. Will not trip due to synchronizing and line switching.

The definite-minimum time-element allows time for surges to subside.

10. Have rugged construction.

They are not subject to vibration. The operating force in many relays now in use varies as the square of the current. It, therefore, happens frequently, that a short-circuit damages a relay so that it fails to operate properly when the next case of trouble occurs. Types CO and CR will not be injured by the momentary passage of current as high as 200 amperes through them.

11. Will not over-swing and make contact if trouble is suddenly cleared.

Should the excess current in any relay be reduced to normal value as late as only ⅛₀ second short of the time for which the relay is set to operate, the movement will return to its normal position without closing the contacts.

12. High resetting value.

Should the value of the current in the relay drop until it is but slightly below the minimum value required to trip, the relay will reset to its neutral position.

13. Require small amount of power to operate.

The load which these relays place on the current or voltage transformers is so small that the accuracy of meters installed on the same circuit is not affected.

14. Operate properly on low-power factor.

When used on three-phase systems, these relays will function correctly, no matter how low the power factor or abnormal the phase relations during the short circuit may be.

15. Operate on low voltage.

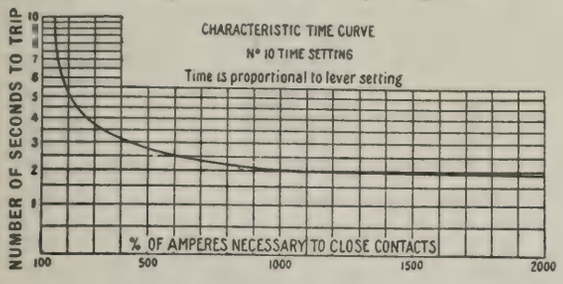
The type CR will select as to direction of power even should the voltage drop to one or two per cent of normal.

16. The type CR relay will not trip a circuit-breaker under normal load conditions.

TYPE CO OVERLOAD RELAYS

Operation and Construction

Operating Principle—The type CO overload relay consists of an induction type of instrument having the functions of an ammeter which closes its contacts on excess current. Damping magnets applied to the disk of the movement make the speed of rotation proportional to the driving force, as in a watthour meter; while the time element is adjusted by varying the distance through which the moving contact on the disk shaft must travel before it engages with the stationary contact on the adjusting arm.



Definite-Minimum Time—If the torque of a relay is allowed to increase with the current, the time element at high currents would be practically instantaneous, thus preventing predetermination of order of relay action when several breakers are in the circuit. In order to obtain definite-minimum time of closing at heavy currents a "torque compensator" is introduced in the instrument. This is a small transformer connected in the relay windings, and is so designed that at a certain value of current the core becomes saturated so that the current in part of the relay windings, and consequently the relay torque, does not increase beyond this point. Standard type CO relays have a definite-minimum-time setting of two seconds; relays with definite-minimum-time setting of four seconds can be furnished on order.

Method of Tripping Breakers—The usual method of tripping circuit-breakers is by a direct-current shunt tripping coil. Type CO relays are particularly adapted for this service. Some circuit-breakers are arranged with the tripping coil connected in the secondary of the current transformer (transformer trip) which also supplies the relay. Type CO relays can be used to trip any circuit-breakers of the latter type, if a type BT transfer relay (described on another page of this catalogue) is interposed between each type CO relay and the trip coil. On most styles of Westinghouse circuit-breakers a "direct-trip attachment" can be supplied. This attachment will allow the type CO relays to operate circuit-breakers by means of the transformer-trip coil; it is described in the catalogue on "Oil-Break Switching Equipment."

Details and Accessories

Internal Contactor Switch.—In order to relieve the relay contacts from the duty of carrying heavy tripping currents, all type CO relays are equipped with an internal contactor switch capable of closing a 30-ampere circuit at 220 volts. Another function of this contactor switch is to protect the relay contacts where operating conditions are such that the excess current may decrease to normal just after the relay has closed its contacts, but before the circuit-breaker has had time to open the circuit, as under these conditions the relay would open the trip circuit through its contacts which are likely to be burned by the resultant arc.

The operating coil of this contactor switch is connected in series with the tripping circuit and its contacts shunt the main relay contacts (see diagram). Thus, when the main relay contacts are closed, the tripping circuit energizes the contactor switch operating coil as well as the circuit-breaker trip coil, but the action of the contactor switch is so nearly instantaneous that its contacts are closed before the direct-current tripping circuit has built up to more than a moderate value. Thus, the contacts of the contactor switch relieve the main relay contacts from carrying any heavy current. The contactor-switch coil when energized also acts as a holding coil to keep its contacts closed even though the relay contacts have opened, until the tripping circuit be broken by pallet switch on circuit-breaker.

The standard contactor switch operates on a minimum trip current of 2 amperes. For values below this, the switch will remain inoperative as the main relay contacts are capable of handling this current without difficulty. However, when a contactor switch operating on very low current is desired, a suitable winding may be obtained on special order.

Shunt Trip Circuit—Standard type CO relays are equipped with single-pole contacts and will control only one trip circuit. Where two trip circuits are to be controlled by one relay, special type CO relays with 3-point trip connections can be supplied. In ordering, specify "Similar to Style No.. except to be equipped with 3-point contactor switch Style No. 285399." Add to list price **$4.50**

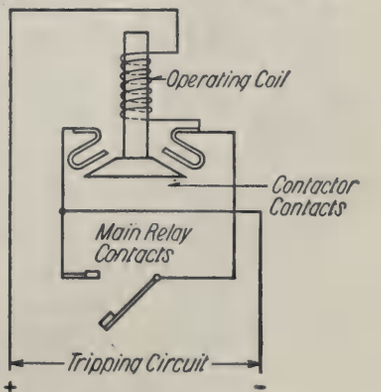


DIAGRAM OF CONNECTIONS OF CONTACTOR SWITCH WITH TYPE CO RELAY

TYPES CO OVERLOAD AND CR REVERSE-POWER A. C. RELAYS—Continued

Where a circuit-breaker trip coil requires more than 30 amperes to operate it, a control relay should be used. For control relays and information as to current required by Westinghouse circuit-breaker trip coils, see sections on "Switchboard Accessories" and "Oil Circuit-Breakers."

Auxiliary Contacts on Circuit-Breakers—Where a relay is used, the circuit-breaker should always have auxiliary contacts (pallet switch) to open the trip circuit, relieving the relay contacts of this duty.

Type CO Overload Relays

Style Number and List Price include type CO relay complete with contactor switch but without current transformers. For number of relays required for each circuit, see diagrams of connections below.

*Range of Current Settings (Minimum Amps. to Operate)	Frequency, Cycles	Approximate Wt., Lbs. Net	Approximate Wt., Lbs. Boxed	Style No.	List Price
½ to 1½	25	9	18	238232	$36 00
½ to 1½	60	9	18	238233	36 00
4 to 12	25	9	18	214236	36 00
4 to 12	60	9	18	214237	36 00
4 to 16	25	9	18	238234	36 00
4 to 16	60	9	18	238235	36 00

Approximate Dimensions—Overall diameter, 6¾ inches; depth from switchboard, 5 7/32 inches; terminal mounting studs are suitable for panels up to 2 inches thick.

*Relays should not be used continuously on currents greater than rating given on curve plate.

Four-Second Relays—In ordering relays having definite-minimum time of 4 seconds specify "Similar to Style No....., except with four-second damping magnets, Style No. 238248, and four second calibration." Add to list price **$8.00.**

Extra Contactor Switches—Extra contactor switches Style No. 285398 can be supplied at a list price of **$3.50.**

Order by Style Number

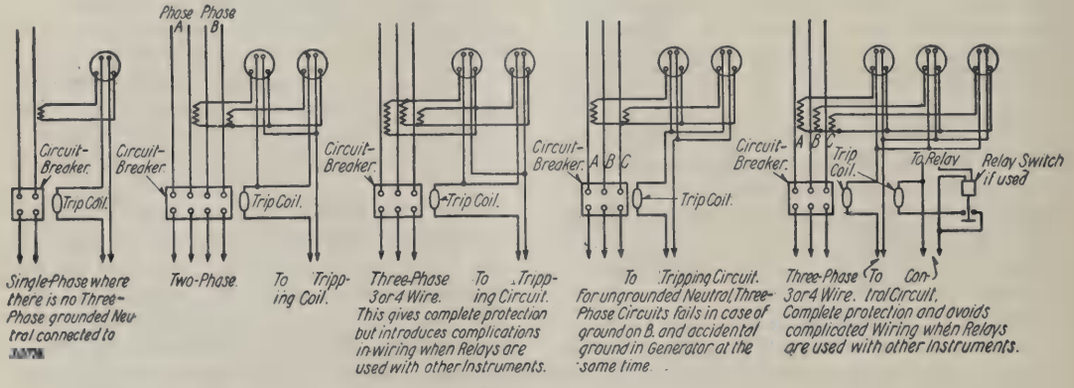

Phase A
Phase B
Circuit-Breaker
Trip Coil
A B C
To Relay
Relay Switch if used
Single-Phase where there is no Three-Phase grounded Neutral connected to
Two-Phase
To Tripping Coil.
Three-Phase 3 or 4 Wire. This gives complete protection but introduces complications in wiring when Relays are used with other Instruments.
To Tripping Circuit.
To Tripping Circuit. for ungrounded Neutral, Three-Phase Circuits fails in case of ground on B. and accidental ground in Generator at the same time.
Three-Phase 3 or 4 Wire.
To Control Circuit. Complete protection and avoids complicated Wiring when Relays are used with other Instruments.

Diagram of Connections, Type CO Relay

TYPE CR REVERSE-POWER RELAYS

Operation and Construction

The type CR relay is a combination of two elements in one case; a type CO overload relay element, with its contacts in series with those of a selective wattmeter element. The overload element closes its contacts on excess current in either direction, but the contacts of the selective wattmeter element remain open as long as power does not flow in the reverse direction. Each element has a type OA watthour-meter movement, the lower element being the excess current element and the upper the selective element.

The method of tripping breakers with the type CR relay is the same as with the type CO described on previous pages.

Double-Contact Reverse-Power Relays—Feeders or tie lines on which power may normally flow in either direction necessitate the balanced "cross-connection" method of installing standard type CR relays; or, in case the feeders are operated in pairs, this method can be modified by using special type CR relays, the watt elements of which have a pair of contacts—one or the other being closed according to the flow of power—thereby requiring only half the standard number of relays. For full description of this system see Leaflet 3974.

Details and Accessories

Contactor Switch—A contactor switch like that described on preceding pages on "Type CO Overload Relay" is included with the type CR to relieve its main contacts of the higher currents required on some breakers. Standard type CR relays will therefore close 30 amperes at 220 volts, but will not open the tripping circuit under any conditions—auxiliary contacts (pallet switch) must be used on the circuit-breaker to open the tripping circuit when the breaker opens.

Control Relays—For tripping two circuit-breakers, a double contact switch similar to that described on preceding pages on type CO overload relay can be supplied on the type CR. Where the circuit-breaker trip coil requires more than 30 amperes to operate it, a control relay should be used. For control relays and information as to current required by Westinghouse circuit-breaker trip coils, see sections on "Switchboard Accessories" and "Oil Circuit-Breakers."

Style number and list price include type CR relay complete with contactor switch, but without current or voltage transformers. For number of relays required for each circuit, see diagram of connections below.

Volts	Ampere Setting	Frequency, Cycles	Approximate Wt., Lbs. Net	Boxed	Style No.	List Price
100	4 to [illegible]	25	20	35	222173	$85 00
100	4 to 8	60	20	35	222174	85 00
100	4 to 16	25	20	35	230270	85 00
100	4 to 16	60	20	35	230271	85 00

Approximate Dimensions—Overall width, 6¾ inches; overall height, 10¾ inches; overall depth, 5 11/16 inches; terminal mounting studs are suitable for panels up to 2 inches thick.

Four-Second Relays—In ordering relays having definite-minimum time of 4 seconds, specify "Similar to Style No..... except to have four-second damping magnets, Style No. 238348, and four-second calibration." Add to list price **$8.00.**

Double-Contact Relays—In ordering specify "Similar to Style No..... except to have double contacts on wattmeter element." Add to list price **$10.00.**

Order by Style Number

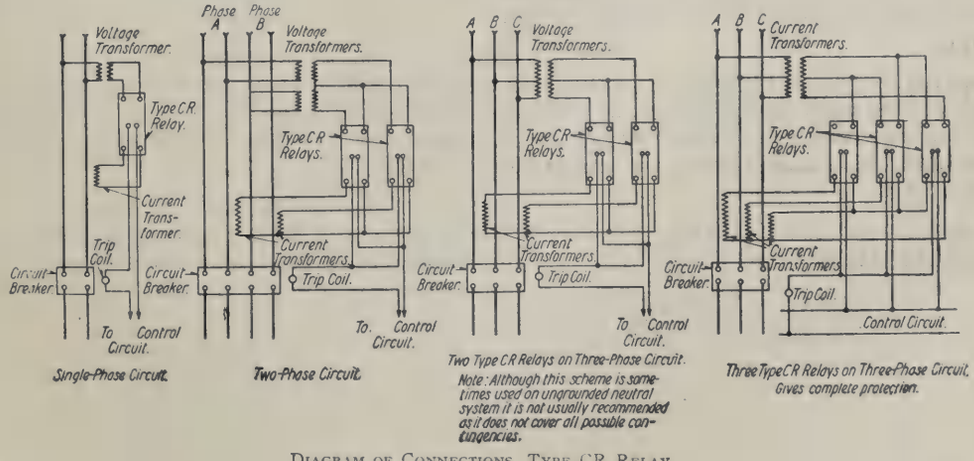


DIAGRAM OF CONNECTIONS, TYPE CR RELAY

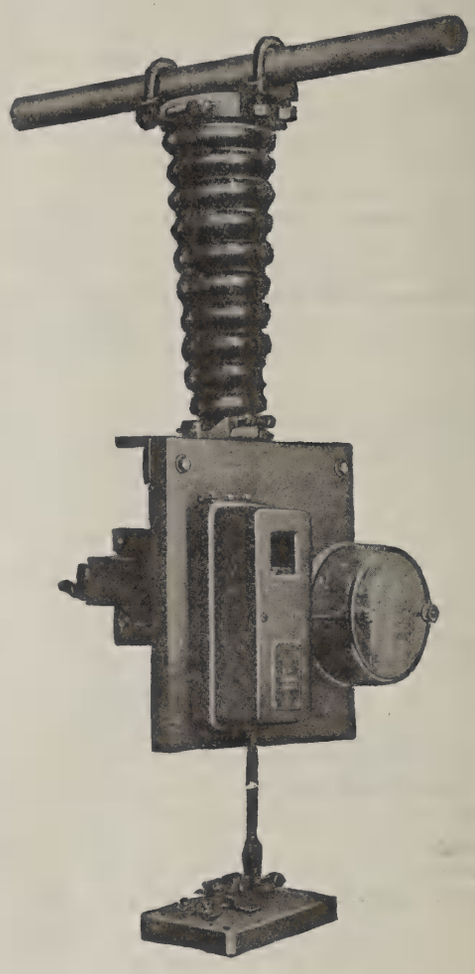
TYPE CB OVERLOAD RELAYS

FOR HIGH-VOLTAGE ALTERNATING-CURRENT CIRCUITS

SHUNT-TRIPPING

Application

In high-voltage stations requiring overload protection, and where the extra cost of high-voltage current transformers has an important bearing on the selection of protective equipment, the type CB relay affords ample overload protection and an approximate time element at a minimum cost. The type CB relay is particularly recommended for use on circuits of 100 amperes or less. For heavier currents the use of ring-type current transformers built around the circuit-breaker bushings and operating type CO relays will be found more convenient and economical. Type CB relays are for indoor use, and are arranged for pipe mounting.



Construction and Operation

The relay consists of a circuit-closing element operated by means of a standard current transformer, type CO relay and special type BT relay through a micarta chain of such length as to provide ample insulation for the voltage in use. The type CO relay, type BT relay and current transformers are mounted on one base which is in turn supported from an insulator. The type CO relay is standard having a 4 to 12-ampere range, and a 2-second inverse definite minimum time limit. Both time and current adjustments are made as described under type CO overload relay. The operation of this relay serves to close the circuit of the releasing coil on the type BT relay.

The current transformer is a standard type KR. It can be used on all voltages since it is thoroughly insulated from ground and from the remainder of the system. These transformers can be supplied in various ratios according to the capacity of the system.

The type BT relay is the same as the one listed in the following pages of this catalogue except that the transfer switch is omitted, and the plunger is connected to the contacts through the micarta insulating chain.

The contacts of the type CB relay will control 3 amperes at 100 volts.

The circuit-breakers should be equipped with auxiliary contacts to open the trip circuit when the breaker opens, thus relieving the relay contacts of this duty.

Up to 35,000 volts, the type P bus support is used as an insulator for mounting the outfit. Above 35,000 volts, a pillar-type insulator is used.

Number Required

One relay is required to protect a single-phase circuit, two relays for a two-phase or three-phase ungrounded circuit and three relays for a three-phase grounded circuit.

Accuracy

Because of the lower capacity of the type KR transformer this outfit is not as accurate as the type CO relay when used in the conventional way with a high-voltage, high-capacity, current transformer. However, the time element will be sufficiently accurate to afford protection on the circuit to which applied. Where it is desirable to secure selective action with regard to all circuits in the system, the type KA current transformer can be supplied on special order, prices on request.

Style Number and List Price include relay complete with transformer, micarta chain, and insulator. When ordering specify frequency at which relay is to be used, and ratio of current transformer.

Voltage	*Approx. Overall Length	Approximate Weight, Lbs. Net	Boxed	Style No.	List Price
25000	8′ 4″	55	100	268395	$150 00
37500	8′ 8″	60	110	268396	180 00
50000	13′ 4″	150	250	268397	200 00
73000	19′ 6″	225	300	268398	230 00
95000	19′ 11″	325	400	268399	320 00
115000	24′ 8″	375	450	268400	350 00
130000	25′ 2″	450	525	268401	375 00

*The overall length given above is for reference only. For official dimensions, refer to the nearest district office. Links may be removed to shorten the chain down to a minimum of 1 link for each 6600 volts.

Order by Style Number

TYPE CV VOLTAGE RELAYS
FOR ALTERNATING-CURRENT CIRCUITS

APPLICATION

In some cases it is necessary to protect a circuit against abnormal increases or decreases in voltage. For this purpose the use of the type CV relay, which is arranged to close an auxiliary circuit that will trip a breaker, ring an alarm, or give some signal so that the operator will know that the circuit requires attention, is recommended.

Operation and Construction

The type CV relay is similar in appearance to the type CO relay and the operation is similar except that it has the action of a voltmeter instead of an ammeter. The relay can be furnished so that it will close a circuit on overvoltage, or close a circuit on undervoltage. *It cannot be arranged to close a circuit on both overvoltage and undervoltage.*

Operating Voltage—Each relay can be calibrated at the factory to operate at any voltage between 75 and 160 volts as ordered. This calibration is made by means of external resistors and is not subject to adjustment in operation. Relays specially adjusted for voltages as high as 250 volts can be furnished on special order at an increase of **$2.75** to list price.

Time Element—Type CV relays have an inverse-time element. The time element is adjustable by means of a lever, as in type CO relays.

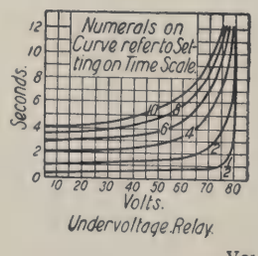
Accuracy—The accuracy of these relays is approximately five per cent.

Style number includes type CV relay complete uncalibrated. **List price** includes relay complete, calibrated as specified. In ordering specify frequency, voltage at which it is to operate, and whether it is to operate on overvoltage or undervoltage. Style number and list price do not include transformers.

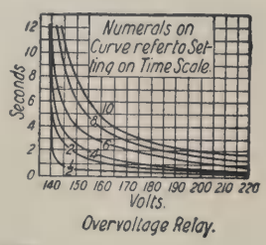
Volts	Frequency Cycles	Approx. Wt., Lbs Net	Boxed	Style No.	List Price
75–160	20 to 80	10	20	232500	$40 00

Approximate Dimensions—Overall diameter, 6 $\frac{11}{32}$ inches; depth from switchboard, 5 $\frac{7}{32}$ inches; terminal mounting studs suitable for panels up to 2 inches thick.

Order by Style Number



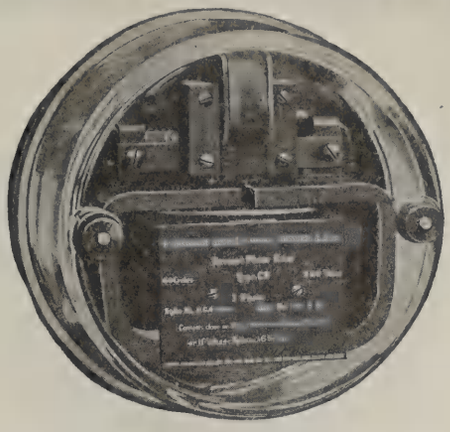
Undervoltage Relay.



Overvoltage Relay.

VOLTAGE-TIME CHARACTERISTIC CURVES

TYPE CP REVERSE-PHASE RELAYS



Application

For use on polyphase circuits to provide protection against phase reversal.

Distinctive Features

The operating characteristics are exceptionally positive and reliable. If a phase is reversed, or if a phase fails, or if voltage drops below 75 per cent of normal, the contacts close and trip the circuit-breaker, either through a shunt trip coil or by short-circuiting an undervoltage trip coil having a series resistor.

It should be borne in mind that a relay of this type will not operate on open phase unless the voltage across the relay in the corresponding phase falls below normal or fails altogether. Thus, it can not be used for protection **against open phase** on an induction motor which runs continuously, or any class of apparatus which tends to hold up the voltage across an open phase. It will, however, protect against phase reversal on any apparatus and affords good open-phase protection for induction motors which are started and stopped frequently as in elevator service. As soon as the motor stops, the voltage across the open phase fails, and the relay operates, thus preventing the motor from being started until the defect is remedied.

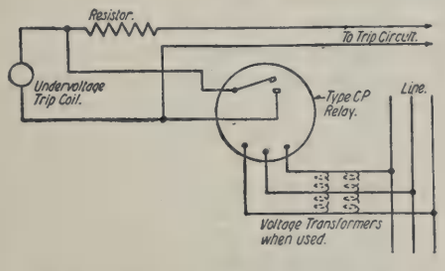


DIAGRAM OF CONNECTIONS, TYPE CP RELAY

Operation

The relay operates on the induction principle. When properly connected to motor terminals, as shown in diagram of connections, the torque holds the relay contacts open against the restraint of a spiral spring. On failure of, or low voltage the torque diminishes an the spring closes the contacts. On reversal of phase connections the reversed torque assists the spring in closing the contacts.

Construction

The type CP relay is of the same general construction as the type CO, the main difference being in the windings, which are made up of coils connected across the phases. It has five terminals, two of which are for connection to the tripping circuit.

Details and Accessories

Voltage Transformers—When used on voltage higher than 250, two voltage transformers are required with the 110-volt relay.

The contacts will close 5 amperes at 250 volts or less.

Auxiliary Contacts on Circuit-Breakers—The circuit-breaker should have auxiliary contacts to open the trip circuit, relieving relay contacts of this duty.

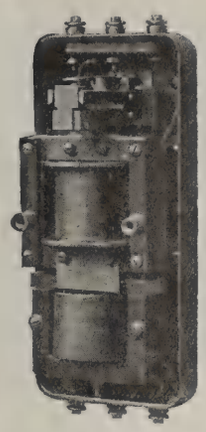
Style number and list price include relay complete. Transformers should be ordered separately. See pages on "Voltage Transformers."

Volts	Approx. Wt., Lbs. Net	Approx. Wt., Lbs. Boxed	Style Number: Two-Phase 25 Cycles	Style Number: Two-Phase 60 Cycles	Style Number: Three-Phase 25 Cycles	Style Number: Three-Phase 60 Cycles	List Prices
110	11	20	245713	245714	245709	245710	$45 00
220	11	20	245715	245716	245711	245712	45 00

Approximate Dimensions—Overall diameter, 6 1/16 inches; depth from switchboard 5 3/8 inches; terminal mounting studs are suitable for panels up to 2 inches thick.

Order by Style Number

TYPE BT TRANSFER RELAYS
FOR ALTERNATING-CURRENT CIRCUITS



TYPE BT RELAY WITH COVER REMOVED

Application

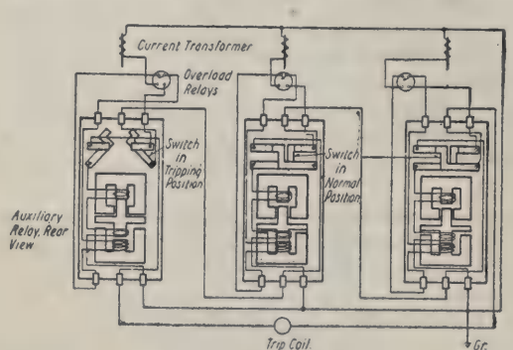
Transfer relays are used with protective relays that operate on excess current, such as type CO and type CR relays, where a direct-current trip circuit is not available. They energize the trip coil of the circuit-breaker through current transformers. While designed particularly for use with the type CO and CR relays, the type BT relay can be applied to any make of circuit-closing relay of similar characteristics.

Distinctive Features

The breaker operates solely through the current transformer and the relays. When there is no fault on the line the trip coil of the breaker is mechanically and electrically isolated from the circuit, avoiding possibility of tripping due to imperfection in the relay contacts ordinarily shunting the trip coil.

Operation

The relay contains two series coils, an upper or operating coil and a lower or holding coil (see diagram of connections). The holding coil holds down the armature core, until a third coil, wound on the same magnetic circuit and known as the releasing coil, is short-circuited by the protective relay. The releasing coil acts as the secondary of a transformer and when short-circuited, a current flows through it, demagnetizing the core, The holding coil, therefore, allows the operating coil to raise the core which operates the transfer switch, thus closing the trip coil circuit.



Note:- All Connections shown as viewed from Rear of Apparatus.

DIAGRAM OF CONNECTIONS—TYPE BT RELAY ON THREE-PHASE ALTERNATING-CURRENT CIRCUIT

Construction

The transfer switch and other current carrying parts of the relay are designed to carry 5 amperes continuously, but during times of short circuit the switch may be called on to handle as much as 100 or 200 amperes.

Details and Accessories

A current transformer must be selected of sufficient capacity to operate the protective relay, the transfer relay, and the trip coil. Low-ratio bushing-type current transformers sometimes used on high-voltage circuit-breakers are not suitable.

Only one trip coil is required for use on a polyphase circuit, but if the breaker is equipped with as many trip coils as there are relays, it is advisable to connect each trip coil to its corresponding relay.

Style number and list price include the type BT relay complete but without protective relays or current transformers. One type BT relay is required for each protective relay installed.

Capacity Amps.	APPROX. WT., LBS. Net	Boxed	Style No.	List Price
5	13	25	252725	$34 00

Approximate Dimensions—Overall width, 4⅝ inches; overall height, 11⅛ inches; depth in front of switchboard, 3½ inches; relay is front connected.

Order by Style Number

TYPE CT TEMPERATURE RELAYS
FOR ALTERNATING-CURRENT CIRCUITS

Application

The usual sectionalizing relays, types CO and CR, are intended for disconnecting defective feeders and are not primarily intended to protect apparatus in case of overload. The current settings of such relays are generally a function of the current flowing under short circuit and are thus higher than required for protection against sustained overloads.

The type CT relay may be used to protect any alternating-current apparatus from excessive heating if the apparatus is so arranged that exploring coils can be installed.

Operation and Construction

The relay is intended to protect apparatus against overheating from sustained overloads. To afford this protection with the least interruption of service the breaker should be tripped through the direct effect of the temperature of the apparatus. The relay should be so arranged that it prevents the breaker from tripping if the overload is of such short duration that the temperature does not rise to a dangerous value; while, if the overload persists the breaker must be tripped out as soon as the temperature rises beyond the critical value. This is accomplished in the type CT relay as follows:

The type CT temperature relay operates on the Wheatstone bridge principle. Two arms of the bridge are copper exploring coils arranged to be placed in the oil or embedded in the windings of the apparatus to be protected, the other two arms are unchanging resistance mounted in the relay. The current for the bridge is supplied by the current transformer connected in the circuit of the apparatus to be protected. The relay has two windings, corresponding to and co-operating to produce torque in a manner similar to the current and voltage coils of a wattmeter. The main winding is a coil operated directly by the current transformer. The auxiliary coils are connected to the Wheatstone bridge arms similarly to a galvanometer connection, and thus receive current the magnitude and direction of which depends upon the resistance of the search coils. Above a certain temperature the torque of the relay is in the contact direction and below, in the opposite direction. It will thus be noted that, in order to close the contact, two predetermined conditions must co-exist: excess current, and excess temperature. Neither one will separately trip the relay.

The type CT relay is similar in construction to the type CO, except that it has special windings, name plate, and two additional terminals.

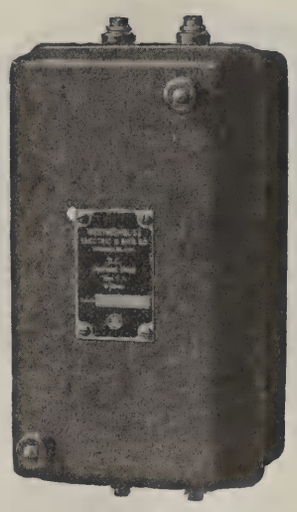
Style number and list price include relay complete as described except "exploring coils" which are usually furnished as part of the order for the apparatus to be protected. The construction of these coils will vary, depending on the kind of apparatus with which they are to be used. Data on the electrical characteristics of these coils will be furnished upon request or, where conditions permit, the exploring coils can be designed and furnished with the type CT relay at an extra price. In ordering, state resistance of exploring coil and temperature at which it is desired that the relay shall operate. One current transformer is required for each relay.

Frequency Cycles	Approx. Wt., Lbs. Net	Boxed	Style No.	List Price
25	10	20	**249519**	**$45 00**
60	10	20	**249520**	**45 00**

Approximate Dimensions—Overall diameter, 6 3/32 inches; depth from switchboard, 5 3/32 inches; terminal mounting studs are suitable for panels up to 2 inches thick.

Order by Style Number

TYPE TO OVERLOAD RELAYS
FOR DIRECT-CURRENT CIRCUITS



Application

Type TO relays are used particularly with three-wire generators that have but four cables running to the switchboard. The circuit-breakers can be mounted on the switchboard, and controlled by the actual armature current as required by the Fire Underwriters, by means of the TO relay, the control coil of the relay being connected to the ammeter shunts.

Distinctive Features

The relay is fully enclosed and easily mounted on the front or rear of the board. Adjustment is simple and the calibration is satisfactory as to accuracy. The relay can be used with a standard 50-millivolt ammeter shunt, the same shunt that is used with the ammeter, without appreciably affecting the readings of the ammeter.

Operation

The pull of the relay coils is opposed by a helical spring. When the pull exceeds the tension of the spring the contacts close. A calibrated adjustable arm is used to adjust the tension of the spring to regulate the voltage drop across the ammeter shunt at which the contacts will close.

Construction

The operating part of the relay is a small two-pole electro-magnet with special winding. This and the adjusting mechanism are enclosed in a dust-proof case of aluminum alloy. The cover is fastened by two thumb nuts and is easily removed for inspecting or adjusting the relay.

Finish—Case is finished in black marine to match the standard switchboard finish. Internal metal parts are polished and lacquered brass.

Calibration—Standard type TO relays are calibrated for adjustment to close contacts at from 40 to 80 millivolts, corresponding to 80 to 160 per cent of full load.

Auxiliary Contacts on Circuit-Breaker—Where a relay is used, the circuit-breaker should have auxiliary contacts to open the trip circuit when the breaker opens, relieving the relay contacts of the duty.

Contacts—The relay contacts will close 1 ampere. When the circuit-breaker trip coil requires more than this, a control relay should be used. For information as to the current required by circuit-breaker shunt-trip coils and for description of control relays see catalogue on "Oil-Break Switching Equipment."

Time Element—The type TO relay is instantaneous in operation.

Style number and list price include relay without ammeter shunt or leads. For shunts see pages on "Ammeter Shunts." Leads should have a resistance of approximately .04 ohm.

Calibration Millivolts	Approx. Wt., Lbs. Net	Boxed	Style No.	List Price
40 to 80	3		221738	$32 00

Dimensions—Over-all height 8 inches; width 4 inches; depth from switchboard 3¼ inches.

Order by Style Number

TYPE D RELAYS
Reverse-Current, Overload, and Temperature
FOR DIRECT-CURRENT CIRCUITS

Application

The type D reverse-current relay opens the circuit-breaker when the direction of current flow is reversed. A circuit-breaker with shunt-trip coils is required. It is particularly applicable in the protection of rotary converters, which require highly sensitive reverse-current relays to prevent running inverted.

Limitations—The leads should not be connected across a shunt of more than 100 millivolts at full load.

Operation

The relay operates on the moving coil principle. It is so connected across a shunt that the contacts are not closed except when current is reversed. The contacts close with a speed inversely proportional to the current in the coil. The controlling magnet is excited by a coil connected across the main circuit or control circuit.

Construction

The relay is mounted in a dust-proof metal case, suitable for rear-connected switchboard mounting.

Adjustment—Numbers on the adjusting scale indicate in millivolts the minimum reverse voltage at the terminals of the moving element that will cause the relay to operate.

When used on a 50-millivolt ammeter shunt a 2-millivolt tripping adjustment gives a 4 per cent sensitivity. A 100-millivolt shunt can be used to increase the sensitivity to double this value.

The **contacts** will close one ampere. For larger tripping currents a control relay should be interposed. An auxiliary contact should be provided on the circuit-breaker to open the tripping circuit when the breaker opens.

The **time element** varies from eight seconds at lowest current that will close the contacts to practically instantaneous action at high-current values.

Overload Relays—Overload relays of this type can be provided for a range of 40 to 80 millivolts, or any other range desired; prices on request.

Temperature Relays—The type D relay with special winding and contacts is used for protecting apparatus from injury due to abnormal temperatures. The Wheatstone Bridge principle is used, one arm of which is an exploring coil placed in the apparatus to be protected. It is adapted to the protection of rotating apparatus, but can be used to protect other apparatus. The operation is independent of the voltage of the control circuit, and is calibrated at two voltages representing the extreme limits.

The temperature-relay outfit includes the relay complete with three arms of the bridge and an auxiliary relay. The exploring coil is generally furnished with the apparatus to be protected. In ordering state resistance and temperature coefficient of search coil, control voltage, and temperature at which the relay shall operate; prices on request.

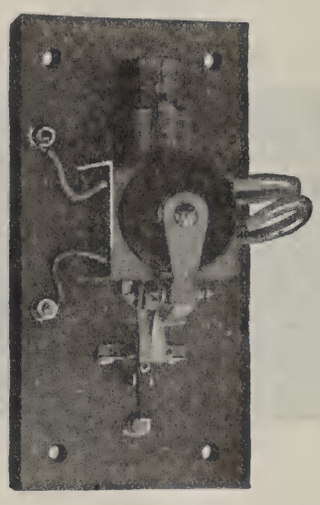
Style number and list price include relay without shunt. A series resistor is included with style number and list price of 200, 500 and 1500-volt relays.

Volts	Approx. Wt., Lbs. Net	Boxed	Style No.	List Price
Reverse-Current Relay				
100–130	27	40	223217	$94 00
200– 260	27	40	223218	100 00
500– 650	27	40	223219	105 00
1200–1560	27	40	223220	115 00

Approximate Dimensions—Overall width, 8⅝ inches; overall height, 6⅝ inches; depth from switchboard, 8 inches.

TYPE KN RELAYS

FOR USE ON CIRCUIT-BREAKER D. C. TRIP CIRCUITS



Application

The type KN relay may be used as a signal relay or a trip-free relay.

The signal relay operates an audible or visible signal to notify the attendant that a circuit-breaker has tripped automatically.

The trip-free relay prevents holding in an electrically-operated device such as a circuit-breaker while an abnormal condition exists on the circuit.

Operation and Construction

The type KN relay is of the bridging contact type, the bridge being forced against the stationary contacts by a spring.

When used as a signal relay, the contacts are normally held latched in the open position. In operating, this latch is released by a coil in series with the circuit-breaker trip coil and is reset by a shunt coil connected across the control circuit. When automatic tripping occurs, current passes through the latch release coil, and the signal circuit is closed. The contacts will remain closed until the circuit of the reset coil is closed by means of a push button. The reset coil latches the contacts in the open position, and the relay is ready for another operation. The signal is actuated only when the tripping is due to the action of automatic devices and does not operate when a circuit-breaker is opened manually.

When used as a trip-free relay, the contacts are also normally held latched in the open position. When the circuit-breaker is opened automatically this latch is released and through an auxiliary relay the circuit-breaker closing circuit is opened. When the trouble has been removed from the lines, the controller is moved to the trip position, thus resetting the trip-free relay, and closing the circuit-breaker closing circuit. The circuit-breaker may then be closed automatically. Tripping the circuit-breaker by hand does not introduce the trip-free feature, since moving the controller to the trip position automatically resets the trip-free relay.

The signal relay is listed for direct current only, though it may be supplied for alternating current operation on special order. The standard voltage coil may be used on control circuits of 100 to 250 volts. For voltages below this, a special coil must be used, while for higher voltages, a resistor must be inserted in series with the coil. The latch release coil is rated in accordance with the current required by standard trip coils, and relays can be supplied for ½, 1 and 3 amperes.

TYPE KN RELAYS—Continued

The signal relay has its main coil wound for voltage, and its release coil wound for current, while in the trip-free relay, both are wound for voltage. It is listed for direct current only; but will be supplied for alternating current on special order. All coils are designed for momentary operation only, and should be so connected that they are in the circuit only for the time required by the operation of the apparatus.

The Type KN relay contacts will close a current of 10 amperes at 100 volts. It may also be supplied with an auxiliary contact which opens when the main contact is closed. This is standard on the trip-free relay.

Style Number and List Price include relay complete, but with no auxiliary apparatus.

Signal Relay With Auxiliary Contact

Amperes	Volts D. C.	Style No.	List Price
½	110–220	289394	$26 00
1	110–220	289395	26 00
3	110–220	289396	26 00

Signal Relay Without Auxiliary Contact

Amperes	Volts D. C.	Style No.	List Price
½	110–220	289397	25 00
1	110–220	289398	25 00
3	110–220	289399	25 00

Trip-Free Relay

Volts D. C.	Style No.	List Price
110–220	289611	25 00

Dimensions—Base 12 inches long, 6 inches wide, 1 inch thick.
Relay projects approximate 4 5/8 inches from base.
Approximate weight 12 pounds, net; 20 pounds, boxed.

Order by Style Number

CYCLE COUNTERS

FOR MEASURING TIME OF OPERATION OF RELAYS, CIRCUIT-BREAKERS AND MACHINERY

Application

The cycle counter is an instrument for indicating definitely the time of operation of any apparatus which is arranged to open or close at the beginning and end of its operation, an alternating-current circuit of known frequency. It is used especially where the interval of time is too short to be measured accurately by means of a stop watch and where the cost and complication of more delicate instruments, such as the chronograph and oscillograph, make these undesirable. While the cycle counter has an almost unlimited field of application, it is most commonly used to test the time elements of high-accuracy relays and circuit-breakers.

Operation

Testing Relays—When used to test relays, it is connected with the relay on a circuit adjusted to give the current value at which the relay is to operate. When the circuit is closed, the cycle pointer begins to revolve, one tooth of the escapement being released per cycle, continuing until the relay contacts are closed. The instrument starts the instant power is applied and stops the instant power is disconnected—it has no effective inertia.

Testing Circuit-Breakers—When used in testing the time of opening of circuit-breakers, the cycle counter is usually used in connection with an auxiliary relay (listed as an extra). This relay consists of two small relays, both of which have the same time lag. The energizing coils of these small relays are so connected to the pallet switch of the breaker that when the breaker trip coil is energized, one side of the auxiliary relay either opens or closes its contacts, according to its connection; and when the breaker is fully opened, the other side opens or closes its contacts. These auxiliary-relay contacts are so connected to the cycle counter that when the breaker trip circuit is closed the cycle counter begins to operate and when the breaker is entirely open, the counter stops. Since both small relays operate in starting and stopping the counter, and each has the same time lag, no error is introduced.

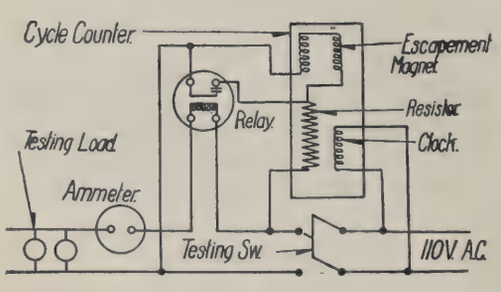


Diagram of Connections

Construction

The mechanism is virtually an electric self-winding clock with the escapement operated by an alternating-current oscillating magnet instead of a pendulum or balance wheel. At each cycle, one tooth of the escapement is released. The self-winding clock periodically rewinds from power supplied from a shunt connection to the circuit when the cycle pointer has made 60 revolutions (3600 cycles). The escapement magnet is not depended on to drive the indicator, but simply to regulate its speed.

Volts	Frequency Cycles	Approx. Wt., Lbs. Net	Boxed	Style No.	List Price
		Cycle Counter			
100	Up to 60	8	20	237124	$100 00
		Auxiliary Relay			
100	Up to 60	1	3	252248	50 00

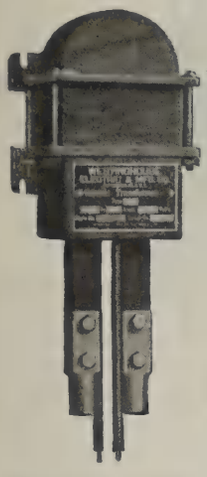
Approximate Dimensions—Overall width, 5¼ inches, overall height (handle lowered), 9¾ inches; overall depth; 4½ inches.

CURRENT TRANSFORMERS

TYPE A (DRY TYPE) INDOOR

Maximum Voltage { 2500, Two-Wire / 600, Three-Wire **Test Voltage for One Minute** { 10000, Two-Wire / 5000, Three-Wire

For 25 to 133 Cycle Circuits. Capacity 10 Volt-Amperes, Compensated for 10 Volt-Amperes



TWO-WIRE, TYPE A

Two-Wire—The type A two-wire transformers comprise a line of low-priced transformers of good accuracy, available over a large range of application. This type is listed for ammeter, wattmeter, or watthour meter use, but may also be used for operating relays and circuit-breaker trip coils where the load at 4 amperes does not exceed 27 volt-amperes at 25 cycles or 64 volt-amperes at 60 cycles. They should not be used with relays where the circuit-breaker trip coil is connected in series with the relay.

Three-Wire Type A—Designed for use with watthour meters on three-wire distribution systems. The primary consists of two separate windings, one of which is connected in each outside wire of the three-wire system, and the secondary winding is connected to the watthour meter. When so connected, the watthour meter measures the total output of the system. The ampere rating refers to the current in the outside wires.

THREE-WIRE, TYPE A

AMPERES Primary	Secondary	Dimen. Fig.	Bore of Term. Inches‡	APPROX. WT., LB. Net	Boxed	Style No.	List Price
			Two-Wire				
			Maximum Voltage 2500, Test Voltage 10,000 for One Minute				
5	5	1	*	12	22	125604	$19 00
10	5	1	*	12	22	125605	19 00
15	5	1	*	12	22	125606	19 00
20	5	1	*	12	22	125607	19 00
25	5	1	*	12	22	227050	20 00
30	5	1	*	12	22	125608	20 00
40	5	1	*	12	22	125609	20 00
50	5	1	*	12	22	227051	21 00
60	5	1	.370	12	22	125610	21 00
75	5	1	.370	12	22	227052	22 00
80	5	1	.370	12	22	125611	22 00
100	5	1	.432	12	22	125612	23 00
120	5	1	.432	12	22	125613	23 00
150	5	1	.521	12	22	227053	24 00
160	5	1	.521	12	22	125614	24 00
200	5	1	.646	12	22	125615	25 00
250	5	1	.747	12	22	125616	25 00
300	5	1	.747	12	22	125617	26 00
400	5	1	.875	12	22	125618	28 00
500	5	1	1.157	12	22	125619	30 00
			Three-Wire				
			Maximum Voltage 600, Test Voltage 5,000 for One Minute				
5†	5	2	*	12	22	125620	20 00
10†	5	2	*	12	22	125621	20 00
20†	5	2	*	12	22	125622	20 00
25†	5	2	*	12	22	227054	20 00
40†	5	2	*	12	22	125623	22 00
50†	5	2	*	12	22	227055	23 00
60†	5	2	.370	12	22	125624	23 00
75†	5	2	.370	12	22	227056	24 00
80†	5	2	.370	12	22	125625	24 00
100†	5	2	.432	12	22	272440	25 00
120†	5	2	.432	12	22	125626	25 00
150†	5	2	.521	12	22	227057	26 00
200†	5	2	.646	12	22	125627	26 00
300†	5	2	.747	12	22	125628	28 00
400†	5	2	.875	12	22	125629	30 00

*Leads are of cable and no terminals are furnished.
†Current in outside wires.
‡These dimensions are for reference only. For official dimensions apply to the nearest district office.

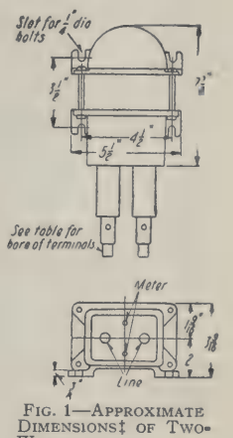


FIG. 1—APPROXIMATE DIMENSIONS‡ OF TWO-WIRE.

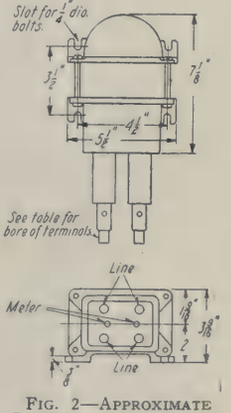


FIG. 2—APPROXIMATE DIMENSIONS‡ OF THREE-WIRE.

Order by Style Number

TYPE KA (DRY TYPE) INDOOR

Maximum Voltage 8000* **Test Voltage 20,000 for One Minute**

For 25 to 133-Cycle Circuits

Capacity 50 Volt-Amperes, Compensated for [redacted] Volt-Amperes

SWITCHBOARD TYPE KA

SEMI-PORTABLE TYPE KA

A high degree of accuracy in the ratio of primary to secondary current and a minimum phase displacement error are obtained in type KA transformers. This type is recommended for indoor use in all cases where highest accuracy is required.

As shown in the illustration, the transformers are arranged with the primary leads on the opposite ends of the coils, an arrangement well adapted for switchboard use. Lugs are provided for mounting purposes.

Portable Type KA—In the ordinary form of portable current transformer, extreme accuracy is sacrificed to obtain portability and convenience of application. The type KA semi-portable transformer is the standard type KA fitted with a special carrying handle and terminals as shown above.

Amperes Primary	Amperes Secondary	Fig.	Dimension† A Inches	Bore of Terminals Inches†	Switchboard-Type Approx. Wt., Lb. Net	Switchboard-Type Approx. Wt., Lb. Boxed	Switchboard-Type Style No.	Switchboard-Type List Price	Semi-Portable-Type Approx. Wt., Lb. Net	Semi-Portable-Type Approx. Wt., Lb. Boxed	Semi-Portable-Type Style No.	Semi-Portable-Type List Price
5	5	1	12½	.168	24	44	125000	$39 00	28	48	269929	$46 50
10	5	1	12½	.168	24	44	125001	39 00	28	48	269930	46 50
15	5	1	12½	.168	24	44	125002	39 50	28	48	269931	47 00
20	5	1	12½	.245	24	44	125003	39 50	28	48	269932	47 00
25	5	1	12½	.245	24	44	180642	40 00	28	48	269933	47 50
30	5	1	12½	.245	24	44	125004	40 00	28	48	269934	47 50
40	5	1	12½	.245	24	44	125005	40 50	28	48	269935	48 00
50	5	1	12½	.370	24	44	180643	41 00	28	48	269936	48 50
60	5	1	12½	.370	24	44	125006	41 00	28	48	269937	48 50
75	5	1	13½	.370	24	44	227058	42 00	28	48	269938	49 50
80	5	1	13	.370	25	45	125007	42 00	29	49	269939	49 50
100	5	1	16¼	.432	27	47	125008	43 00	31	51	269940	50 50
120	5	1	16¼	.432	27	47	125009	43 50	31	51	269941	51 00
150	5	1	16¼	.521	27	47	180644	45 00	31	51	269942	52 50
160	5	1	16¼	.521	27	47	125010	45 00	31	51	269943	52 50
200	5	1	16½	.646	27	47	125011	46 50	31	51	269944	54 00
250	5	1	17	.646	27	47	125012	48 00	31	51	269945	55 50
300	5	1	17	.747	27	47	125013	49 50	31	51	269946	57 00
400	5	1	18½	.935	27	47	125014	51 50	31	51	269947	59 00
500	5	1	18½	1.157	27	47	125015	53 50	..	..	.....	.....
600	5	1	18½	1.157	27	47	125016	55 50	..	..	.....	.....
800	5	1	17	(2) .935	30	50	125017	58 50	..	..	.....	.....
1000	5	2	18⅞	(2)1.157	30	50	125018	61 50	..	..	.....	.....
1200	5	2	20⅜	(2)1.138	30	50	242117	65 00	..	..	.....	.....

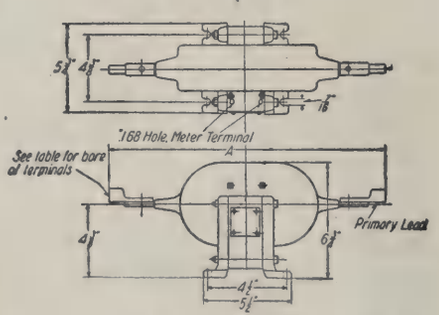


FIG. 1—APPROXIMATE DIMENSIONS† OF TYPE KA
Style Nos. 125008 to 125017 and 186044 have their leads staggered off center line.

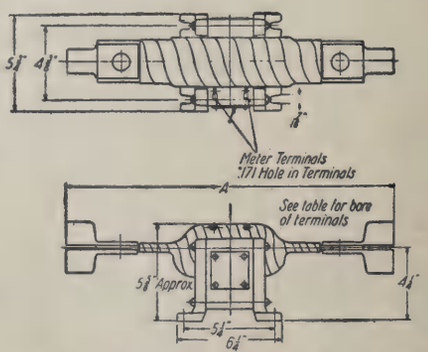


FIG. 2—APPROXIMATE DIMENSIONS† OF TYPE KA

*As determined by rating rules of the A. I. E. E.

†Dimensions shown are for switchboard type; semi-portable type are same execpt that handle and longer terminals are added. These dimensions are for reference only. For official dimensions apply to the nearest district office.

Order by Style Number

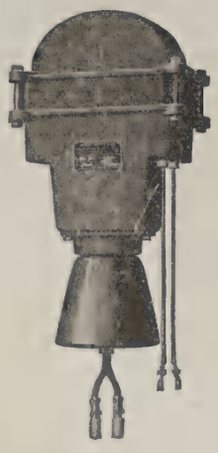
CURRENT TRANSFORMERS | Continued

TYPE MA (DRY TYPE)—OUTDOOR

Maximum Voltage 8000* **Test Voltage 20,000 for One Minute**

For 25 to 133 Cycle Circuits
Capacity 50 Volt-Amperes, Compensated for 25 Volt-Amperes

These transformers are mounted in cast iron end caps with the leads extending downwards through suitable bushings. The transformers are impregnated with an insulating compound which thoroughly seals up joints between the laminations and end caps.



Amperes Primary	Amperes Secondary	Dimensions Fig.	Dimension A Inches†	Bore of Terminals Inches†	Approx. Wt., Lb. Net.	Approx. Wt., Lb. Boxed	Style No.	List Price
5	5	1	30 11/16	.245	60	80	242300	$55 00
10	5	1	30 11/16	.245	60	80	242301	55 00
15	5	1	30 11/16	.245	60	80	242302	55 00
20	5	1	30 11/16	.245	60	80	242303	55 00
25	5	1	30 11/16	.245	60	80	242304	55 00
30	5	1	30 11/16	.245	60	80	242305	55 00
40	5	1	30 11/16	.245	60	80	242306	55 00
50	5	1	30 11/16	.370	60	80	242307	55 00
60	5	1	30 11/16	.370	60	80	242308	60 00
75	5	1	30 11/16	.370	60	80	242309	60 00
80	5	1	30 11/16	.370	60	80	242310	60 00
100	5	1	30 11/16	.432	60	80	242311	60 00
120	5	1	30 11/16	.432	60	80	242312	60 00
150	5	2	24 1/4	.521	70	95	242313	65 00
160	5	2	24 1/4	.521	70	95	242314	65 00
200	5	2	24 1/2	.646	70	95	242315	65 00
250	5	2	25 1/2	.747	70	95	242316	65 00
300	5	2	25 1/2	.747	70	95	242317	65 00
400	5	2	25 3/4	.935	70	95	242318	65 00
500	5	2	26	1.157	70	95	242319	65 00

Style No.	Description	List Price
109712	Set of two Hanger Irons for Type MA transformer	$2 75

*As determined by rating rules of A. I. E. E.

Order by Style Number

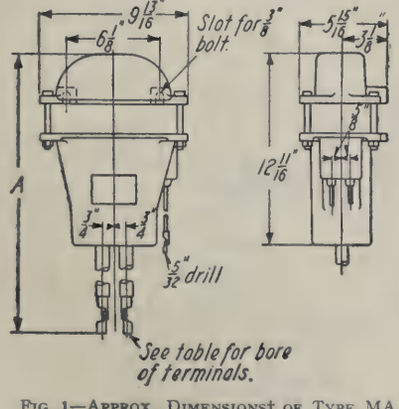


FIG. 1—APPROX. DIMENSIONS† OF TYPE MA

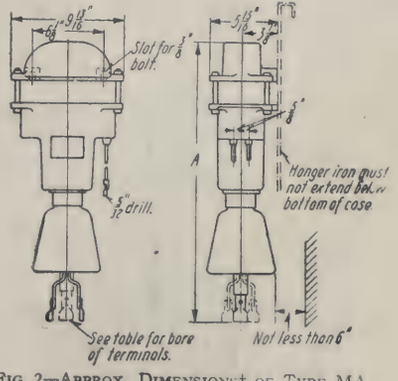


FIG. 2—APPROX. DIMENSIONS† OF TYPE MA

†These dimensions are for reference only. For official dimensions apply to the nearest district office.

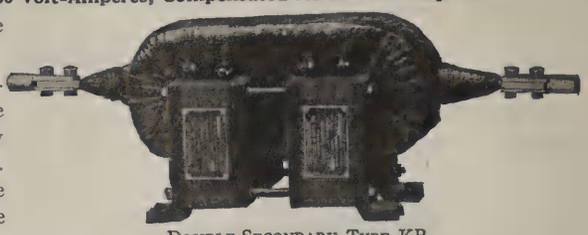
TYPE KB (DRY-TYPE) INDOOR

Maximum Voltage 17,000* **Test Voltage 40,500 for one Minute**

For 25 to 133-Cycle Circuits Capacity 50 Volt-Amperes, Compensated for 25 Volt-Amperes

These transformers are similar to the type KA, except for the higher potential rating.

Double-Secondary Type KB—These transformers are similar in construction and voltage rating, but have two independent secondary windings, each compensated for 25 volt-amperes. One of these transformers therefore takes the place of two ordinary transformers on the same line.



DOUBLE-SECONDARY TYPE KB

Amperes Primary	Amperes Secondary	Dimensions Fig.	Dimension A Inches†	Bore of Terminal Inches†	Approx. Wt. Lbs. Net	Approx. Wt. Lbs. Boxed	Style No.	List Price
				Single Secondary				
5	5	2	16 5/8	.168	31	51	125019	$58 00
10	5	2	16 5/8	.168	31	51	125020	58 00
15	5	2	16 5/8	.168	31	51	125021	59 00
20	5	2	16 5/8	.245	31	51	125022	59 00
25	5	2	16 5/8	.245	31	51	180646	59 00
30	5	2	16 5/8	.245	31	51	125023	59 00
40	5	2	17	.245	31	51	125024	60 00
50	5	2	17	.370	31	51	180647	60 00
60	5	2	17	.370	31	51	125025	60 00
75	5	2	18	.370	32	52	227059	61 00
80	5	2	18	.370	32	52	125026	61 00
100	5	2	18 5/8	.432	34	54	125027	62 00
120	5	2	18 5/8	.432	34	54	125028	63 00
150	5	2	18 3/8	.521	34	54	180648	64 00
160	5	2	18 3/8	.521	34	54	125029	64 00
200	5	2	19	.646	34	54	125030	66 00
250	5	2	19 7/8	.646	34	54	125031	67 00
300	5	2	20 7/8	.747	34	54	125032	69 00
400	5	2	21 3/8	.935	34	54	125033	71 00
500	5	2	22 5/8	1.157	34	54	125034	73 00
600	5	2	22 5/8	1.157	34	54	125035	75 00
800	5	2	21 3/8	(2) .935	34	54	242118	78 00
1000	5	2	27 1/4	(2) 1.125	38	58	288926	80 00
1200	5	2	23 1/2	(2) 1.125	38	58	288927	83 00
1500	5	2	23 1/4	(2) 1.375	40	60	288990	85 00
				Double Secondary				
5	5+5	1	21 7/8	.168	55	80	182796	97 00
10	5+5	1	21 7/8	.168	55	80	182797	97 00
15	5+5	1	21 7/8	.168	55	80	182798	98 00
20	5+5	1	21 7/8	.245	55	80	182799	98 00
25	5+5	1	21 7/8	.245	55	80	182800	99 00
30	5+5	1	21 7/8	.245	55	80	182801	99 00
40	5+5	1	22 1/4	.245	55	80	182802	100 00
50	5+5	1	22 1/4	.370	55	80	182803	101 00
60	5+5	1	22 1/4	.370	55	80	182804	102 00
75	5+5	1	23 1/8	.370	55	80	245482	103 00
80	5+5	1	23 1/8	.370	55	80	182805	103 00
100	5+5	1	23 1/8	.432	58	83	182806	105 00
120	5+5	1	22 7/8	.432	58	83	182807	106 00
150	5+5	1	22 7/8	.521	58	83	182808	109 00
160	5+5	1	27 7/8	.521	58	83	182809	109 00
200	5+5	1	22 1/2	.646	58	83	182810	112 00
250	5+5	1	23 1/8	.646	58	83	182811	115 00
300	5+5	1	25 1/2	.747	58	83	182812	118 00
400	5+5	1	26 1/2	.935	58	83	182813	120 00
500	5+5	1	27 1/2	1.157	58	83	182814	122 00
600	5+5	1	27 1/2	1.157	58	83	182815	126 00
800	5+5	1	27 1/2	(2) .935	58	83	242119	130 00
1000	5+5	1	29 1/4	(2) 1.125	60	85	288991	135 00

*As determined by rating rules of A. I. E. E.

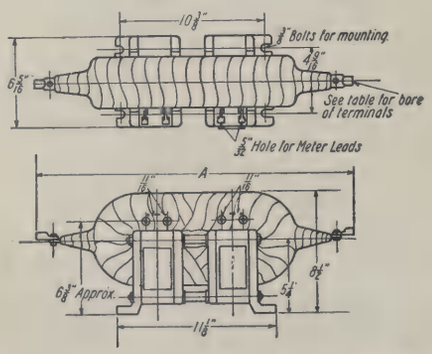


FIG. 1—APPROX. DIMENSIONS† OF DOUBLE-SECONDARY TYPE KB. (Styles Nos. 182806 to 182815 and 242119 have their leads staggered off center line similar to Fig. 2)

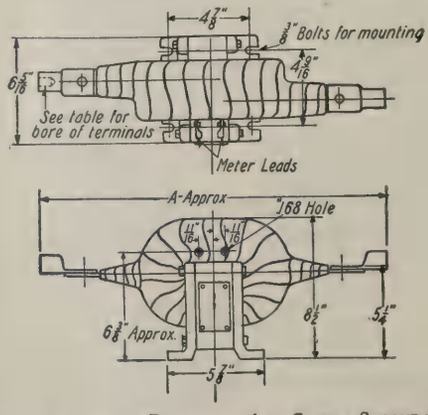


FIG. 2—APPROX. DIMENSIONS† OF SINGLE-SECONDARY TYPE KB. (Style Nos. 125019 to 125026, 180646, 180647 and 227059 have their leads on center line similar to Fig. 1)

†These dimensions are for reference only. For official dimensions apply to the nearest district office.

CURRENT TRANSFORMERS—Continued

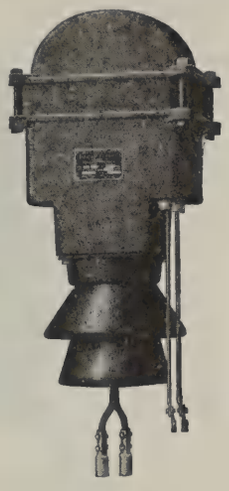
TYPE MB (DRY TYPE) OUTDOOR

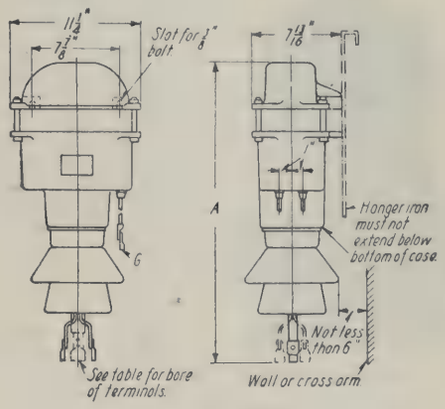
Maximum Voltage 17,000* **Test Voltage 40,500 for One Minute**

For 25 to 133-Cycle Circuits

Capacity 50 Volt-Amperes, Compensated for 25 Volt-Amperes

These transformers are mounted in cast iron end caps with the leads extending downwards through suitable bushings. The transformers are impregnated with an insulating compound which thoroughly seals up joints between the laminations and end caps.





Amperes Primary	Amperes Secondary	Dimen. A Inches†	Bore of Terminal†	Approx. Wt., Lb. Net	Approx. Wt., Lb. Boxed	Style No.	List Price
5	5	29	.245	90	115	242320	$77 00
10	5	29	.245	90	115	242321	77 00
15	5	29	.245	90	115	242322	77 00
20	5	29	.245	90	115	242323	77 00
25	5	29	.245	90	115	242324	77 00
30	5	29	.245	90	115	242325	77 00
40	5	29	.245	90	115	242326	80 00
50	5	29	.370	90	115	242327	80 00
60	5	29	.370	90	115	242328	80 00
75	5	29	.370	90	115	242329	80 00
80	5	29	.370	90	115	242330	80 00
100	5	27¼	.432	90	115	242331	80 00
120	5	27¼	.432	90	115	242332	80 00
150	5	27¼	.521	90	115	242333	80 00
160	5	27¼	.521	90	115	242334	80 00
200	5	27½	.646	90	115	242335	85 00
250	5	28	.747	90	115	242336	85 00
300	5	28⅜	.747	90	115	242337	85 00
400	5	28¼	.935	90	115	242338	85 00
500	5	28¾	1.157	90	115	242339	85 00

Hanger Irons

Style No.	Description	List Price
109712	Set of hanger irons for type MB transformer	$2 75

*As determined by rating rules of A. I. E. E.
†These dimensions are for reference only. For official dimensions apply to the nearest district office.

Order by Style Number

CURRENT TRANSFORMERS—Continued

TYPE KC (DRY TYPE) INDOOR

Maximum Voltage 24,000* **Test Voltage 56,000 for One Minute**

For 25 to 133-Cycle Circuits
Capacity 50 Volt-Amperes, Compensated for 25 Volt-Amperes

SINGLE SECONDARY

Type KC—Mounted in cast iron end caps which are filled with insulating compound. This construction insures ample insulation between the high voltage winding and the secondary winding or the core.

Double Secondary Type KC—Similar in construction and voltage rating to the type KC, but have two independent secondary windings, each compensated for 25 volt-amperes. One of the transformers, therefore, takes the place of two ordinary transformers on the same circuit.

DOUBLE-SECONDARY

Amperes Primary	Amperes Secondary	Dimensions Fig.	Dimension A Inches‡	Bore of Terminals Inches‡	Approx. Wt., Lb. Net	Approx. Wt., Lb. Boxed	Style No.	List Price
Single Secondary								
5	5	1	30½	†	112	142	182756	$100 00
10	5	1	30½	†	112	142	182757	100 00
15	5	1	30½	†	112	142	182758	100 00
20	5	1	30½	†	112	142	182759	100 00
25	5	1	30½	†	112	142	182760	100 00
30	5	1	30½	†	112	142	182761	100 00
40	5	1	30½	†	112	142	182762	105 00
50	5	1	30½	†	112	142	182763	105 00
60	5	1	30½	†	112	142	182764	105 00
75	5	1	30½	†	112	142	242299	110 00
80	5	1	30½	†	112	142	182765	110 00
100	5	1	37½	.432	116	146	182766	110 00
120	5	1	37½	.432	116	146	182767	110 00
150	5	1	37½	.521	116	146	182768	115 00
160	5	1	37½	.521	116	146	182769	115 00
200	5	1	37½	.646	116	146	182770	115 00
250	5	1	37½	.747	116	146	182771	120 00
300	5	1	37½	.747	116	146	182772	120 00
400	5	1	37½	.875	116	146	182773	125 00
500	5	1	37½	1.157	116	146	182774	125 00
Double Secondary								
5	5+5	2	35¼	†	160	190	182776	150 00
10	5+5	2	35¼	†	160	190	182777	150 00
15	5+5	2	35¼	†	160	190	182778	150 00
20	5+5	2	35¼	†	160	190	182779	150 00
25	5+5	2	35¼	†	160	190	182780	150 00
30	5+5	2	35¼	†	160	190	182781	150 00
40	5+5	2	35¼	†	160	190	182782	165 00
50	5+5	2	35¼	†	160	190	182783	165 00
60	5+5	2	35¼	†	160	190	182784	165 00
75	5+5	2	35¼	†	160	190	242579	165 00
80	5+5	2	35¼	†	160	190	182785	165 00
100	5+5	2	42¼	.432	165	195	182786	165 00
120	5+5	2	42¼	.432	165	195	182787	170 00
150	5+5	2	42¼	.521	165	195	182788	170 00
160	5+5	2	42¼	.521	165	195	182789	170 00
200	5+5	2	42¼	.646	165	195	182790	170 00
250	5+5	2	42¼	.747	165	195	182791	175 00
300	5+5	2	42¼	.747	165	195	182792	175 00
400	5+5	2	42¼	.875	165	195	182793	175 00
500	5+5	2	42¼	1.157	165	195	182794	175 00

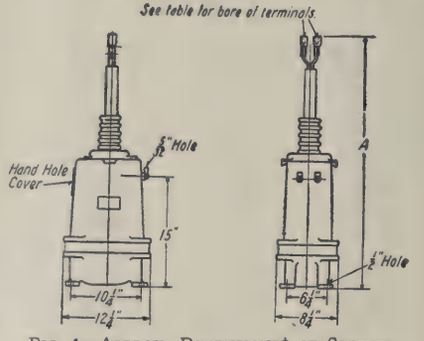


FIG. 1—APPROX. DIMENSIONS‡ OF SINGLE-SECONDARY

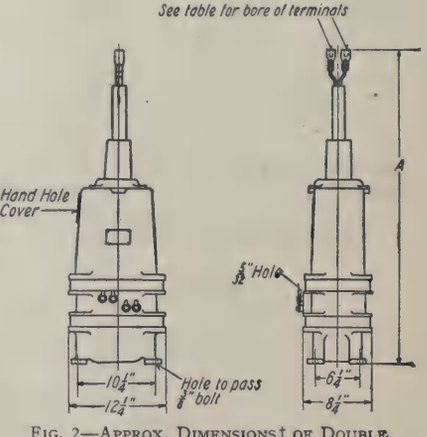


FIG. 2—APPROX. DIMENSIONS‡ OF DOUBLE SECONDARY

*As determined by rating rules of A. I. E. E.
†Leads are of cable and no terminals are furnished.
‡These dimensions are for reference only. For official dimensions apply to the nearest district office.

Order by Style Number

CURRENT TRANSFORMERS—Continued

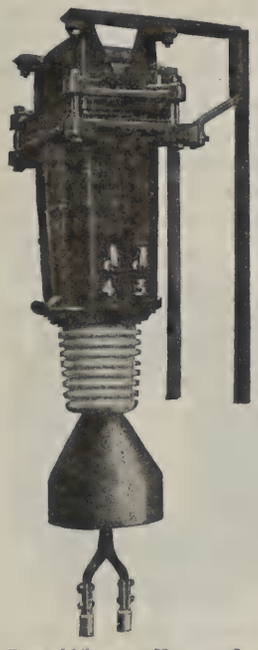
TYPE MC (DRY TYPE)—OUTDOOR

Maximum Voltage 24,000* **Test Voltage 56,000 for One Minute**

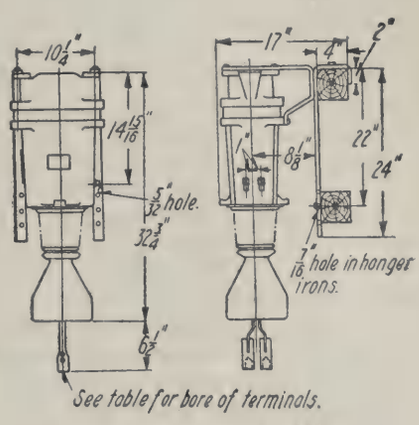
For 25 to 133 Cycle Circuits

Capacity 50 Volt Amperes, Compensated for 25 Volt Amperes

These transformers are mounted in cast iron end caps with the leads extending downwards through suitable bushings. The transformers are impregnated with an insulating compound which thoroughly seals up joints between the laminations and end caps.



TYPE MC WITH HANGER IRONS



APPROX. DIMENSIONS† OF TYPE MC

(Hanger Irons Not Included in Style Number and Price.)

Amperes Primary	Amperes Secondary	Bore at Terminals†	Approx. Wt., Lb. Net	Approx. Wt., Lb. Boxed	Style No.	List Price
5	5	.245	125	155	242340	$125 00
10	5	.245	125	155	242341	125 00
15	5	.245	125	155	242342	125 00
20	5	.245	125	155	242343	125 00
25	5	.245	125	155	242344	125 00
30	5	.245	125	155	242345	125 00
40	5	.245	125	155	242346	130 00
50	5	.370	125	155	242347	130 00
60	5	.370	125	155	242348	130 00
75	5	.370	125	155	242349	135 00
80	5	.370	125	155	242350	135 00
100	5	.432	125	155	242351	135 00
120	5	.432	125	155	242352	135 00
150	5	.521	125	155	242353	140 00
160	5	.521	125	155	242354	140 00
200	5	.646	125	155	242355	140 00
250	5	.747	125	155	242356	145 00
300	5	.747	125	155	242357	145 00
400	5	.935	125	155	242358	150 00
500	5	1.157	125	155	242359	150 00

Hanger Irons

Style No.	Description	List Price
242576	Set of two Hanger Irons for type MC Transformer	$12 00

*As determined by rating rules of A. I. E. E.
†These dimensions are for reference only. For official dimensions apply to the nearest district office.

THROUGH-TYPES FS AND FB (DRY TYPE) INDOOR

Maximum Voltage 3500* **Test Voltage 10,000 for One Minute**

For 25 to 133-Cycle Circuits

TYPE FS

TYPE FB

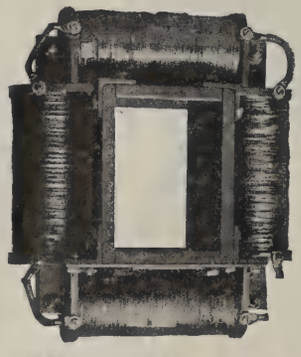
Except the 8000 and 10,000-ampere sizes these transformers have a potential rating of 3500 volts. By the use of longer insulating tubes over the primary conductor, they may be used at higher voltages up to and including 8000 volts. For transformers for higher voltages, information will be furnished on application.

In sizes up to and including 1000 amperes, they have a capacity of 25 volt-amperes and are compensated for 10 volt-amperes; above 1000 amperes they have a capacity of 50 volt-amperes and are compensated for 25 volt-amperes.

These "through-type" transformers have no primary windings, but slip over a cable stud or bus-bar, which forms the primary of the transformer. The type FS is intended for cables and round studs, and the type FB for rectangular bus-bars.

The momentary current due to a heavy short circuit on a large system is extremely great, and the mechanical stresses set up between the primary and secondary windings of a current transformer due to this current are extraordinarily large. The "through type" of transformer is the only type in which these stresses are balanced up within the transformer itself; and they are therefore of special value where, due to special conditions, other types of transformers are liable to overstrain from such stresses.

NOTE—**The 8000 and 10,000-ampere** transformers are insulated for 500 volts. They are so constructed that they can be placed over a bus-bar in place, the two halves being joined by interleaving the laminations of the magnetic circuit and inserting the bolts.



TYPE FB 8000 AND 10000-AMPERE PRIMARY

AMPERES Primary	AMPERES Secondary	Capacity Volt-Amperes	Compensated for-Volt-Amperes	Dimension Reference†	APPROX. WT., LB. Net	APPROX. WT., LB. Boxed	Style No.	List Price
Type FS for Cable or Stud								
600	5	25	10	I	8	28	125053	$ 25 00
800	5	25	10	I	8	28	125054	27 00
1000	5	25	10	I	8	28	125055	29 00
1200	5	50	25	I	8	28	125056	31 00
1200	5	50	25	II	20	40	125057	31 00
1600	5	50	25	II	20	40	125058	36 00
2000	5	50	25	II	20	40	125059	40 00
2000	5	50	25	III	26	46	125060	40 00
2400	5	50	25	III	26	46	125061	44 00
3000	5	50	25	III	26	46	125062	50 00
Type FB for Bus Bars								
600	5	25	10	IV	10	30	125063	25 00
800	5	25	10	IV	10	30	125064	27 00
1000	5	25	10	IV	10	30	125065	29 00
1200	5	50	25	IV	10	30	125066	31 00
1200	5	50	25	V	20	40	125067	31 00
1600	5	50	25	V	20	40	125068	36 00
2000	5	50	25	V	20	40	125069	40 00
2000	5	50	25	VI	30	50	125070	40 00
2400	5	50	25	VI	30	50	125071	44 00
3000	5	50	25	VI	30	50	125072	50 00
4000	5	50	25	VII	44	69	219799	90 00
5000	5	50	25	VIII	58	83	219800	100 00
6000	5	50	25	IX	70	95	179908	110 00
8000	5	50	25	X	46	71	241776	125 00
10000	5	50	25	X	56	81	241777	140 00

*As determined by rating rules of A. I. E. E.
†See table on next page.

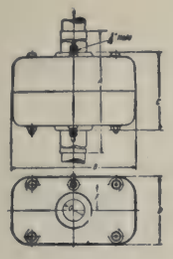


FIG. 1

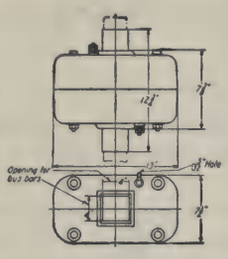


FIG. 3

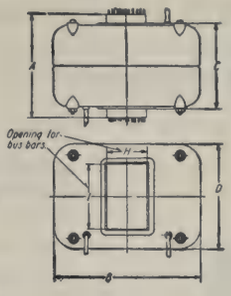


FIG. 4

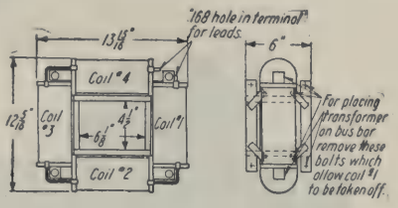

.168 hole in terminal for leads
13/16"
6"
Coil #4
Coil #3
Coil #1
Coil #2
For placing transformer on bus bar remove these bolts which allow coil #1 to be taken off.

FIG. 5

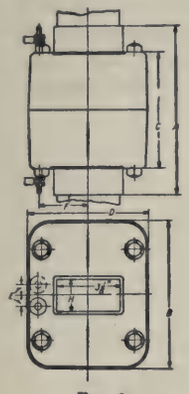


FIG. 2

Outline Dimensions †

Dimension Reference	Fig.	DIMENSION, INCHES A	B	C	D	E	F	G (For Cable, Stud or Bus Bars — Dia.)	H (For Cable, Stud or Bus Bars)	I (For Cable, Stud or Bus Bars)
Type FS for Cable or Stud										
I	1	11¼	7⅝	5¾	4⅝	....	1⅝	1½	....	....
II	1	11¾	9½	6¼	5¾	....	2	2	....	....
III	1	12⅛	10⅝	6⅝	6	....	2¼	2½	....	....
Type FR for Bus Bars										
IV	2	10⅞	8⅝	5⅜	5⅝	½	2	...	1⅛	...
V	2	11¼	8¼	5¾	5¾	1	2⅜	...	1⅞	...
VI	2	11½	10⅜	6	6	2¼	2⅝	...	3⅜	...
VII	3	...	...	...	...	...	...	...	...	...
VIII	4	12½	10¾	7⅝	9¾	...	...	...	2⅜	6
IX	4	15	13⅞	8⅝	9⅞	...	...	...	3⅝	6
X	5	....	....	...	...	...	...	...	...	...

TYPE KR (DRY TYPE) INDOOR

For Operating Relays and Circuit-Breaker Trip Coils

Maximum Voltage 8000* **Test Voltage 20,000 for One Minute**

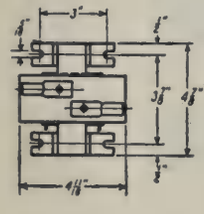
For 25 to 133-Cycle Circuits

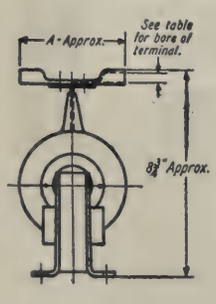
This line of transformers in capacities 5 to 200 amperes inclusive is supplementary, for circuit-breaker use, to the through type FR transformers listed in capacities up to 500 amperes.

These transformers have sufficient capacity to operate relays or trip coils and will have an error in ratio not exceeding about 10% where the load at 4 amperes does not exceed 27 volt-amperes at 25 cycles or 64 volt-amperes at 60 cycles. They should not be used with relays where the circuit-breaker trip coil is in series with the relay.

These transformers are for use only with relays, or circuit-breaker trip coils. They have sufficient capacity for operating circuit-breakers within the limits of ordinary accuracy demanded in such service but should not be used for connection to measuring instruments. The general type of construction is similar to type KA transformers, except that these are much smaller.

TYPE KR





APPROX. DIMENSIONS† OF TYPE KR

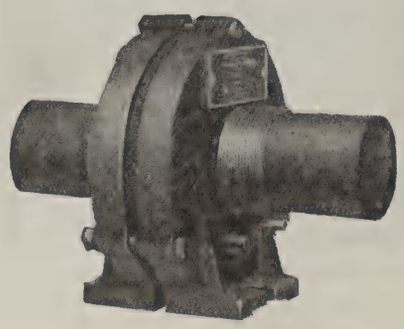
Amperes Primary	Amperes Secondary	Dimension A Inches	Bore of Terminals Inches†	Approx. Wt. Net	Approx. Wt. Boxed	Style No.	List Price
5	5	3¼	.168	9	29	187788	$17 00
10	5	3½	.168	9	29	187789	17 00
15	5	3½	.168	9	29	187790	18 00
20	5	3½	.245	9	29	187791	18 00
25	5	3½	.245	9		187792	18 00
30	5	3½	.245	9	29	187793	19 00
40	5	3⅞	.245	9	29	187794	19 00
50	5	3⅞	.370	9	29	187795	19 00
60	5	3⅞	.370	9	29	187796	20 00
75	5	4¼	.370	9	29	242577	20 00
80	5	4¼	.370	9	29	187797	20 00
100	5	5⅞	.432	10	30	187798	21 00
120	5	6¼	.432	10	30	187799	21 00
150	5	6¼	.521	10	30	242578	22 00
160	5	6¼	.521	10	30	187800	22 00
200	5	6¾	.646	10	30	187801	24 00

*As determined by rating rules of A. I. E. E.
†These dimensions are for reference only. For official dimensions apply to the nearest district office.

THROUGH-TYPE FR (DRY TYPE) INDOOR

For Operating Relays and Circuit-Breaker Trip Coils

For 25 to 133-Cycle Circuits

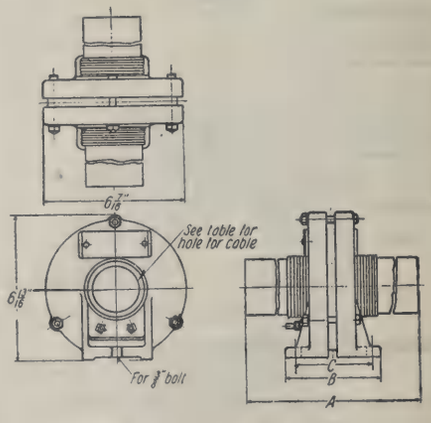


TYPE FR

Through Type FR—Similar to types FS and FB; but in the capacities covered by this line, 100 to 500 amperes inclusive, a through-type transformer cannot be made of sufficient accuracy for ordinary use in connection with measuring instruments. This line of transformers is, therefore, primarily adapted for circuit-breaker tripping, either through relays or by direct connection to the breaker.

In order to obtain the advantage of a through-type transformer of low current rating for instrument service, these transformers may be so used where it is possible to calibrate the instrument with the transformer. This application can only be made in the case of ammeters, and requires the use of a calibration curve for each instrument. The same transformers should not, however, be used both for instrument work and circuit-breaker work.

These transformers have sufficient capacity to operate relays or trip coils and will have an error in ratio not exceeding about 10% where the load at 4 amperes does not exceed 25 volt-amperes at 25 cycles or 55 volt-amperes at 60 cycles. They should not be used with relays where the circuit-breaker trip coil is in series with the relay.



APPROX. DIMENSIONS† OF TYPE FR

Amperes Primary	Amperes Secondary	Dimensions Inches A	B	C	Holes for Cable Inches Diameter†	Approx. Wt., Lb. Net	Boxed	Style No.	List Price
Maximum Voltage 3,500, Test Voltage 10,000 for One Minute									
250	5	8 7/8	5 1/8	3 7/8	1 1/4	14 1/2	34	125077	$22 00
300	5	8 7/8	5 1/16	3 13/16	1 3/4	12	32	125078	23 00
400	5	8 9/16	4 3/4	3 1/2	2	10	30	125079	25 00
500	5	8 1/4	4 1/2	3 1/4	2	9	29	125080	27 00
Maximum Voltage 8,000, Test Voltage 20,000 for One Minute									
250	5	14 7/8	5 1/8	3 7/8	1 1/4	14 1/4	34	125085	24 00
300	5	14 7/8	5 1/16	3 13/16	1 3/4	12	32	125086	25 00
400	5	14 9/16	4 3/4	3 1/2	2	10	30	125087	27 00
500	5	14 1/4	4 1/2	3 1/4	2	9	29	125088	29 00
Maximum Voltage 14,400, Test Voltage 35,000 for One Minute									
100	5	24	8 3/4	7 1/2	1	23	43	125089	32 00
120	5	24	6 1/2	5 1/4	1	19 1/2	40	125090	32 00
160	5	24	6 1/2	5 1/4	1 1/4	18	38	125091	33 00
200	5	24	5 3/4	4 1/2	1 1/4	16 1/2	36	125092	33 00
250	5	24	5 1/8	3 7/8	1 1/4	14 1/2	34	125093	34 00
300	5	24	5 1/16	3 13/16	1 3/4	12	32	125094	34 00
400	5	24	4 3/4	3 1/2	2	10	30	125095	35 00
500	5	24	4 1/2	3 1/4	2	9	29	125096	35 00

†These dimensions are for reference only. For official dimensions apply to the nearest district office.

Order by Style Number

TYPE OA (OIL INSULATED)

Maximum Voltage 35,000* **Test Voltage 81,000 for One Minute**

For 25 to 133-Cycle Circuits

Capacity 50 Volt-Amperes, Compensated for 25 Volt-Amperes

TYPE OA INDOOR

TYPE OA OUTDOOR

These transformers are designed for separate mounting, in compartments or otherwise. They are heavily insulated between primary and secondary windings and form a barrier of great strength between the line and the instrument circuits.

Double-Secondary Type OA—In cases where it is desirable to operate relays or circuit-breakers together with indicating instruments or watthour meters, transformers having two independent secondary circuits can be furnished. The instruments can then be isolated from the relays or circuit-breakers, and the accuracy of the former will be unaffected by the heavy load represented by the latter.

Outdoor Type OA transformers differ from the indoor type only in having high-voltage outlet bushings suitable for outdoor service.

AMPERES Primary	AMPERES Secondary	Bore of Terminals	Gals. Oil†	INDOOR‡ Style No.	INDOOR‡ List Price	OUTDOOR Style No.	OUTDOOR List Price
Single Secondary							
5-10	5	.307	12	**217450**	$250 00	**242360**	$300 00
10-20	5	.307	12	**217451**	250 00	**242361**	300 00
15-30	5	.307	12	**217452**	250 00	**242362**	300 00
20-40	5	.307	12	**217453**	250 00	**242363**	300 00
25-50	5	.307	12	**239609**	250 00	**242364**	300 00
30-60	5	.370	12	**217454**	250 00	**242365**	300 00
40-80	5	.370	12	**217455**	250 00	**242366**	300 00
50-100	5	.432	12	**239610**	250 00	**242367**	300 00
60-120	5	.432	12	**217456**	250 00	**242368**	300 00
75-150	5	.521	12	**239611**	250 00	**242369**	300 00
80-160	5	.521	12	**217457**	250 00	**242370**	300 00
100-200	5	.646	12	**217458**	250 00	**242371**	300 00
125-250	5	.747	12	**217462**	250 00	**242372**	300 00
150-300	5	.747	12	**217463**	250 00	**242373**	300 00
200-400	5	.935	12	**217464**	250 00	**242374**	300 00
Double Secondary							
For double secondary add to list price of transformer					55 00		85 00

Dimensions will be furnished on request.

Approximate Weight—Single secondary, indoor 275 pounds; outdoor, 295 pounds; add 60 pounds for boxing. Double secondary, indoor 475 pounds; outdoor, 495 pounds, add 80 pounds for boxing. Weights do not include oil; oil weighs approximately 7 pounds per gallon.

The current transformers have two primary windings which can be connected in series or parallel to give the lower or higher current rating listed.

*As determined by rating rules of A. I. E. E.

†Transformers are regularly shipped in their own tanks without oil—oil is shipped separately. On receipt at destination they should be filled with clean dry oil immediately.

‡Indoor type shipped with high-voltage terminal in place.

Order by Style Number

TYPE OB (OIL INSULATED)

Maximum Voltage 47,000* **Test Voltage 108,000 for One Minute**

For 25 to 133-Cycle Circuits

Capacity 50 Volt-Amperes, Compensated for ≅ Volt-Amperes

These transformers are similar to the type OA transformer, but have a voltage rating of 47,000 volts.

Double Secondary Type OB—These are similar to the double secondary type OA, but have a voltage rating of 47,000 volts.

Outdoor Type OB Transformers differ from the indoor type only in having outdoor type high-voltage outlet bushings.

These transformers have two primary windings which can be connected in series or parallel to give the lower or higher current rating listed.

INDOOR TYPE OB

AMPERES Primary	AMPERES Secondary	Bore of Terminals	Gals. Oil†	INDOOR Style No.	INDOOR List Price	OUTDOOR Style No.	OUTDOOR List Price
Single Secondary							
5-10	5	.307	56	217465	$500 00	242385	$600 00
10-20	5	.307	56	217466	500 00	242386	600 00
15-30	5	.307	56	217467	500 00	242387	600 00
20-40	5	.307	56	217468	500 00	242388	600 00
25-50	5	.307	56	239612	500 00	242389	600 00
30-60	5	.370	56	217469	500 00	242390	600 00
40-80	5	.370	56	217470	500 00	242391	600 00
50-100	5	.432	56	239613	500 00	242392	600 00
60-120	5	.432	56	217471	500 00	242393	600 00
75-150	5	.521	56	239614	500 00	242394	600 00
80-160	5	.521	56	217472	500 00	242395	600 00
100-200	5	.646	56	217473	500 00	242396	600 00
125-250	5	.747	56	217477	500 00	242397	600 00
150-300	5	.747	56	217478	500 00	242398	600 00
200-400	5	.935	56	217479	500 00	242399	600 90
Double Secondary							
For double secondary add to list price of transformer.....					85 00		135 00

Dimensions will be furnished on request.

Approximate Weight—Single secondary, indoor, 850 pounds; outdoor, 525 pounds; add 150 pounds for boxing. Double secondary, indoor 700 pounds; outdoor, 770 pounds; add 175 pounds for boxing. Weights do not include oil; oil weighs approximately 7 pounds per gallon.

*As determined by rating rules of A. I. E. E.

†Transformers are regularly shipped in their own tanks without oil—oil is shipped separately. On receipt at destination they should be filled with clean dry oil immediately.

Order by Style Number

CURRENT TRANSFORMERS—Continued

TYPE OC (OIL INSULATED)

Maximum Voltage 70,000* **Test Voltage 160,000 for One Minute**

For 25 to 133-Cycle Circuits

Capacity 50 Volt-Amperes, Compensated for 25 Volt-Amperes

These trasformers are similar to the type OA transformers, but have a voltage rating of 70,000 volts.

Double Secondary Type OC—Similar to the double secondary type OA, but have a voltage rating of 70,000 volts.

Outdoor Type OC Transformers differ from the indoor-type only in having outdoor-type high voltage outlet bushings.

These transformers have two primary windings which can be connected in series or parallel to give the lower or higher current rating listed.

TYPE OC INDOOR

TYPE OC OUTDOOR

Amperes Primary	Amperes Secondary	Bore of Terminals	Gals. Oil†	Indoor Style No.	Indoor List Price	Outdoor Style No.	Outdoor List Price
Single Secondary							
5-10	5	.307	60	217680	$600 00	242400	$750 00
10-20	5	.307	60	217681	600 00	242401	750 00
15-30	5	.307	60	217682	600 00	242402	750 00
20-40	5	.307	60	217683	600 00	242403	750 00
25-50	5	.307	60	239615	600 00	242404	750 00
30-60	5	.370	60	217684	600 00	242405	750 00
40-80	5	.370	60	217685	600 00	242406	750 00
50-100	5	.432	60	239616	600 00	242407	750 00
60-120	5	.432	60	217686	600 00	242408	750 00
75-150	5	.521	60	239617	600 00	242409	750 00
80-160	5	.521	60	217687	600 00	242410	750 00
100-200	5	.646	60	217688	600 00	242411	750 00
125-250	5	.747	60	217692	600 00	242412	750 00
150-300	5	.747	60	217693	600 00	242413	750 00
200-400	5	.935	60	217694	600 00	242414	750 00
Double Secondary							
For double secondary, add to list price of transformer.....					150 00		200 00

Dimensions and Weights will be furnished on request.

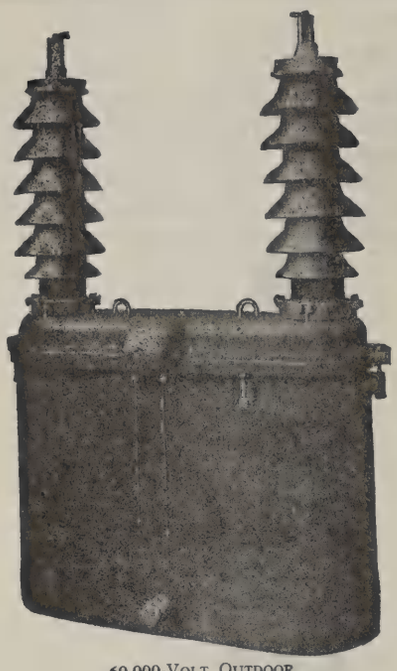
Approximate Weight—Single secondary, indoor 575 pounds; outdoor, 700 pounds; add 175 pounds for boxing. Double secondary, indoor 900 pounds; outdoor 1025 pounds; add 200 pounds for boxing. Weights do not include oil; oil weighs approximately 7 pounds per gallon.

*As determined by rating rules of A. I. E. E.

†Transformers are regularly shipped in their own tanks without oil—oil is shipped separately. On receipt at destination they should be filled with clean dry oil immediately.

Order by Style Number

VOLTAGE TRANSFORMERS



60,000-Volt Outdoor Oil-Insulated

22,000-Volt Indoor Oil-Insulated

Dry-Type

Dry Type—The dry-type voltage transformers are mounted in end frames and are adapted for use on voltages up to 6000. The end frames of transformers up to and including 2000 volts have lugs cast on them for mounting fuse blocks.

Oil Insulated Type—The oil-insulated type voltage transformers are designed for use on voltages from 200 to 70,000. Up to 14,000 volts they are mounted in cases made to fit in cells or in the limited space behind switchboards. For voltages up to 3500, they are mounted in cast iron cases provided with mounting lugs. For voltages above 3500, the transformers are built for floor mounting. For voltages of 4000 to 12000 inclusive, the transformers are so designed that the high-voltage leads can be brought through either the top or the sides of the case, by means of the extra bushing holes and flanges. This feature is of particular advantage in switchboard wiring.

Outdoor Type—Oil insulated transformers for outdoor operation can be furnished for standard voltages—prices for outdoor transformers of voltages lower than those listed will be supplied on request.

Semi-Portable Type—In the ordinary form of portable voltage transformers, extreme accuracy is sacrificed to obtain portability and convenience of application. The semi-portable transformer is the standard dry-type transformer fitted with a special carrying handle and terminals as shown.

The ratio of transformation should be such as to give a **nominal** voltage of 100 on the instruments. Thus, for a 2200-volt circuit, a 2000-100 ratio should be used, making the normal voltage on the instruments 110. Transformers for any special ratio or voltage not listed herein can be supplied, but it is recommended that standard transformers be ordered whenever possible.

Choke Coils—For protection against line surges, transformers designed for voltages of 22,000 and above, have choke coils mounted in their cases and connected between the transformer windings and the line.

Semi-Portable Dry-Type

VOLTAGE TRANSFORMERS—Continued

Fuse Protection—The style number and list price of voltage transformers do not include fuse blocks.

Front-connected fuse blocks made of glazed porcelain are available. They are adapted to the protection of instrument transformers up to 2500 volts. The base can be bolted to the fuse block supports on standard Westinghouse dry-type voltage transformers, thus economizing space and making a compact equipment. For description, dimensions, ratings, and prices of instrument-transformer fuse blocks, see catalogue on "Westinghouse Miscellaneous Switches and Carbon Circuit-Breakers."

Capacity, 200‡ Volt-Amperes **Compensated For 15 Volt-Amperes**
Nominal Secondary Voltage, 100

Dry-Type—Indoor

Primary Volts at 100 Volts Secondary	25 Cycles: Maximum Continuous Primary Voltage	25 Cycles: Approx. Wt. Lb. Net	25 Cycles: Approx. Wt. Lb. Boxed	25 Cycles: Style No.	25 Cycles: List Price	60 Cycles: Maximum Continuous Primary Voltage	60 Cycles: Approx. Wt.* Lb. Net	60 Cycles: Approx. Wt.* Lb. Boxed	60 Cycles: Style No.	60 Cycles: List Price
200	240	28	53	30901	$ 31 00	240	22	42	30057	$ 27 00
400	480	30	55	30902	33 00	480	22	42	30058	28 00
500	600	30	55	10333	33 00	600	25	45	10369	29 00
600	720	37	62	10352	35 00	720	28	53	10347	30 00
1000	1200	37	62	30055	36 00	1200	28	53	30053	32 00
2000	2400	39	64	30056	43 00	2500	28	53	30054	36 00
3000	3600	60	85	10370	50 00	3600	33	58	10371	41 00
4000	4800	63	93	10374	55 00	4800	50	75	10375	46 00
5000	5800	70	100	10004	60 00	6000	55	80	10372	51 00
6000	6800	85	115	10351	68 00	7200	60	85	10373	56 00

Semi-Portable Dry-Type

200	240	34	63	269954	38 50	240	28	52	269948	34 50
400	480	36	65	269955	40 50	480	28	52	269949	35 50
500	600	36	65	269956	40 50	600	31	55	269950	36 50
600	720	43	72	269957	41 50	720	34	63	269951	36 50
1000	1200	43	72	269958	43 50	1200	34	63	269952	39 50
2000	2400	45	74	269959	50 50	2500	34	63	269953	43 [illegible]

Oil-Insulated Type

Primary Volts at 100 Volts Secondary	25 Cycles: Maximum Continuous Primary Voltage	25 Cycles: Approx. Wt.* Lb. Net	25 Cycles: Approx. Wt.* Lb. Boxed	25 Cycles: Gal. Oil	25 Cycles: Style No.	25 Cycles: List Price	60 Cycles: Maximum Continuous Primary Voltage	60 Cycles: Approx. Wt.* Lb. Net	60 Cycles: Approx. Wt.* Lb. Boxed	60 Cycles: Gal. Oil	60 Cycles: Style No.	60 Cycles: List Price
Indoor												
200	240	52	77	1	10353	$ 70 00	240	52	77	1	10354	$ 60 00
400	480	54	80	1	10281	70 00	480	52	77	1	10355	60 00
500	600	54	80	1	10344	70 00	600	52	77	1	10356	60 00
600	700	54	80	1	10345	75 00	720	52	77	1	10368	65 00
1000	1180	62	88	1½	9994	85 00	1200	52	77	1	9992	75 00
2000	2360	80	110	1½	9995	90 00	2500	52	77	1	9993	80 00
3000	3600	83	115	1½	10334	100 00	3600	57	85	1	10335	90 00
4000	4800	100	130	4	10449	125 00	4800	85	120	4	10450	100 00
5000	5800	115	145	4	10451	150 00	6000	90	125	4	10452	115 00
6000	7200	130	150	4	10453	165 00	7200	95	130	4	10454	125 00
10000	12000	170	210	6	10441	200 00	12000	150	190	6	10358	140 00
12000	14000	205	250	6	97604	225 00	14400	175	215	6	97605	150 00
15000	17500	260	320	11½	10359	375 00	18000	210	270	10	10349	280 00
20000	24500	485	665	20	271671	550 00	24500	450	640	19	271667	450 00
30000	35000	750	1000	36	271672	650 00	35000	460	650	23	271668	550 00
40000	47000	900	1150	42	271673	850 00	47000	750	1000	42	271669	750 00
60000	70000	1500	1675	85	271674	1150 00	70000	1100	1470	85	271670	1050 00
Outdoor												
20000	24500	535	715	20	271679	750 00	24500	500	690	19	271675	650 00
30000	35000	700	950	36	271680	850 00	35000	510	700	23	271676	750 00
40000	47000	975	1225	42	271681	1050 00	47000	825	1075	42	271677	950 00
60000	70000	1400	1770	85	271682	1350 00	70000	1200	1570	85	271678	1250 00

*Weights given do not include oil. Weight of oil per gallon is approximately 7 pounds net and 9 pounds gross.
‡For 500-volt-ampere dry-type voltage transformers see "Accessories" for "Generator Voltage Regulators."

Order by Style Number

VOLTAGE TRANSFORMERS—Continued

OUTLINE DIMENSIONS

Switchboard† Dry-Type

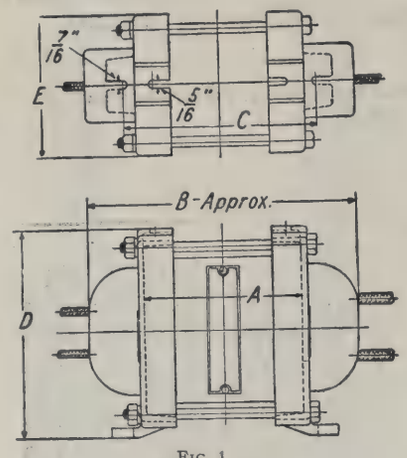


FIG. 1

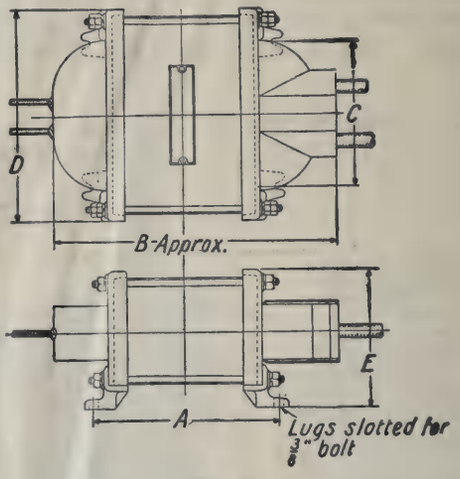
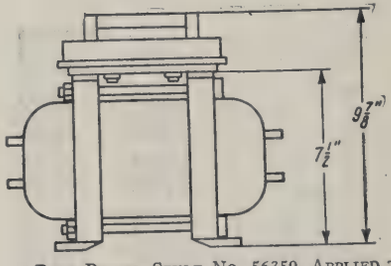
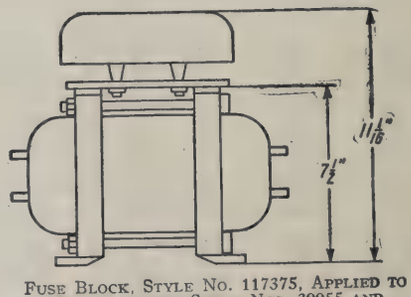


FIG. 2

Primary Voltage	25 CYCLES								60 CYCLES							
	Fig.	Dimensions—Inches					Weight		Fig.	Dimensions—Inches					Weight	
		A	B	C	D	E	Net	Boxed		A	B	C	D	E	Net	Boxed
200	1	4	8	5 7/16	7 1/2	5 1/16	28	53	1	4	7 1/4	5 7/16	7	4 1/8	22	42
400	1	4 1/2	8 1/2	5 7/16	7 1/2	5 1/16	30	55	1	4	7 1/4	5 7/16	7	4 1/8	22	42
500	1	4 1/2	8 1/2	5 7/16	7 1/2	5 1/16	30	55	1	4 1/2	7 3/4	5 7/16	7	4 1/8	25	45
600	1	6	10	7 7/16	7 1/2	5 1/16	37	62	1	4	8	5 7/16	7 1/2	5 1/16	28	53
1000	1	6	10	7 7/16	7 1/2	5 1/16	37	62	1	4	8	5 7/16	7 1/2	5 1/16	28	53
2000	1	6 1/2	10 1/2	7 7/16	7 1/2	5 1/16	39	64	1	4	8	5 7/16	7 1/2	5 1/16	33	58
3000	2	6 3/8	11 3/8	6 1/2	9 11/16	6 3/16	60	85	1	5	9	6 7/16	7 1/2	5 1/16	50	75
4000	2	7 3/8	12 3/8	6 1/2	9 11/16	6 3/16	63	93	2	5 3/8	10 3/8	6 1/2	9 11/16	6 3/16	55	80
5000	2	7 3/8	12 3/8	6 1/2	9 11/16	6 3/16	70	100	2	5 7/8	10 7/8	6 1/2	9 11/16	6 3/16	60	85
6000	2	7 7/8	12 7/8	6 1/2	9 11/16	6 3/16	85	115	2	6 3/8	11 3/8	6 1/2	9 11/16	6 3/16		



FUSE BLOCK, STYLE NO. 56359. APPLIED TO TRANSFORMERS, STYLE NOS. 10352, 10333, AND 30902, BY STRAP, STYLE NO. 229104



FUSE BLOCK, STYLE NO. 117375, APPLIED TO TRANSFORMERS STYLE NOS. 30055 AND 30056, BY STRAP, STYLE NO. 168041

†Dimensions of semi-portable dry-type are the same except for the handle and terminal blocks. These dimensions are for reference only. For official dimensions apply to the nearest district office.

VOLTAGE TRANSFORMERS—Continued

OUTLINE DIMENSIONS

Oil-Insulated Type

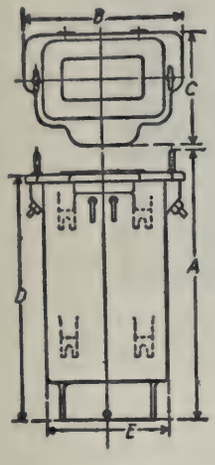


FIG. 1

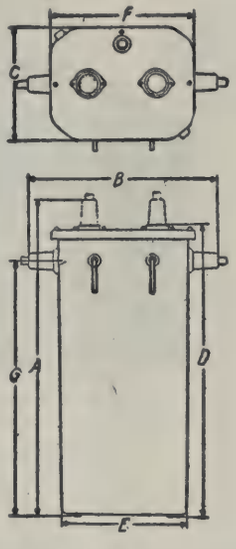


FIG. 2

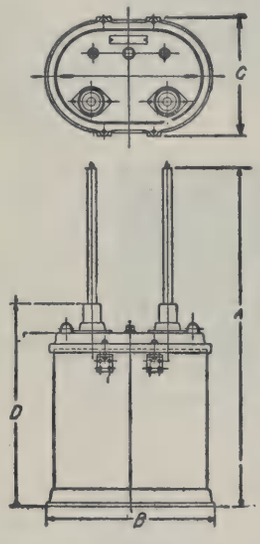


FIG. 3

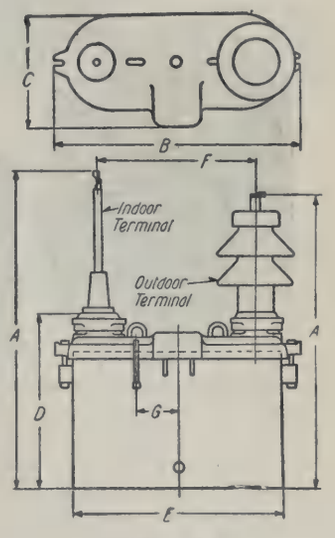


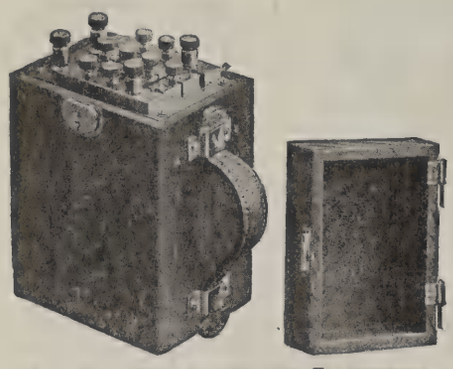
FIG. 4*

Primary Voltage	DIMENSIONS—INCHES																
	25 CYCLES									60 CYCLES							
	Fig.	A		B	C	D	E	F	G	Fig.	A		B	C	D	E	F	G
		Indoor	Outdoor								Indoor	Outdoor						
200 400 500 600	1	14 3/4	....	12	8 3/8	12 3/4	7 1/2	....	....	1	14 3/4	....	12	8 3/8	12 3/4	7 1/2	....	....
1000 2000 3000	1	16 7/8	....	12	8 3/8	15	7 1/2	....	....	1	14 3/4	....	12	8 3/8	12 3/4	7 1/2	....	....
4000 5000 6000	2	24 5/8	....	17 3/4	10 5/8	22 5/8	11 5/8	13 5/8	19 3/8	2	24 5/8	....	17 3/4	10 5/8	22 5/8	11 5/8	13 5/8	19 3/8
10000 12000	2	30 1/8	....	17 3/4	10 7/8	28 1/8	11 7/8	13 3/4	24 1/4	2	30 1/8	....	17 3/4	10 7/8	28 1/8	11 7/8	13 3/4	24 1/8
15000	3	62 1/2	....	19 7/8	14 5/16	26 1/2	....	....	....	3	46 3/8	....	19 7/8	14 5/16	24 3/8	....	....	....
20000	4	46 3/8	45 1/2	35 1/8	15 7/8	24 3/4	30 1/8	22 3/4	6	4	44 1/4	43 1/2	35 1/8	15 7/8	24 1/2	30 1/8	22 3/4	6
30000	4	52 1/2	53	41 1/2	18 1/8	30 1/8	36 3/8	28	9 1/2	4	51 1/2	52 1/2	35 1/8	15 7/8	29 3/8	30 1/8	22 3/4	6
40000	4	64 1/4	61 1/4	41 1/2	18 1/8	34 1/8	36 3/8	28	9 1/2	4	62 1/2	60	41 1/2	18 1/2	32 1/8	36 3/8	28	9 1/2
60000	4	75	76	53 1/2	22 1/2	40 3/4	48 1/2	36	12	4	75	76	53 1/2	22 1/2	40 3/4	48 1/2	36	12

*Number of rain shields on outdoor terminal and structural details of indoor terminal vary with the voltage.

These dimensions are for reference only. For official dimensions. apply to the nearest district office.

PORTABLE CURRENT TRANSFORMERS



PLUG-TYPE PORTABLE CURRENT TRANSFORMER

THROUGH-TYPE PORTABLE CURRENT TRANSFORMER, STYLE NO. 37281

Accuracy—Portable current transformers are generally used for emergency tests in the field and are therefore made smaller in size and lighter in weight than the switchboard instrument transformers in order to facilitate their portability. It is therefore necessary to work the material in these at a somewhat higher density than in the case of switchboard transformers so that the error in ratio, will be somewhat greater than for switchboard-type transformers.

Capacity—These current transformers are rated at a current which gives 5 amperes secondary. Since 5 amperes represents the full scale rating of most instruments, the transformers are usually applied to a circuit whose full-load rating is about 65 per cent of the rating of the transformer. They therefore should not be used for continuous operation on a load greater than 65 per cent of their rated primary current, and for not more than two hours at full primary capacity, but can be used for short periods on loads of 150 per cent rated primary current.

Secondary Capacity — All the portable current transformers listed are compensated for 10 volt-amperes load at five amperes secondary. Except where noted to the contrary, they are for use on either 25 or 60-cycle circuits

Plug-Type

Construction—The coils of the primary can be connected either in series, in series-parallel, or in parallel, by means of connecting plugs to obtain a suitable ratio.

These transformers are contained in a neat wooden case with a cover and handle for carrying.

Insulation—The plug-type transformers are insulated for use on 2500-volt circuits.

Accuracy—The ratio accuracy of the plug-type transformers is guaranteed to be within one per cent at the full-current rating with each ratio setting when used with a load of 10 volt-amperes on the secondary.

Through-Type

Construction—The through-type transformer is constructed so that the conductor of the circuit to be measured forms the primary winding. The conductor is passed through the hole in the case once for the highest rating, twice for the middle rating, and four times for the low rating. It is mounted in a wooden case with handle for carrying.

Insulation—Style No. 29796 is insulated for 2500-volt circuits and Style No. 37281 for 500 volts. It is assumed that for higher voltages they will be used over cable having sufficient insulation for protection of operator and instrument.

Accuracy—The ratio accuracy of the through-type transformers is guaranteed to be within one per cent at the full current rating with each ratio setting when used with a load of 10 volt-amperes on the secondary.

Split-Type

Application—These transformers are used for making measurements of current in circuits that it would be inconvenient or impossible to open, in stations or on large systems. Except Style No.

SPLIT-TYPE TRANSFORMER
Style No. 117508, for use with type PR ammeter

PORTABLE CURRENT TRANSFORMERS—Continued

CLOSED OPEN

SPLIT-TYPE PORTABLE CURRENT TRANSFORMER

117508 they may be used without special calibration with any standard ammeters having 5-ampere coils-

Construction—The iron core of the split-type transformer is built in the shape of a rectangle with an opening through its center, the opening varying in size according to the capacity of the transformer. One side of the core is detachable so that the other part of the core can be slipped over the conductor and the detached side then clamped tightly in place.

Each transformer is suitable for only one primary current, but can be used for one-half or one-quarter normal current by passing the conductor two or four times through the opening. It is mounted in a metal case with metal handle cast on case.

Insulation—The split-type current transformers are insulated for use on 6600-volt circuits, it being assumed that for higher voltages they will be used over cable having sufficient insulation for the protection of the operator and instrument.

Accuracy—The ratio accuracy of the split-type transformer is guaranteed to be within two per cent at the full current rating when used with a load of 10 volt-amperes on the secondary.

In a split-type transformer the phase displacement is high, due to the fact that the magnetic circuit is broken by two small air gaps. It is also a variable quantity as the contact will vary every time the transformer is opened and closed. The effect of phase displacement is to make a watthour meter or wattmeter read high, especially at low line power factor. This error varies roughly from ½ to 1½ per cent at 90 per cent line power factor to 3 to 8 per cent at 50 per cent line power factor. For this reason the split-type current transformer is not suitable for use with wattmeters or watthour meters.

Type PR Portable Testing Outfit—A testing outfit consisting of split-type transformers, Style No. 117508, type PR ammeter, and leads is described on the pages on type PR ammeters.

Style number and price include transformer complete as described.

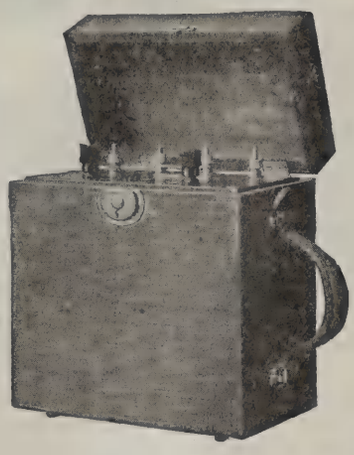
Primary Amperes at 5 Amp. Secondary	Dimensions—Inches: Approx. Overall	Opening for Primary Conductor	Approximate Wt.—Lbs.: Net	Shipping	Style No.	List Price
Plug-Type						
10, 20 or 40	6¼ x 9 x4¼	.....	15	35	29795	$65 00
25, 50 or 100	6 x 8¾x4¼	.....	15	35	35591	65 00
Through-Type						
100, 200 or 400	7 x 7 x4½	2 (dia.)	15	35	29796	50 00
400, 800 or 1600	8½x 7⅝x5	2 x4	20	40	37281	55 00
Split-Type						
600	11½x10x7⅜	1⅞x3¼	35	50	108143	60 00
800					108144	62 00
1000					108145	64 00
1200					108146	66 00
1200	12¾x10½x7	2½x3⅜	40	65	108147	66 00
1600					108148	68 00
2000					108149	72 00
2000	11x12⅞x6⅞	3½x3⅛	45	70	108150	72 00
2400					108151	76 00
3000					108152	80 00

Split-Type For Testing Set

Frequency Cycles	Full Scale Capacity Amperes	Description	Opening in Transformer for Conductor Inches	Approximate Wt.—Lbs.: Net	Shipping	Style No.	List Price
60	125 or 250	Transformer only	1¾x1⅞	19½	35	117508	$65 00

Order by Style Number

PORTABLE VOLTAGE TRANSFORMERS



Construction—These voltage transformers are of the improved core type mounted in wood cases with a leather handle. They have insulated binding posts for the secondary connections and uninsulated binding posts for the primary. The primary binding posts are left uninsulated because it is impossible to insulate them sufficiently for perfect safety under all conditions, and a partly insulated terminal is considered to be more dangerous than a bare one.

Insulation—For 660 and 2200-volt transformers the primary winding will stand a test of 10,000 volts. For 440-volt transformers the primary winding will stand a test of 5000 volts. The secondary winding in all cases is tested at 2000 volts.

Accuracy—The ratio accuracy of these transformers is guaranteed to be within ½ per cent of the full voltage rating when used with a load of 15 volt-amperes on the secondary. They will carry a load of 100 volt-amperes continuously.

Secondary Capacity—All portable voltage transformers listed are compensated for 15 volt-amperes at 110 volts secondary. Without appreciable change in accuracy, the 25-cycle transformers may be used on 60 cycle and the 60-cycle transformers on 133 cycles.

Style number and price include transformer complete as described.

Primary Volts at 110 Volts Secondary	Approx. Overall Dimensions Inches	Approx. Wt., Lbs. Net	Approx. Wt., Lbs. Shipping	Style No.	List Price
For 25-Cycle Circuits					
440– 220 660– 330 2200–1100	10x5¾x10⅛	27	48	215976 215975 190797	$82 00 66 00 80 00
For 60-Cycle Circuits					
440– 220 660– 330 2200–1100	9 1/16x5 1/16x 8¾	18½	33	215978 215977 190798	64 00 66 00 65 00

Order by Style Number

WESTINGHOUSE DISTRIBUTION TRANSFORMERS

POLE, PLATFORM, OR MANHOLE MOUNTING

SINGLE OR THREE-PHASE

Distribution transformers range in capacity from 1 to 200 kilovoltamperes and are listed for voltages from 460 to 34,500 volts, both 25 and 60 cycles. As no one form of construction is best adapted for this wide range of capacity and voltage, Westinghouse distribution transformers are made in four different forms of construction; the particular construction used is determined by consideration from all standpoints as to which design is best suited for the particular voltage, capacity, and frequency.

Form of Construction	General Application
Distributed-Shell	Single-Phase Transformers for 460, 575 and 2300-Volt distribution service.
Rectangular-Core	Single-Phase Transformers for distribution service from 4600 to 23,000 volts. Three-Phase Transformers for distribution service from 460 to 23,000 volts.
Cruciform-Core	Single and Three-Phase Transformers for 34,500 volts distribution service.
Simple-Shell	Large capacity 25-cycle transformers for distribution service from 2300 to 13800 volts.

Distribution transformers are required for pole, platform, or manhole mounting, single or three-phase, and to distinguish not only the form of construction but also the class of service, Westinghouse distribution transformers are listed under eleven different types, as follows:

Fig. 1—Group of Steel-Clad Type S Transformers

Type	Class of Service	Form of Contruction
S	Single-Phase, Pole or Platform-Mounting	Distributed-Shell
SA	Single-Phase, Pole or Platform-Mounting	Distributed-Shell
SM	Single-Phase, Manhole-Mounting	Distributed-Shell
SK	Single-Phase, Pole or Platform-Mounting	Rectangular-Core
SKA	Single-Phase, Pole or Platform-Mounting	Rectangular-Core
SKM	Single-Phase, Manhole-Mounting	Rectangular-Core
ST	Three-Phase, Pole or Platform-Mounting	Rectangular-Core
STM	Three-Phase, Manhole-Mounting	Rectangular-Core
SC	Single-Phase, Platform-Mounting	Cruciform-Core
SCT	Three-Phase, Platform-Mounting	Cruciform-Core
SS	Single-Phase, Platform-Mounting	Simple-Shell

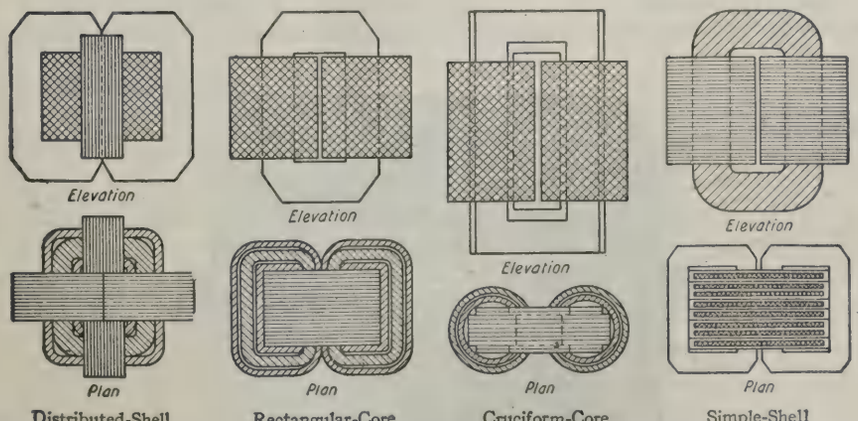


Fig. 2—Diagrams of Arrangements of Coils and Magnetic Circuits of Westinghouse Distribution Transformers
(In these diagrams, the coils are indicated by oblique or crossed oblique lines; and the iron by horizontal or vertical lines or by unshaded portions.)

CONSTRUCTION

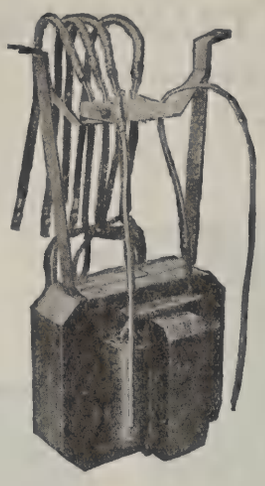


FIG. 3—COILS AND IRON OF DISTRIBUTED-SHELL STEEL-CLAD TYPE S TRANSFORMER

Weather proof Sheet-Steel cover with over-lapping sides to prevent entrance of moisture.
Sherardized wing bolt fastens cover firmly to tank.
High-Voltage Bushing babbitted in re-entrant corner of tank, thus protected from mechanical injury.
Weather-proof Sheet-Steel tank having minimum weight with maximum strength.
High-Voltage Lead of weather proof braid covered treated cloth cable.
Hole for lag screws.

FIG. 4—STEEL-CLAD TYPE S TRANSFORMER (Showing Two-Piece Hanger Irons Bolted On, Ready for Hoisting to Crossarm)

DISTRIBUTED-SHELL TYPES S, SA AND SM

General—The distributed-shell form of construction consists of concentric rectangular coils with a four-part magnetic circuit.

The laminations are clamped top and bottom with steel end-frames, which are held together by locking irons and which remove all strain from the coils. The transformer is centered by a projection in the bottom of the tank and is locked in position by means of wrought iron braces welded to the upper end-frame and bolted to the sides at the top of the tank. In this way positive insurance is provided that the transformer will be held securely in position in the case during shipment. The tanks and covers are of sheet-steel pressed to shape and welded by the oxy-acetylene process, this construction combining maximum strength with minimum weight. An exception is made in the case of the 1, 2, and 3 kv-a., 60 cycle and 1 and 2 kv-a. 25-cycle transformers which have machine-moulded cast-iron tanks, for the reason that there is a very small saving in weight to be achieved by making the cases of these small capacities of sheet-steel instead of cast-iron. The sheet-steel tanks are rendered thoroughly weatherproof by the application of a coat of special paint to the tank surfaces which have previously been sand-blasted to remove all scale and dirt and to form a roughened surface for the adhesion of the weatherproof coating. The coating of paint is given a heat treatment in an oven specially designed for this purpose. This is continued for several hours until the coating is thoroughly dry and hard and has in fact become integral with the roughened tank surface. A finishing coat of a heavy oil paint is next applied and baked on, giving the case a smooth and pleasing finish which is impervious to the action of the weather.

The distributed-shell type of construction, (rectangular coils with two large and two small magnetic circuits—see Figure 2), has a relatively small mean turn of iron and copper, which results, at the voltage and capacity for which it is used, in a

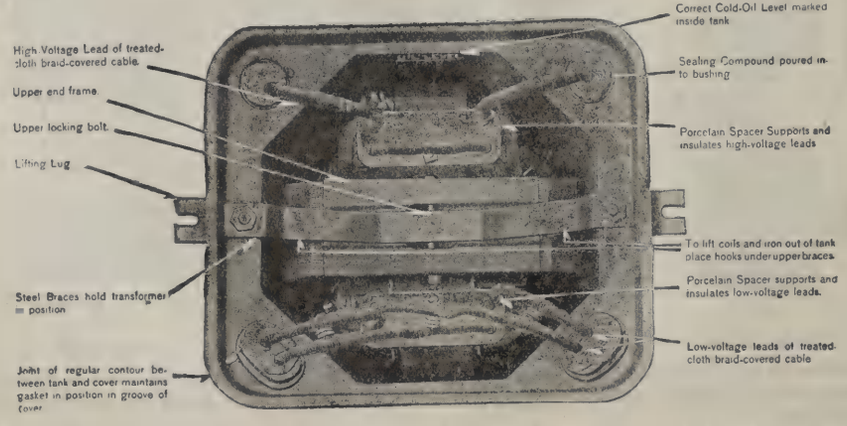

High Voltage Lead of treated-cloth braid-covered cable.
Upper end frame.
Upper locking bolt.
Lifting Lug
Steel Braces hold transformer in position
Joint of regular contour between tank and cover maintains gasket in position in groove of cover
Correct Cold-Oil Level marked inside tank
Sealing Compound poured into bushing
Porcelain Spacer Supports and insulates high-voltage leads
To lift coils and iron out of tank place hooks under upper braces
Porcelain Spacer supports and insulates low-voltage leads.
Low-voltage leads of treated-cloth braid-covered cable

FIG. 5—TOP VIEW (COVER REMOVED) OF SMALL-CAPACITY STEEL-CLAD TYPE S TRANSFORMER (All Parts Accessible for Inspection)

DISTRIBUTED-SHELL CONSTRUCTION—Continued

well-balanced electrical performance (high efficiency, good regulation and low exciting current) for a given weight of material.

Insulation—An exclusive feature of Westinghouse distribution transformers is the use of machine-moulded mica-micarta barriers between windings. The barriers are continuous and uniform in mechanical and electrical strength, and contain several layers of built-up sheet mica. The dielectric strength of these barriers is shown by the fact that the tubes used for 2300-volt transformers have an ultimate breakdown strength when tested under oil of around 70,000 volts although they are only approximately $\frac{3}{32}$ inch in thickness. Channel pieces of mica on the smaller sizes and micarta or fullerboard collars of insulation on the larger sizes are placed along the ends of the high voltage coils. This insulation provides protection from abnormal voltage stresses between the coils and the magnetic circuit caused by high-frequency line-surges.

Standard Steel-Clad Type S Transformers are not supplied with terminal blocks, but instead porcelain spacers, mounted on the wrought-iron straps or on the end-frames are provided to insulate and support the leads between the coils and the porcelain bushings. Wherever it is necessary to furnish a terminal block, such as in the case of a transformer with high-voltage taps, the terminal block is submerged below the level of the oil to prevent flash-overs, due to lightning surges, from the terminal studs to the case. The bushings used with the steel-clad Type S Transformers are larger than have previously been furnished, providing a longer flash-over distance. This feature is particularly desirable on account of the increasing use of the 2300–4000-volt, 3-phase, 4-wire system with resultant greater strain from this service on the 2300-volt transformer bushings.

FIG. 6—MACHINE-MOULDED MICA-MICARTA BARRIERS

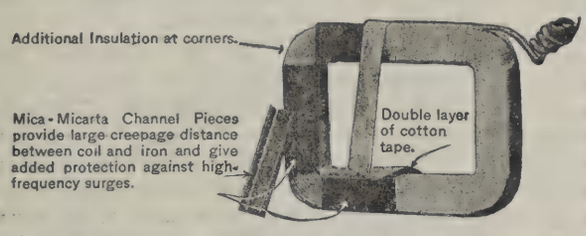

Additional Insulation at corners.
Mica-Micarta Channel Pieces provide large creepage distance between coil and iron and give added protection against high-frequency surges.
Double layer of cotton tape.

FIG. 7—MACHINE-WOUND HIGH-VOLTAGE COIL OF DISTRIBUTED-SHELL (TYPE S) TRANSFORMERS
(Partially Complete, Showing Micarta Channel Pieces)

Coil Construction—All coils are wound separately on moulds or micarta tubes. This permits careful inspection and testing at all stages of manufacture. The high-voltage coils are sub-divided into a number of sections to reduce the voltage stress between layers. In certain sizes, from 5 to 15 kv-a. inclusive, special machine-wound high-voltage coils of round wire are used. These are so wound that each wire lies in a gutter formed by two other wires of the preceding layer. This construction makes a very strong coil mechanically, prevents crawling of the wires and gives an excellent space factor. The low voltage coils are of round wire or copper strap, wound directly on micarta barriers.

Magnetic Circuit—The four-part magnetic circuit is built up with L-shaped punchings of non-aging silicon steel. This steel is manufactured under rigid Westinghouse specifications but the steel from different heats is necessarily subject to slight variations in quality. To insure uniform magnetic characteristics the sheets are graded after annealing and the highest grade only is selected for use in the manufacture of Westinghouse distribution transformers. The effect of punching out the sheets is to increase the hysteresis loss and this effect is removed by re-annealing the punchings.

It is a well-known fact that much vigilance is necessary to insure uniformity of iron loss and exciting current. In Westinghouse distribution transformers the special arrangement of the magnetic circuit, which has a minimum mean length of turn, combines with careful selection of the steel, double annealing, enamelling and weighing, to produce a uniformly low iron loss. A small exciting current

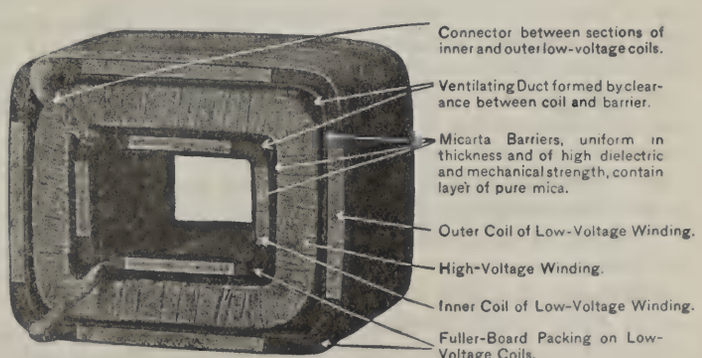

Connector between sections of inner and outer low-voltage coils.
Ventilating Duct formed by clearance between coil and barrier.
Micarta Barriers, uniform in thickness and of high dielectric and mechanical strength, contain layer of pure mica.
Outer Coil of Low-Voltage Winding.
High-Voltage Winding.
Inner Coil of Low-Voltage Winding.
Fuller-Board Packing on Low-Voltage Coils.

FIG. 8—COIL GROUP OF SMALL DISTRIBUTED-SHELL (TYPE S) TRANSFORMER
(All Coils Wound Separately on Moulds or on Micarta Barriers)

DISTRIBUTED-SHELL CONSTRUCTION—Continued

is secured by working the iron at low inductions, by care in building and by the use of "L" shaped punchings, so assembled that the reluctance of the magnetic circuit differs only slightly from that of a circuit without joints.

Assembly—The high and low-voltage windings are first assembled with micarta insulating barriers and then an exact weight of "L" shaped punchings is built-up around the coils, piece by piece, the coils being protected against abrasion by fullerboard saddles. This method prevents mechanical injury to the windings and provides additional insulation between the coils and the iron. The top and bottom end-frames are next clamped on to the magnetic circuit by bolts which pass through locking irons which fasten the upper and lower end frames together. The complete transformer is then subjected to an impregnation treatment.

Impregnation—Type S Transformers are impregnated with the coils and iron assembled complete. The assembled units are first placed in an oven through which a current of heated air is circulated. After this preliminary drying-out process the transformers are lowered into a steam-heated tank. The cover of this tank is bolted on and a vacuum is then established in the tank by means of a pump that removes all air and all remaining moisture, which evaporates readily at the low pressure. The impregnating compound, which consists chiefly of a mixture of resinous gums and which has been pre-heated in an adjoining tank, is then drawn into the vacuum tank until it completely covers the transformers. The air and moisture having previously been removed, the compound is drawn by capillary attraction into all the interstices of the winding, but to insure the most thorough coil penetration, a gas pressure of over 80 pounds per square inch is applied to force the compound into the winding. After a period of several hours the remainder of the compound is withdrawn from the vacuum tank and the transformers are lifted out and placed in a vertical position to cool.

The treatment has the following advantages:

(1) The insulation strength of the windings is greatly improved, the function of the cotton covering of the wires and other fibrous insulations being simply to absorb the insulating compound.

(2) The heat conductivity of the windings is increased which eliminates hot spots and produces a more uniform temperature rise.

(3) After impregnation the windings will not readily absorb moisture.

(4) The mechanical strength of the windings is increased.

Mechanical Details—Type S Transformers present a neat and well-finished appearance. The mechanical details have been designed to secure the utmost convenience for inspection, storage and installation. The case is light but strong, which facilitates handling. Simple two-piece hanger irons and lugs on the sides of the tanks are provided for lifting and mounting the transformers. Sherardized wing-bolts and nuts fasten the cover to the tank and are so arranged that the cover can be removed without unscrewing the nuts from the wing bolts. The bushings are babbitted into the re-entrant corners or the overhanging sides of the tank, and are thus protected against mechanical injury. Pressed-tube copper connectors are furnished on the low-voltage leads. The quantity of oil is stencilled on the nameplate and the cold-oil level is marked inside the case. The connection diagram is fastened inside the cover and the per cent impedance is given on the nameplate so that the possibility of group or parallel operation with other transformers can be readily determined. Oil siphoning is prevented by placing a solid joint in each lead above the oil level. A felt gasket protected by an over-hanging cover prevents the entrance of moisture and the smooth contour of the joint between the cover and tank which has curves of large radius prevents the displacement of the gasket when the cover is removed.

Application—Types S and SA transformers are both arranged for pole or platform mounting and have their general field of application in 2300-volt distribution service. The difference between the two types is that type SA transformers have a lower efficiency, smaller size of parts, and consequently lower price than type S transformers of the same rating. It should be understood that the type SA transformer differs in operating characteristics from the type S only on the question of electrical performance, and that in quality of material, grade of workmanship and insulation strength the type SA transformer is in every respect the equal of the type S. Type SA transformers find their correct application on circuits which have a high load factor and they can also be used to advantage where the cost of generating power is relatively small, such as in the case of a water power plant. For such service the saving in initial investment will usually more than counterbalance the losses resulting from the lower efficiency.

Type SM transformers are type S transformers arranged for manhole service.

Manhole transformers operate in vaults and therefore are provided with water-proof tanks. The smallest sizes of type SM transformers are mounted in cast-iron tanks and the larger sizes in corrugated sheet-iron tanks with top flange and base cast on. The joint between the cover and the tank is made perfectly water-tight and air-tight by a special gasket. Sherardized bolts and nuts that are rust-resisting are used to clamp the cover to the tank. Rusting of the tanks is effectually prevented, as the cast-iron tanks are coated with a weatherproof finish

DISTRIBUTED-SHELL CONSTRUCTION—Continued

FIG. 9—TYPE SM MANHOLE TRANSFORMER IN MACHINE MOULDED CAST-IRON TANK

and the sheet-iron tanks are first coated with a special grade of weatherproof paint and then are finished with a coating of heavy oil paint.

Since these transformers are made perfectly air-tight, internal pressures are developed due to the expansion of the air and oil caused by the increase in temperature on load. An air chamber between the oil level and the cover forms a cushion for this expansion.

The leads from the low-voltage winding are connected to a terminal block inside the tank and the different low-voltage connections are made on this block. The leads from the high-voltage winding are connected to a terminal block below the oil level.

To connect the transformer to the line, the cover is first removed; the lead-covered cables are drawn through the outlet bushings; and connectors, which have been soldered to the ends of the cable, are attached to the studs on the terminal blocks.

The outlet bushings for these transformers are standard pipe unions. One-half of the union is welded to a short brass pipe which in turn is screwed into the top casting of the transformer. The other half of the union is welded to a short piece of brass pipe which forms a nipple to which, on installation, the lead covering of the cable is attached by a plumber's wiped joint.

FIG. 10—TYPE SM MANHOLE TRANSFORMER IN TANK OF CORRUGATED SHEET-IRON SIDES WITH BASE AND TOP-FLANGE CAST ON

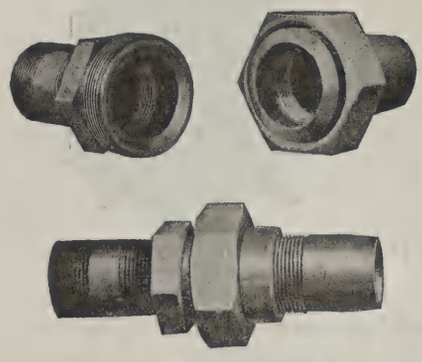


FIG. 11—UNION-TYPE BUSHING USED ON MANHOLE TRANSFORMERS

To disconnect the transformer from the line, the line leads are disconnected from the terminal blocks, the pipe unions are disconnected, and the lead cables withdrawn.

RECTANGULAR-CORE—TYPES SK, SKA, SKM, ST AND STM

General—The rectangular-core form of construction has a core of rectangular cross-section, with rectangular sets of concentric coils. The punchings are clamped top and bottom with cast iron end-frames which remove all strain from the coils. The top and bottom end-frames are held together by locking irons. In the smaller sizes, the complete transformer is held in position by iron wedges which slide in tapered lugs and which are pressed against the upper end-frames by bolts and nuts. Lock washers prevent the nuts from loosening in shipment. In the larger sizes, wrought iron supports bolt the upper end-frame to the top flange of the tank and thus hold the transformer securely in the tank. The tanks are of cast iron in the smaller sizes; the larger sizes have corrugated sheet iron walls welded by the oxy-acetylene process with base and top-flange cast-on.

The combination of rectangular coils with a core of rectangular cross-section composed of L-shaped

RECTANGULAR-CORE CONSTRUCTION—Continued

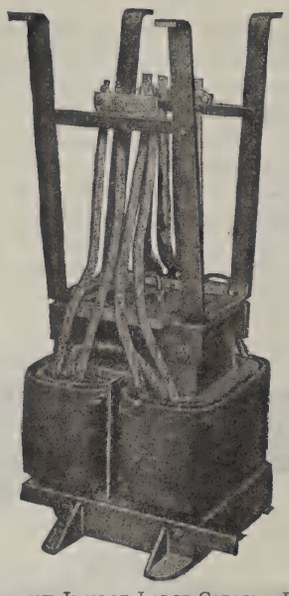


FIG. 12—COILS AND IRON OF LARGE-CAPACITY RECTANGULAR-CORE (TYPE SK) TRANSFORMERS

punchings gives better results for the higher voltage classes than the shell type of construction. This form of construction, in its own field of service, gives the highest electrical performance for a given weight of material.

Insulation—Bakelized micarta tubes are used between windings. The end turns of the high-voltage windings are strongly reinforced against high-frequency surges and built up insulation at the ends of the coils provides additional creepage distance between the coils and the iron circuit.

Coil Construction—The coils are wound separately on moulds or micarta tubes. This permits careful inspection and test at all stages of manufacture. The high-voltage coils are divided into a number of sections to reduce the voltage stress between layers.

Magnetic Circuit—The magnetic circuit is built up of L-shaped punchings of non-aging silicon steel, graded and selected in the same manner as described for the distributed-shell-type design. This insures a low iron loss while the low induction and the use of L-shaped punchings results in a uniformly low exciting current.

Assembly—The coils are first assembled complete and then an exact weight of L-punchings is built up, piece by piece, thus insuring uniformity of the iron loss and exciting current.

Impregnation—All coils are impregnated by the vacuum process as described for "Distributed-Shell Transformers."

Mechanical Details—In general the advantages cited previously for the distributed-shell transformers apply equally to the rectangular-core trans-

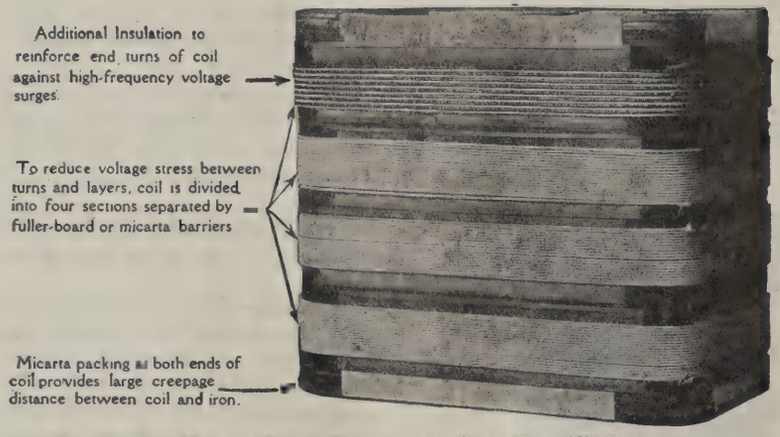

Additional Insulation to reinforce end turns of coil against high-frequency voltage surges.
To reduce voltage stress between turns and layers, coil is divided into four sections separated by fuller-board or micarta barriers
Micarta packing at both ends of coil provides large creepage distance between coil and iron.

FIG. 13—HIGH-VOLTAGE COIL OF RECTANGULAR-CORE (TYPE SK) TRANSFORMER
Showing Reinforced Winding

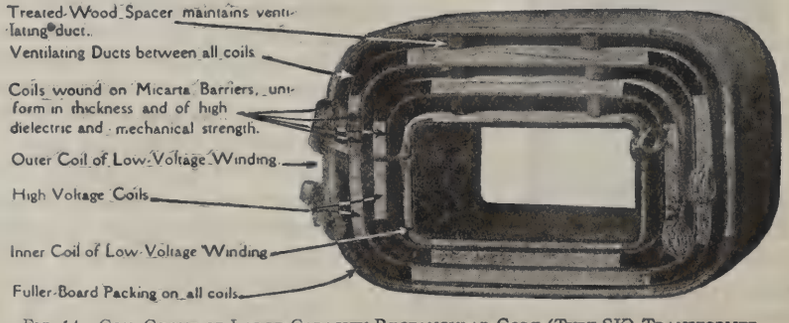

Treated-Wood Spacer maintains ventilating duct.
Ventilating Ducts between all coils
Coils wound on Micarta Barriers, uniform in thickness and of high dielectric and mechanical strength.
Outer Coil of Low-Voltage Winding
High Voltage Coils
Inner Coil of Low-Voltage Winding
Fuller-Board Packing on all coils

FIG. 14—COIL GROUP OF LARGE-CAPACITY RECTANGULAR-CORE (TYPE SK) TRANSFORMER

RECTANGULAR-CORE CONSTRUCTION—Continued

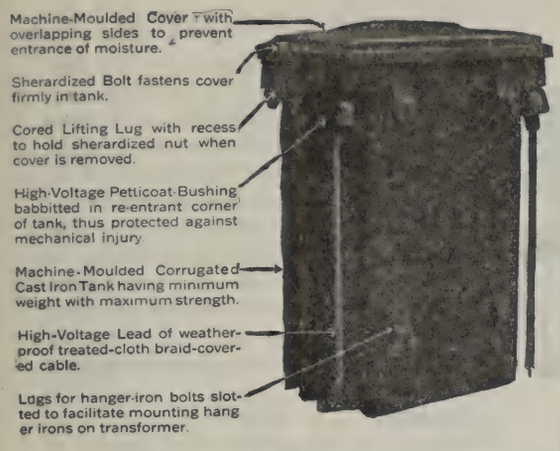

Machine-Moulded Cover with overlapping sides to prevent entrance of moisture.
Sherardized Bolt fastens cover firmly in tank.
Cored Lifting Lug with recess to hold sherardized nut when cover is removed.
High-Voltage Petticoat-Bushing babbitted in re-entrant corner of tank, thus protected against mechanical injury.
Machine-Moulded Corrugated Cast Iron Tank having minimum weight with maximum strength.
High-Voltage Lead of weather-proof treated-cloth braid-covered cable.
Lugs for hanger-iron bolts slotted to facilitate mounting hanger irons on transformer.

FIG. 15—13,800-VOLT TYPE SK TRANSFORMER IN CAST-IRON TANK

formers with the exception that machine-moulded cast-iron tanks are used instead of welded steel tanks. The high-voltage bushings of the 22,000-volt transformers are cemented into a cast iron bushing which is screwed into the case. These bushings are packed and shipped separately to protect them against breakage.

Application—The type SK transformer is designed for single-phase service, pole or platform mounting. The most general field of application is for distribution voltages from 4600 up to 23,000.

The type SKA transformer has a lower efficiency, smaller size of parts and consequently lower price than a type SK transformer of the same rating. In other respects however, it is equal to the type SK transformer. The conditions under which the type SKA transformer can advantageously be used instead of the type SK are the same as cited previously for the type SA transformer.

The type SKM transformer is the type SK transformer arranged for manhole service and therefore is provided with a special water-proof tank and bushings. The details of the tank and bushing construction are, in general, the same as described under "Type SM Transformers."

The type ST transformer is similar in general construction to the type SK transformer except that, being designed for three-phase service, it has three sets of coils.

The type STM transformer is the type ST transformer adapted for manhole service by special tanks and bushings. The mechanical construction of tanks and bushings is, in general, the same as that previously outlined for type SM transformers.

CRUCIFORM-CORE—TYPES SC AND SCT

General—The cruciform-core form of construction has circular concentric coils assembled with a core of cruciform cross-section. The punchings are clamped top and bottom by angle or channel irons. The tanks are of boiler iron in the smaller sizes and have corrugated sheet-iron walls with cast-on top-flange and base in the larger. The transformers are held in position in the tank by means of wrought iron supports and centering blocks at the bottom of the tank.

Circular coils naturally possess considerable mechanical strength and can be readily insulated. Therefore they are particularly well adapted for transformers of high voltage and small capacity, requiring a relatively small size wire. The cruciform core also provides for a large cross-section of iron within the circular coils, in other words, gives a good space factor. This design, therefore, gives the necessary mechanical and dielectric strength for a high-voltage transformer, together with a satisfactory performance. It is in fact the ideal design for this particular field of service.

Insulation—The insulation between windings consists of unbroken circular barriers. The high-voltage coils are taped and insulated from each other by additional barrier insulation or by oil ducts.

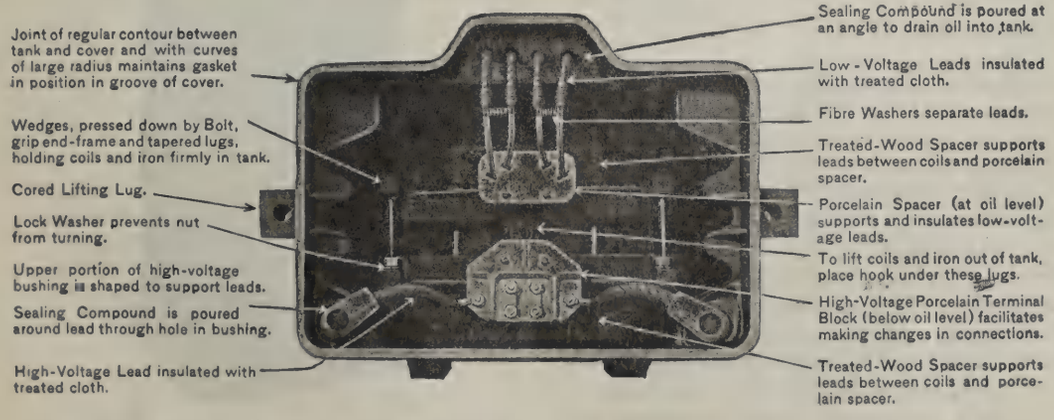

Joint of regular contour between tank and cover and with curves of large radius maintains gasket in position in groove of cover.
Wedges, pressed down by Bolt, grip end-frame and tapered lugs, holding coils and iron firmly in tank.
Cored Lifting Lug.
Lock Washer prevents nut from turning.
Upper portion of high-voltage bushing is shaped to support leads.
Sealing Compound is poured around lead through hole in bushing.
High-Voltage Lead insulated with treated cloth.
Sealing Compound is poured at an angle to drain oil into tank.
Low-Voltage Leads insulated with treated cloth.
Fibre Washers separate leads.
Treated-Wood Spacer supports leads between coils and porcelain spacer.
Porcelain Spacer (at oil level) supports and insulates low-voltage leads.
To lift coils and iron out of tank, place hook under these lugs.
High-Voltage Porcelain Terminal Block (below oil level) facilitates making changes in connections.
Treated-Wood Spacer supports leads between coils and porcelain spacer.

FIG. 16—TOP VIEW (COVER REMOVED) OF 13,800-VOLT TYPE SK TRANSFORMER IN CAST-IRON TANK

CRUCIFORM-CORE CONSTRUCTION—Continued

In Boiler-Iron Tank Coils and Iron

FIG. 17—TYPE SC (CRUCIFORM-CORE) TRANSFORMER

Coil Construction—The high and low-voltage coils are wound separately on moulds or insulating tubes. The high-voltage winding is built up of a number of circular coils. The low-voltage coils are wound with a circular insulating barrier between layers.

Magnetic Circuit—I-plate punchings of different widths to give a cruciform cross-section inside the coils, are assembled and held together by insulated rivets. The punchings are non-aging silicon steel, double annealed to insure uniform magnetic characteristics.

Assembly—The high and low-voltage coils are assembled and placed over the legs of the magnetic circuit, which is completed by placing the yoke punchings in position.

Impregnation—All coils are impregnated by the vacuum process. The process is the same as previously described under "Distributed-Shell Transformers."

Mechanical Details—The smaller transformers are mounted in boiler-iron tanks and are suspended from a cast-iron cover in which the bushings are mounted. This permits the transformer with cover and bushings to be removed intact from the tank. The sheet-iron cast-in tanks used with the larger sizes have a large radiating surface for a given floor space. Lifting lugs are provided on the top-flange.

Application—Type SC transformers are for single-phase service, platform mounting. The general field of service is for the highest distribution voltages in use today, such as 34,500 volts.

Type SCT transformers are for three-phase service platform mounting.

SIMPLE-SHELL—TYPE SS

General—These transformers are constructed with flat pan-cake coils arranged vertically and assembled with a built-up shell of steel punchings. The construction used is the same as for Westinghouse shell-type power transformers of large capacity.

This design is best suited for large units because it insures a uniform ventilation of the coils—especially important where a large amount of heat is to be dissipated—and also because the coils can be most effectively braced against the mechanical shocks of short circuits.

Insulation—The insulation between turns, layers, or coil sections consists of barriers or layers of fullerboard or treated paper. The end turns are reinforced against high-frequency surges and a large creepage distance between coils is provided by extending the barrier insulation between coils or layers.

Coil Construction—The flat pan-cake coils are of copper strap and are wound separately on moulds in either single or double sections. One side of each coil is exposed to the oil, the other being insulated by a fullerboard or paper barrier.

Magnetic Circuit—The magnetic circuit is built up of I-plates of non-aging double-annealed silicon steel.

Assembly—The coils are assembled complete with insulating barriers and then an exact weight

FIG. 18—TYPE SS TRANSFORMER IN TANK OF CORRUGATED SHEET-IRON SIDES WITH BASE AND TOP-FLANGE CAST-ON

1619–38

SIMPLE-SHELL CONSTRUCTION—Continued

of I-plate punchings is built up around the coils. Heavy structural iron end-frames clamp the magnetic circuit and steel plates with tie rods support the ends of the coils, preventing mechanical distortion in case of a short circuit.

Impregnation—All coils are varnished and, after assembly, the complete transformer is dried out and oil impregnated by the vacuum process. The process is similar to that described under "Distributed-Shell Transformers," except that the transformers are impregnated with an oil instead of a resinous compound.

Mechanical Details—The transformers are mounted in sheet-iron cast-in-tanks, centered by wooden centering blocks and held in position by wrought iron supports. Lifting lugs are provided on the upper flange of the tank.

Application—Type SS transformers are for single-phase outdoor service and have their field of application for 25-cycle circuits of relatively large capacity.

FIG. 19—COILS AND IRON OF SIMPLE-SHELL (TYPE SS) TRANSFORMER

AUXILIARY APPARATUS

HANGER IRONS

Those transformers adapted for mounting directly on the cross-arm of poles (see tables of ratings) are supplied with two-piece hanger irons. These are of steel bent to engage standard cross-arms and punched to fit the lugs on the backs of the transformer tanks.

FUSE BLOCKS, FUSE BOXES AND FUSES

Distribution transformers are normally protected on the high-voltage side by fuse blocks or boxes. Four types of these fuse blocks and boxes are listed in section 1-B: plug type, expulsion type, safety-first type and disconnecting-switch type.

Plug Type—The plug-type fuse block consists of a porcelain receptacle and plug. The receptacle is mounted on the pole cross-arm and is provided with suitable terminals for line connection. The fuse is connected between the contacts of the plug, which engage contacts in the receptacle.

The above fuse blocks can be used on circuits up to and including 2500 volts at 30 amperes maximum or 3300 volts at 12 amperes maximum.

Expulsion Type—The expulsion-type fuse box is used with transformers of higher capacities and voltages. It is weatherproof and can be mounted on the pole cross-arms or any other place convenient to the transformer.

This block consists of a wooden box having mounted therein an expulsion tube within which is placed the fuse wire. A hinged door permits easy access for the purpose of inspection or replacement of the fuses.

This type of fuse box can be used on circuits of 2300 and 3300 volts at 60 amperes and on 6900 volts at 30 amperes.

Type OD Safety-First Fuse Box—The type OD fuse box is of the expulsion-type similar to that already described but embodying a number of features that provide perfect safety in operation. The fuse tube is mounted on the 7500-volt insulators on the door of the box in such a manner that it is readily detachable for refusing. Complete separation of those parts to be handled from all live parts is accomplished automatically by opening the door. On closing the door, contacts on the fuse tube engage other contacts mounted on insulators on the back of the box and a latch insures good contact by holding the door closed. An indication of the condition of the fuse is obtained by means of a piece of white paper which is clamped under the box and is punctured by the gases when the fuse blows.

This type of box is made in two sizes; one good for 30 amperes maximum, 7,500 volts and the other good for 100 amperes maximum, 7500 volts.

Disconnecting-Switch Type—The disconnecting-switch type of expulsion fuse block is used for still higher voltages. This fuse block has a capacity of 50 amperes on all voltages from 6600 to 73000. The fuse tube should be removed and inserted by a special fuse pole, one or more of which should be supplied for each installation.

Fuse Wire—Standard aluminum fuse wire listed in section on "Wiring Devices and Carbon Circuit-Breakers" is used, but not included, with all of the fuse blocks described above.

AUXILIARY APPARATUS—Continued

LIGHTNING ARRESTERS

The following is the list of lightning arresters recommended for use in the protection of Westinghouse Distribution Transformers. For information on correct type to use on a given installation refer to Section 1-A of this catalogue.

Voltage of Arresters	Type of Arrester	Remarks
400	MP	Multi-path—unlimited application.
750	MP	Multi-path—unlimited application.
1000–2500	C	Multi-gap—limited application and for use on 60-cycle service only.
1000–5000	CR	Series Resistance Type—unlimited application—For the usual 2500-volt service install iron box arrester style No. 240916 or wood box arrester style No. 272985.
3000–13200	W	Series Resistance Type—unlimited application.
2000–7500	S	Shunt resistance type—limited application.
2000–39000	LE	Shunt resistance type—unlimited application.
1000 and up	AK	Electrolytic type.
22000 and up	AL	Electrolytic type with impulse gaps.

OIL

Westinghouse Lectroseal oil is regularly supplied with Westinghouse distribution transformers. Lectroseal oil is a pure mineral oil free from moisture, acid, alkali, or sulphur compounds and is very fluid. It is not affected by temperatures reached under ordinary operating conditions and has a high breakdown voltage. For additional information on Lectroseal oil and "The Storage, Handling and Filtering of Oil," see sections on "Insulating Materials and Supplies" and "Feeder-Voltage Regulators and Transformer Apparatus."

OMISSION ALLOWANCES

The following deductions are to be made from the net prices obtained by applying the discounts specified on the discount sheets for this section:

Oil—When oil is not desired with any of these transformers, a deduction may be made from the net price of the transformers of $0.20 per gallon.

Fuse Blocks—When fuse blocks, Style Nos. 147190 or 29865, are not desired with any of the transformers *for which they are regularly supplied*, a deduction of $0.75 for each block may be made from the net price of the transformer.

Hanger Irons—No allowance from the price is made for the omission of hanger irons.

INSTRUCTIONS FOR ORDERING

Style Number includes transformer only.

List Price includes transformer complete and, except as noted, the following:

Oil in quantity as specified in tables.

Hanger Irons, the style numbers of which are shown in the tables. Where no hanger iron style number for a particular transformer is shown in the tables, the transformer is intended for platform mounting and hanger irons are not included.

Fuse Blocks—One set of fuse blocks, complete with lag screws, is included in the list price of the transformer of voltages up to 2300, except where otherwise noted in the tables. Fuse blocks are not included in the price of transformers for voltages of 4600 or higher. Fuse wire or links are not included with fuse blocks and must be ordered separately from section on "Wiring Devices and Carbon Circuit-Breakers."

On Ordering, Specify as Separate Items:

Transformer—State the capacity, phase, frequency, high and low voltages, and the style number.

Oil—Specify the gallons of oil required for each transformer. The quantity required is given in the tables.

Hanger Irons—Order by the style number shown in the tables. (Style number includes a pair of hanger-irons.)

Fuse Blocks—Where the list price includes fuse blocks, either Style No. 29865 or Style No. 147190 can be ordered, as desired. Order two for each single-phase transformer or three for each three-phase.

Fuse Wire and Links—Order by description and list price shown in section on "Wiring Devices and Carbon Circuit-Breakers."

Ratings

Capacity and Voltage—The capacity and voltage ratings of Westinghouse distribution transformers are in agreement with the recommendations of the Apparatus Committee of the National Electric Light Association, and the Electric Power Club, determined under the conditions specified in the standardization rules of the American Institute of Electrical Engineers.

Secondary Voltage Classes—To facilitate listing, the low-voltage windings are given in two classes, Class 200 and Class 400. Class 200 transformers are those whose highest low-voltage winding is nominally 200 volts (220, 230, 240). In like manner, class

INSTRUCTIONS FOR ORDERING—Continued

400 transformers are those whose highest low-voltage winding is nominally 400 volts (440, 460, 480).

All the low-voltage windings (480 volts and lower) for single-phase transformers of capacities up to 100 kilovoltamperes, are separated into two independent groups, the leads from which are brought out through the case. These two groups can be connected in multiple for the lower voltage and in series for the higher voltage; when connected for the higher voltage, the series connection may be used as the neutral lead for a three-wire circuit. Single-phase transformers of capacities above 100 kilovoltamperes and with low-voltage windings for Class 200 are provided with low-voltage leads out of the case for 230 volts two-wire operation or for 230–115 volts three-wire operation, but the low-voltage coils cannot be connected in parallel for 115 volts.

In the tables listing the trnasformers, the high-voltage rating is given first, separated by the word "to" from the low-voltage rating.

Frequency—Transformers are listed for use on 25 and 60-cycle circuits. For other frequencies, prices will be furnished on request.

SINGLE-PHASE 60-CYCLE TRANSFORMERS

FOR SUPPLYING SERVICE VOLTAGES 600 VOLTS AND BELOW

Capacity Kva.	Type	Dimension Reference Fig.	Item	Approximate Weight, Pounds Net*	Shipping†	Ordering Data: Style No. Transformer Only	Style No. Hanger Iron	Gallons Oil	List Price
				440 to 220-110 Volts **460 to 230-115 Volts** 480 to 240-120 Volts		**(Class 200)**			
1	S	20	1	60	106	258747	109712	¾	$ 42 00
2	S	20	2	100	165	258748	109712	1¾	59 00
3	S	20	2	105	170	258749	109712	1¾	74 00
5	S	20	3	132	187	258750	109712	1¾	103 00
7.5	S	20	6	160	262	258751	109712	5½	135 00
10	S	20	9	200	321	258752	109713	5¾	164 00
15	S	20	10	259	400	258753	109713	9	‡216 00
25	S	21	2	394	580	258755	109713	10½	‡314 00
37.5	S	21	6	522	780	258757	234482	17	‡422 00
50	S	21	11	704	1100	258758	234482	31	‡519 00
				550 to 220-110 Volts **575 to 230-115 Volts** 600 to 240-120 Volts		**(Class 200)**			
1	S	20	1	60	106	258768	109712	¾	42 00
2	S	20	2	100	165	258769	109712	1¾	59 00
3	S	20	2	106	170	258770	109712	1¾	74 00
5	S	20	6	132	187	258771	109712	1¾	103 00
7.5	S	20	6	160	262	258772	109712	5½	135 00
10	S	20	9	200	321	258773	109713	5¾	164 00
15	S	20	10	259	400	258774	109713	9	218 00
25	S	21	2	394	580	258776	109713	10½	‡314 00
37½	S	21	6	522	780	258778	234482	17	‡422 00
50	S	21	11	704	1100	258779	234482	31	‡519 00

*Net weight includes transformer only.

†Shipping weight includes transformer boxed for shipment, complete with hanger irons and fuse blocks (when supplied) and oil in container.

‡Fuse blocks are not included in this price (see pages on "Auxiliary Apparatus").

Oil weighs approximately 7 pounds net per gallon and 8½ pounds shipping.

NOTE—All of the above single-phase transformers can be operated in bank on three-phase with the high-voltage winding connected in star or in delta.

SINGLE-PHASE 60-CYCLE TRANSFORMERS—Continued

FOR SUPPLYING SERVICE VOLTAGES 600 VOLTS AND BELOW—Continued

Capacity Kva.	Type	Dimension Reference Fig.	Item	Approximate Weight, Pounds Net*	Shipping†	Ordering Data: Style No., Transformer Only Class 200	Class 400	Style No. Hanger Iron	Gallons Oil	List Price
	2200 to 220-110 Volts 2300 to 230-115 Volts 2400 to 240-120 Volts				(Class 200)		2200 to 440-220 Volts 2300 to 460-230 Volts 2400 to 480-240 Volts		(Class 400)	
	High Efficiency Type									
1	S	20	1	60	106	222561	.....	109712	¾	$ 42 00
2	S	20	2	100	165	222562	223362	109712	1¾	59 00
3	S	20	3	128	193	222563	223363	109712	1¾	74 00
5	S	20	4	152	230	222564	223364	109712	2½	103 00
7.5	S	20	7	209	315	222565	223365	109713	4	135 00
10	S	20	8	243	394	222566	223366	109713	5	164 00
15	S	20	10	300	460	222567	223367	109713	9	218 00
25	S	21	5	475	715	222569	223369	234482	14½	317 00
37.5	S	21	9	690	1046	222571	223371	234482	26	424 00
50	S	21	11	935	1344	222572	223372	234482	31	522 00
75	SK	22	1	1630	2450	280174	280176	129383	56	‡653 00
100	SK	22	3	1670	2670	280175	280177	129384	70	‡785 00
150	SK	22	9	2485	4060	281691¶	267132	§	148	‡993 00
200	SK	22	10	2560	4200	281692¶	267133	§	162	‡1146 00
	Reduced Efficiency Type									
1	SA	On Application	On Application	On Application	On Application	261471	.....	109712	On Application	$ 36 00
2	SA					261472	268484	109712		51 00
3	SA					261473	268485	109712		65 00
5	SA					261474	268486	109712		87 00
7.5	SA					261475	268487	109713		117 00
10	SA					261476	268488	109713		142 00
15	SA					261477	268489	234482		190 00
25	SA					261479	268490	234482		273 00
37.5	SA					261481	268491	234482		362 00
50	SA					261482	268492	234482		443 00
75	SKA					267075	267095	129384		587 00
100	SKA					267076	267096	129384		727 00

Capacity Kva.	Type	Dimension Reference Fig.	Item	Approximate Weight, Pounds Net*	Shipping†	Ordering Data: Style No. Transformer Only	Style No. Hanger Iron	Gallons Oil	List Price
	2200 to 550 Volts 2300 to 575 Volts 2400 to 600 Volts								
1	S	20	1	60	106	268573	109712	¾	$ 42 00
2	S	20	2	100	165	268574	109712	1¾	59 00
3	S	20	3	128	193	268575	109712	1¾	74 00
5	S	20	4	152	230	268576	109712	2½	103 00
7.5	S	20	7	209	315	268577	109713	4	135 00
10	S	20	8	243	394	268578	109713	5	164 00
15	S	20	10	300	460	268579	109713	9	218 00
25	S	21	5	475	715	268580	234482	14½	317 00
37.5	S	21	9	690	1046	268581	234482	26	424 00
50	S	21	11	935	1344	268582	234482	31	522 00
75	SK	22	1	1630	2450	268583	129384	56	‡653 00
100	SK	22	3	1670	2670	268584	129384	70	‡785 00
150	SK	22	9	2485	4060	268585	§	148	‡993 00
200	SK	22	10	2560	4200	268586	§	162	‡1146 00

¶Low voltage winding is arranged for 230 volts, two-wire and 230-115 volts three-wire operation, but the low voltage coils cannot be connected in parallel for 115 volts.

*Net weight includes transformer only.

†Shipping weight includes transformer boxed for shipment, complete with hanger irons and fuse blocks (when supplied) and oil in container.

‡Fuse blocks are not included in this price (see pages on "Auxiliary Apparatus").

§Hanger irons are not included with this capacity, as transformer is intended for platform mounting.

Oil weighs approximately 7 pounds net per gallon and 8½ pounds shipping.

NOTE—All of the above single-phase transformers can be operated in bank on three-phase with the high-voltage windings connected in star or in delta.

SINGLE-PHASE 60-CYCLE TRANSFORMERS—Continued

FOR SUPPLYING SERVICE VOLTAGES 600 VOLTS AND BELOW—Continued

Capacity Kva.	Type	Dimension Reference Fig.	Item	Approximate Weight, Pounds Net*	Shipping†	Ordering Data: Style No. Transformer Only Class 200	Class 400	Style No. Hanger Iron	Gallons Oil	List Price
4400-2200 to 220-110 Volts 4600-2300 to 230-115 Volts 4800-2400 to 240-120 Volts						**(Class 200)**	**4400-2200 to 440-220 Volts 4600-2300 to 460-230 Volts 4800-2400 to 480-240 Volts**		**(Class 400)**	
1	SK	23	1	133	210	267134	.....	109713	3¾	$ 59 00
2	SK	23	1	133	210	267135	.....	109713	3¾	78 00
3	SK	23	2	190	290	267136	.....	109713	5¾	93 00
5	SK	23	3	230	350	267137	.....	109713	8	122 00
7.5	SK	23	3	240	350	267138	.....	109713	6½	157 00
10	SK	23	4	346	530	267139	.....	109713	11½	187 00
15	SK	23	5	465	705	267140	.....	109714	16	242 00
25	SK	24	1	748	1100	267337	267156	109714	25	348 00
37.5	SK	24	3	953	1430	267338	267157	109715	34½	461 00
50	SK	24	5	1270	2010	267339	267158	109715	58	562 00
75	SK	22	3	1542	2580	267340	267159	129384	70	702 00
100	SK	22	4	1810	2980	267341	267160	199217	86	833 00
150	SK	22	9	2600	4200	281694¶	267162	§	148	1037 00
200	SK	22	11	2670	4600	281695¶	267163	§	190	1200 00
6600-6300-6000-5700 to 220-110 Volts 6900-6585-6275-5960 to 230-115 Volts 7200-6875-6545-6220 to 240-120 Volts						**(Class 200)**				
6600-6300-6000-5700 to 440-220 Volts 6900-6585-6275-5960 to 460-230 Volts 7200-6875-6545-6220 to 480-240 Volts						**(Class 400)**				
1.5	SK	23	1	140	215	267164	267175	109713	3½	$ 88 00
3	SK	23	2	192	305	267165	267176	109713	5½	113 00
5	SK	23	3	240	350	267166	267177	109713	6½	142 00
7.5	SK	23	4	346	530	267167	267178	109713	11½	177 00
10	SK	23	4	380	555	267168	267179	109713	11	211 00
15	SK	23	5	543	780	267169	267180	109714	16	268 00
25	SK	24	2	853	1250	267170	267181	109714	28	378 00
37.5	SK	24	4	1080	1640	267171	267182	109715	42	496 00
50	SK	24	5	1390	2130	267172	267183	109715	58	600 00
75	SK	22	3	1542	2580	267173	267184	129384	70	738 00
100	SK	22	4	1810	2980	267174	267185	199217	86	857 00
150	SK	22	9	2600	4200	281697¶	267187	§	148	1083 00
200	SK	22	11	2670	4600	281698¶	267188	§	190	1275 00
11000-10450- 9900 to 220-110 Volts 11500-10925-10350 to 230-115 Volts						**(Class 200)**				
11000-10450- 9900 to 440-220 Volts 11500-10925-10350 to 460-230 Volts						**(Class 400)**				
2.5	SK	23	6	286	425	267206	267215	109713	7½	$165 00
5	SK	23	7	376	560	267207	267216	109713	12	208 00
10	SK	23	7	421	610	267208	267217	109713	12	269 00
15	SK	23	8	577	850	267209	267218	109714	18	329 00
25	SK	24	2	853	1250	267210	267219	109714	28	437 00
37.5	SK	24	4	1080	1630	267211	267220	109715	42	560 00
50	SK	24	5	1390	2120	267212	267221	109715	58	667 00
75	SK	22	4	1810	2880	267213	267222	199217	93	825 00
100	SK	22	6	2150	3150	267214	267223	§	97½	967 00
150	SK	22	9	2600	4200	281700¶	267204	§	148	1212 00
200	SK	22	11	3010	5000	281701¶	267205	§	190	1412 00

*Net weight includes transformer only.

†Shipping weight includes transformer boxed for shipment, complete with hanger irons and fuse blocks (when supplied) and oil in container.

§Hanger irons are not included with this capacity, as transformer is intended for platform mounting.

¶Low-voltage winding is arranged for 230 volts two-wire and 230-115 volts three-wire operation but the low voltage coils cannot be connected in parallel for 115 volts.

Oil weighs approximately 7 pounds net per gallon and 8½ pounds shipping.

NOTE—With the exception of the 11500-volt transformers all of the above transformers can be operated in bank on three-phase with the high-voltage windings connected in star or in delta. The 11500-volts transformer are suitable only for delta connection.

SINGLE-PHASE 60-CYCLE TRANSFORMERS—Continued

FOR SUPPLYING SERVICE VOLTAGES 600 VOLTS AND BELOW—Continued

Capacity Kva.	Type	Dimension Reference Fig.	Dimension Reference Item	Approximate Weight, Pounds Net*	Approximate Weight, Pounds Shipping†	Ordering Data: Style No. Transformer Only Class 200	Ordering Data: Style No. Transformer Only Class 400	Ordering Data: Style No. Hanger Iron	Ordering Data: Gallons Oil	List Price
13200-12540-11880 to 220-110 Volts / 13800-13110-12420 to 230-115 Volts (Class 200)										
13200-12540-11880 to 440-220 Volts / 13800-13110-12420 to 460-230 Volts (Class 400)										
2.5	SK	23	6	286	425	267236	267245	109713	7½	$198 00
5	SK	23	7	376	560	267237	267246	109713	12	236 00
10	SK	23	7	421	610	267238	267247	109713	12	303 00
15	SK	23	8	577	850	267239	267248	109714	18	369 00
25	SK	24	2	853	1250	267240	267249	109714	35	479 00
37.5	SK	24	4	1081	1630	267241	267250	109715	42	595 00
50	SK	24	[illegible]	1390	2120	267242	267251	109715	58	689 00
75	SK	22	4	1810	2880	267243	267252	199217	93	850 00
100	SK	22	6	2150	3150	267244	267253	[illegible]	97½	992 00
150	SK	22	9	2600	4200	281703¶	267255	§	148	1234 00
200	SK	22	11	3010	5000	281704¶	267256	§	190	1438 00
22000-20900-19800 to 220-110 / 23000-21850-20700 to 230-115 (Class 200)										
22000-20900-19800 to 440-220 / 23000-21850-20700 to 460-230 (Class 400)										
5	SK	25	1	500	750	267287	267295	109713	18	$429 00
10	SK	25	2	715	1060	267288	267296	109713	26	490 00
15	SK	25	3	850	1250	267289	267297	109733	29½	538 00
25	SK	25	4	1150	1720	267290	267298	129384	39	631 00
37.5	SK	25	5	1360	2070	267291	267299	129384	51	743 00
50	SK	26	1	1660	2460	267292	267300	129384	59½	842 00
75	SK	26	2	2035	3100	267293	267301	199217	84	1034 00
100	SK	26	3	2270	3650	267294	267302	199217	108	1196 00
150	SK	26	5	2920	5060	281706¶	267304	§	150	1412 00
200	SK	26	6	3440	6800	281707¶	267305	§	210	1618 00
33000-31350-29700 to 220-110 Volts / 34500-32775-31050 to 230-115 Volts (Class 200)										
33000-31350-29700 to 440-220 Volts / 34500-32775-31050 to 460-230 Volts (Class 200)										
10	SC	31	[illegible]	700	1150	267489	267490	§	43	$547 00
15	SC	31	1	740	1200	267491	267492	[illegible]	43	599 00
25	SC	31	3	930	1640	267493	267494	§	70	692 00
37.5	SC	31	4	1100	1970	267495	267496	§	85	803 00
50	SC	31	7	1400	2780	267497	267498	[illegible]	140	906 00
75	SC	32	1	2400	3800	267499	267500	§	130	1096 00
100	SC	32	3	2550	4290	267501	267502	§	165	1275 00
150	SC	32	5	2850	4800	267505¶	267506	§	186	1592 00
200	SC	33	9	4250	6720	267507¶	267508	[illegible]	225	1771 00

*Net weight includes transformer only.

†Shipping weight includes transformer boxed for shipment, complete with hanger irons (when supplied) and oil in container.

§Hanger irons are not included with this capacity, as transformer is intended for platform mounting.

¶Low voltage winding is arranged for 230 volts two-wire and 230-115 volts three-wire operation but the low voltage coils cannot be connected in parallel for 115 volts.

Oil weighs approximately 7 pounds net per gallon and 8½ pounds shipping.

NOTE—The above transformers are suitable for delta-connection but not suitable for star-connection on the high-voltage side when banked for three-phase operation.

SINGLE-PHASE 60-CYCLE TRANSFORMERS—Continued

FOR SUPPLYING DISTRIBUTING VOLTAGES ABOVE 600 VOLTS

Capacity Kva.	Type	Dimension Reference Fig.	Item	Approximate Weight, Pounds Net*	Shipping†	Ordering Data: Style No. Transformer Only	Style No. Hanger Iron	Gallons Oil	List Price
				‡6600-6270-5940 to 2300 Volts					
1.5	SK	23	2	176	290	267189	109713	5¾	98 00
3	SK	23	2	192	305	267190	109713	5½	124 00
5	SK	23	4	346	530	267191	109713	11½	157 00
7.5	SK	23	4	380	550	267192	109713	11	195 00
10	SK	23	4	380	550	267193	109713	11	232 00
15	SK	23	5	543	780	267194	109714	16	295 00
25	SK	24	2	853	1250	267195	109714	28	415 00
37.5	SK	24	4	1080	1640	267196	109715	42	521 00
50	SK	24	5	1390	2130	267197	109715	58	630 00
75	SK	22	3	1542	2580	267198	129384	70	775 00
100	SK	22	4	1810	2980	267199	199217	93	900 00
150	SK	22	9	2600	4200	267201	§	148	1083 00
200	SK	22	11	2670	4600	267202	§	190	1275 00
				‡11000-10450-9900 to 2300 Volts					
2.5	SK	23	7	376	560	267224	109713	12	173 00
5	SK	23	7	421	610	267225	109713	12	218 00
10	SK	23	§	577	850	267226	109714	18	282 00
15	SK	24	1	748	1100	267227	109714	25	329 00
25	SK	24	3	957	1440	267228	109715	34½	437 00
37.5	SK	24	4	1080	1630	267229	109715	42	560 00
50	SK	24	5	1390	2120	267230	109715	58	667 00
75	SK	22	4	1810	2880	267231	199217	93	825 00
100	SK	22	6	2150	3150	267232	§	97½	967 00
150	SK	22	9	2600	4200	267234	§	148	1212 00
200	SK	22	11	3010	5000	267235	§	190	1412 00
				‡13200-12540-11880 to 2300 Volts					
2.5	SK	23	7	376	560	267257	109713	12	208 00
5	SK	23	7	421	610	267258	109713	12	248 00
10	SK	23	8	577	850	267259	190714	18	303 00
15	SK	24	1	748	1100	267260	109714	25	369 00
25	SK	24	3	957	1440	267261	109715	34½	479 00
37.5	SK	24	4	1080	1630	267262	109715	42	595 00
50	SK	24	5	1390	2120	267263	109715	58	689 00
75	SK	22	4	1810	2880	267342	199217	93	850 00
100	SK	22	6	2150	3150	267264	§	97½	992 00
150	SK	22	9	2600	4200	267266	§	148	1234 00
200	SK	22	11	3010	5000	267267	§	190	1438 00

*Net weight includes transformer only.

†Shipping weight includes transformer boxed for shipment, complete with hanger irons (when supplied) and oil in container.

§Hanger irons are not included with this capacity, as transformer is intended for platform mounting.

‡Can be operated 5 per cent above rated voltage.

Oil weighs approximately 7 pounds net per gallon and 8½ pounds shipping.

NOTE—With the exception of the 6600-volt transformers which can be star-connected for 11430 volts, the above transformers are suitable for delta-connection but not suitable for star-connection on the high voltage side when banked for three-phase operation. The 2300-volt low-voltage windings can be star-connected for three-phase operation but 6600-volt transformers should not be star-connected on both high and low-voltage windings.

SINGLE-PHASE 60-CYCLE TRANSFORMERS—Continued

FOR SUPPLYING DISTRIBUTION VOLTAGES ABOVE 600 VOLTS—Continued

Capacity Kva.	Type	Dimension Reference Fig.	Item	Approximate Weight, Pounds Net*	Shipping†	Ordering Data: Style No. Transformer Only	Style No. Hanger Iron	Gallons Oil	List Price
				††22000-20900-19800 to 2300 Volts					
5	SK	25	1	500	750	248931	109713	18	$ 429 00‡
10	SK	25	2	715	1060	231575	109713	26	490 00‡
15	SK	25	3	850	1250	231576	109733	29½	538 00‡
25	SK	25	4	1150	1720	231577	129384	39	631 00‡
37.5	SK	25	5	1360	2070	217020	129384	51	743 00‡
50	SK	26	1	1660	2460	217021	129384	59½	842 00‡
75	SK	26	2	2035	3100	217078	199217	84	1034 00‡
100	SK	26	3	2270	3650	217079	199217	108	1196 00‡
150	SK	26	5	2900	5040	252424	‖	150	1412 00‡
200	SK	26	6	3440	6800	252425	‖	210	1618 00‡
				††33000-31350-29700 to 2300 Volts					
10	SC	31	1	700	1150	247090	‖	43	547 00‡
15	SC	31	1	740	1200	250384	§	43	599 00‡
25	SC	31	3	930	1640	247091	‖	70	692 00‡
37.5	SC	31	4	1100	1970	250385	§	85	803 00‡
50	SC	31	7	1400	2780	247092	‖	140	906 00‡
75	SC	32	1	2400	3800	247093	‖	130	1096 00‡
100	SC	32	3	2550	4290	250386	‖	165	1275 00‡
150	SC	32	5	2850	4800	247094	§	186	1592 00‡
200	SC	33	9	4250	6720	247095	‖	225	1771 00‡

NOTE—The above transformers are suitable for delta-connection but are not suitable for star-connection on the high voltage side when banked for three-phase operation. The 2300-volt low-voltage windings can be star-connected for three-phase operation.

THREE-PHASE 60-CYCLE TRANSFORMERS

FOR SUPPLYING SERVICE VOLTAGES 600 VOLTS AND BELOW

Capacity Kva.	Type	Dimension Reference Fig.	Item	Approximate Weight, Pounds Net*	Shipping†	Ordering Data: Style No. Transformer Only	Style No. Hanger Iron	Gallons Oil	List Price
				2200–3810Y to 440-220 Volts 2300–3984 Y to 460-230 Volts 2400–4157Y to 480-240 Volts } (Class 400)					
3	ST	27	1	242	360	267361	109712	5	$ 126 00
5	ST	29	1	340	510	267362	109712	9	160 00
7.5	ST	29	2	358	530	267363	109713	8¾	199 00
10	ST	29	2	450	640	267364	109713	10	235 00
15	ST	29	3	535	775	267365	109713	13½	310 00
25	ST	28	2	800	1100	267366	234482	25	434 00
37.5	ST	28	3	1290	1825	267367	129384	44	574 00
50	ST	28	4	1430	2130	267368	129384	52	704 00
75	ST	28	9	1980	2870	267369	129384	62	950 00
100	ST	28	11	2155	3300	267370	199217	100	1165 00‡
150	ST	28	15	2685	4270	267372	§	144	1565 00‡
200	ST	28	17	3070	5400	267373	§	185	1828 00‡

Unless otherwise specified the above three-phase transformers are connected star in the high-voltage and delta in the low-voltage to transform from a nominal line voltage of 4000 volts. If required with the windings connected delta in the high-voltage, to transform from a nominal line voltage of 2300 volts it should be so specified on the order. Connectors for the delta connection can also be ordered separately as follows:

Connectors for 3-kva. to 10-kva. transformers, inclusive.....Style No. 280436 List Price per set $5.00.
Connectors for 15-kva. to 50-kva. transformers, inclusive.....Style No. 280437 List Price per set $5.00.
Connectors for 75-kva. to 200-kva. transformers, inclusive.....Style No. 280438 List Price per set $6.00.

*Net weight includes transformer only.

†Shipping weight includes transformer boxed for shipment, complete with hanger irons and fuse blocks (when supplied) and oil in container.

‡Fuse blocks are not included in this price (see pages on "Auxiliary Apparatus").

§Hanger irons are not included with this capacity as transformer is intended for platform mounting.

††Can be operated at 5 per cent above rated voltage.

Oil weighs approximately 7 pounds net per gallon and 8½ pounds shipping.

THREE-PHASE 60-CYCLE TRANSFORMERS—Continued

FOR SUPPLYING SERVICE VOLTAGES 600 VOLTS AND BELOW—Continued

Capacity Kva.	Type	Dimension Reference Fig.	Item	Approximate Weight, Pounds Net*	Shipping†	Ordering Data: Style No. Transformer Only	Style No. Hanger Iron	Gallons Oil	List Price
				4400 to 440-220 Volts **4600 to 460-230 Volts** 4800 to 480-240 Volts	(Class 400)				
5	ST	29	2	450	620	267384	109713	10	$ 214 00
7.5	ST	29	2	450	620	267385	109713	10	257 00
10	ST	29	3	535	740	267386	109713	13½	294 00
15	ST	28	2	735	1055	267387	234482	22½	368 00
25	ST	28	3	1290	1820	267389	129384	38	501 00
37.5	ST	28	4	1430	2100	267390	129384	47	644 00
50	ST	28	9	1980	2840	267391	129384	62	778 00
75	ST	28	10	2135	3070	267392	199217	68	1043 00
100	ST	28	11	2135	3360	267393	199217	100	1269 00
150	ST	28	15	2710	4420	267395	§	160	1685 00
200	ST	28	18	3120	5490	267396	§	228	1967 00
				6600-5940 to 440-220 Volts **6900-6210 to 460-230 Volts** 7200-6480 to 480-240 Volts	(Class 400)				
10	ST	29	3	535	740	267407	109713	13½	$ 335 00
15	ST	28	2	735	1055	267408	234482	22½	406 00
25	ST	28	3	1290	1820	267410	129384	38	537 00
37.5	ST	28	4	1430	2100	267411	129384	47	684 00
50	ST	28	9	1980	2840	267412	129384	62	817 00
75	ST	28	10	2135	3000	267413	199217	68	1076 00
100	ST	28	11	2135	3280	267414	199217	100	1302 00
150	ST	28	15	2710	4420	267416	§	160	1710 00
200	ST	28	18	3120	5490	267417	§	228	1973 00
				11000- 9900 to 440-220 Volts **11500-10350 to 460-230 Volts**	(Class 400)				
10	ST	30	1	494	135	267428	109713	18	$ 352 00
15	ST	30	2	624	955	267429	109714	25	428 00
25	ST	30	4	870	1380	267431	109715	40	566 00
37.5	ST	28	5	1350	2000	267432	129384	47	719 00
50	ST	28	4	1390	2120	267433	129384	55	860 00
75	ST	28	10	2135	3000	267434	129384	68	1132 00
100	ST	28	11	2150	3300	267435	199217	100	1369 00
150	ST	28	16	2700	4400	267437	§	160	1800 00
200	ST	28	18	3120	5500	267438	§	228	2077 00

*Net weight includes transformer only.

†Shipping weight includes transformer boxed for shipment, complete with hanger irons (when supplied) and oil in container.

§Hanger irons are not included with this capacity, as transformer is intended for platform mounting.

Oil weighs approximately 7 pounds net per gallon and 8½ pounds shipping.

NOTE—The high-voltage windings of the above three-phase transformers are connected in star and the low-voltage windings in delta.

THREE-PHASE 60-CYCLE TRANSFORMERS—Continued

FOR SUPPLYING SERVICE VOLTAGES 600 VOLTS AND BELOW—Continued

Capacity Kva.	Type	Dimension Reference Fig.	Item	Approximate Weight, Pounds Net*	Shipping†	Ordering Data: Style No. Transformer Only	Style No. Hanger Iron	Gallons Oil	List Price
				13200-11880 to 440-220 Volts / 13800-12420 to 460-230 Volts (Class 400)					
10	ST	30	1	494	735	267449	109713	18	$569 00
15	ST	30	2	624	955	267450	109714	25	637 00
25	ST	30	4	870	1380	267452	109715	40	761 00
37.5	ST	28	3	1350	2000	267453	129384	47	908 00
50	ST	28	4	1390	2120	267454	129384	55	1046 00
75	ST	28	10	2135	3000	267455	129384	68	1294 00
100	ST	28	11	2150	3300	267456	199217	100	1502 00
150	ST	28	16	2700	4400	267458	§	160	1861 00
200	ST	28	18	3100	5500	267459	§	228	2150 00
				22000-19800 to 440-220 Volts / 23000-20700 to 460-230 Volts (Class 400)					
15	ST	28	15	850	1300	268208	.....	35	$1094 00
25	ST	28	16	1370	1940	268209	.....	43	1198 00
37.5	ST	28	17	1450	2170	268210	.....	58	1311 00
50	ST	28	18	1750	2620	268211	.....	72	1411 00
75	ST	28	19	2170	3360	268212	.....	105	1608 00
100	ST	28	20	2490	3900	268213	.....	128	1800 00
150	ST	28	21	3075	5000	268214	§	190	2147 00
200	ST	28	22	3475	5870	268215	§	240	2472 00
				33000-29700 to 440-220 Volts / 34500-31050 to 460-230 Volts (Class 400)					
25	SCT	31	12	1180	2625	268572	§	130	$1267 00
37.5	SCT	31	10	1500	3600	280989	§	230	1377 00
50	SCT	31	11	1700	4100	280990	§	260	1475 00
75	SCT	33	14	2660	4200	280991	§	150	1660 00
100	SCT	33	15	2910	4780	280992	§	185	1838 00
150	SCT	33	16	3270	5430	280993	§	215	2177 00
200	SCT	33	17	4850	7890	280994	§	300	2479 00

*Net weight includes transformer only.

†Shipping weight includes transformer boxed for shipment, complete with hanger irons (when supplied) and oil in container.

§Hanger irons are not included with this capacity, as transformer is intended for platform mounting.

Oil weighs approximately 7 pounds net per gallon and 8½ pounds shipping.

NOTE—The high-voltage windings of the above three-phase transformers are connected in star and the low-voltage windings in delta.

SINGLE-PHASE 25-CYCLE TRANSFORMERS

FOR SUPPLYING SERVICE VOLTAGES 600 VOLTS AND BELOW

Capacity Kva.	Type	Dimension Reference Fig.	Item	Approximate Weight, Pounds Net*	Shipping†	Ordering Data: Style No. Transformer Only Class 200	Style No. Hanger Iron	Gallons Oil	List Price
				440 to 220-110 Volts **460 to 230-115 Volts** 480 to 240-120 Volts		(Class 200)			
1	S	20	2	110	163	268455	109712	1¾	▮ 71 00
2	S	20	4	132	190	268456	109712	2½	98 00
3	S	20	4	160	220	268457	109712	2½	118 00
5	S	20	7	236	330	268458	109713	4	156 00
7.5	S	21	1	340	470	268459	109713	7	198 00
10	S	21	4	425	565	268460	109713	7¼	232 00
15	S	21	5	545	780	268461	234482	14½	296 00
25	S	21	9	820	1175	268462	234482	26	422 00
37.5	S	22	1	1630	2350	267603	129384	56	558 00
50	S	22	2	1690	2550	267604	129384	70	680 00

Capacity Kva.	Type	Dimension Reference Fig.	Item	Approximate Weight, Pounds Net*	Shipping†	Ordering Data: Style No. Transformer Only Class 200	Class 400	Style No. Hanger Iron	Gallons Oil	List Price
		2200 to 220-110 Volts **2300 to 230-115 Volts** 2400 to 240-120 Volts		(Class 200)			2200 to 440-220 Volts **2300 to 460-230 Volts** 2400 to 480-240 Volts	(Class 400)		
1	S	20	2	110	163	268216	.....	109712	1¾	▮ 71 00
2	S	20	4	132	190	251972	267638	109712	2½	98 00
3	S	20	4	160	220	251973	267639	109712	2½	118 00
5	S	20	7	236	330	251974	267640	109713	4	156 00
7.5	S	21	1	340	470	251975	267641	109713	7	198 00
10	S	21	4	425	565	251976	267642	109713	7	232 00
15	S	21	5	545	780	251977	267643	234482	14½	298 00
25	S	21	9	820	1175	251979	267644	234482	26	424 00
37.5	SK	22	1	1630	2720	268224	267645	129384	56	560 00
50	SK	22	2	1690	2840	268225	267646	129384	56	682 00
75	SK	22	4	2150	3260	268226	267647	§	97½	900 00‡
100	SK	22	6	2920	4600	268227	267648	§	138	1013 00‡
150	SS	33	2	3370	5250	267561¶	267562	§	170	1396 00‡
200	SS	33	▮	4500	6650	267563¶	267564	§	184	1675 00‡
		4400-2200 to 220-110 Volts **4600-2300 to 230-115 Volts** 4800-2400 to 240-120 Volts		(Class 200)			4400-2200 to 440-220 Volts **4600-2300 to 460-230 Volts** 4800-2400 to 480-240 Volts	(Class 400)		
1	SK	23	2	192	305	267649	267661	109713	5½	▮ 93 00‡
2	SK	23	3	230	350	267650	267662	109713	▮	117 00‡
3	SK	23	3	240	350	267651	267663	109713	6½	137 00‡
5	SK	23	4	346	530	267652	267664	109713	11½	176 00‡
7.5	SK	23	5	543	760	267653	267665	109713	16	218 00‡
10	SK	23	5	543	785	267654	267666	109714	16	257 00‡
15	SK	24	2	853	1275	267655	267667	109715	28½	331 00‡
25	SK	24	4	1080	1650	267656	267668	109715	42	458 00‡
37 5	SK	22	2	1520	2450	267657	267669	129384	58	616 00‡
50	SK	22	3	1675	2740	267658	267670	129384	70	733 00‡
75	SK	22	6	2270	3390	267659	267671	▮	97½	950 00‡
100	SK	22	▮	2920	4470	267660	267672	▮	138	1138 00‡
150	SS	33	2	3370	5300	267555¶	267556	▮	170	1454 00‡
200	SS	33	4	4500	6600	267557¶	267558	§	184	1746 00‡

*Net weight includes transformer only.

†Shipping weight includes transformer boxed for shipment, complete with hanger irons and fuse blocks (when supplied) and oil in container.

‡Fuse blocks are not included in this price (see pages on "Auxiliary Apparatus").

§Hanger irons are not included with this capacity as transformer is intended for platform mounting.

¶Low-voltage winding is arranged for 230-volt two-wire and 230-115-volt three-wire operation, but the low-voltage coils cannot be connected in parallel for 115 volts.

Oil weighs approximately 7 pounds net per gallon and 8½ pounds shipping.

NOTE—All of the above single-phase transformers can be operated in bank on three-phase with the high-voltage windings connected in star or in delta.

SINGLE-PHASE 25-CYCLE TRANSFORMERS—Continued

FOR SUPPLYING SERVICE VOLTAGES 600 VOLTS AND BELOW—Continued

Capacity Kva.	Type	Dimension Reference Fig.	Item	Approximate Weight, Pounds Net*	Shipping†	Ordering Data: Style No. Transformer Only Class 200	Class 400	Style No. Hanger Iron	Gallons Oil	List Price
				6600-6300-6000-5700 to 220-110 Volts **6900-6585-6275-5960 to 230-115 Volts** 7200-6875-6545-6220 to 240-120 Volts		**(Class 200)**				
				6600-6300-6000-5700 to 440-220 Volts **6900-6585-6275-5960 to 460-230 Volts** 7200-6875-6545-6220 to 480-240 Volts		**(Class 400)**				
1.5	SK	23	3	230	350	267673	267684	109713	8	$ 130 00
3	SK	23	4	346	530	267674	267685	109713	11½	160 00
5	SK	23	4	380	550	267675	267686	109713	11	199 00
7.5	SK	23	5	543	780	267676	267687	109714	16	243 00
10	SK	24	1	748	1100	267677	267688	109714	25	283 00
15	SK	24	3	957	1430	267678	267689	109715	34½	356 00
25	SK	24	4	1080	1700	267679	267690	109715	42	479 00
37.5	SK	22	2	1520	2450	267680	267691	129384	58	623 00
50	SK	22	3	1675	2740	267681	267692	129384	70	743 00
75	SK	22	6	2270	3390	267682	267693	§	97½	980 00
100	SK	22	8	2920	4470	267683	267694	§	138	1154 00
150	SS	33	3	3650	5450	267549¶	267550	§	170	1467 00
200	SS	33	6	4900	7400	267551¶	267552	§	184	1767 00
				11000-10450- 9900 to 220-110 Volts **11500-10925-10350 to 230-115 Volts**		**(Class 200)**				
				11000-10450- 9900 to 440-220 Volts **11500-10925-10350 to 460-230 Volts**		**(Class 400)**				
2.5	SK	23	7	421	610	267695	267704	109713	12	$ 184 00
5	SK	23	8	560	870	267696	267705	109714	18	232 00
10	SK	24	1	748	1100	267697	267706	109714	25	333 00
15	SK	24	4	1080	1650	267698	267707	109715	42	421 00
25	SK	24	5	1390	2120	267699	267708	109715	58	567 00
37.5	SK	22	2	1650	2440	267700	267709	129384	58	715 00
50	SK	22	6	2150	3260	267701	267710	§	97½	870 00
75	SK	22	6	2620	3790	267702	267711	§	97½	1113 00
100	SK	22	8	2910	4470	267703	267712	§	138	1312 00
150	SS	33	3	3650	5450	267543¶	267544	§	170	1667 00
200	SS	33	6	4900	7400	267545¶	267546	§	235	2000 00

*Net weight includes transformer only.

†Shipping weight includes transformer boxed for shipment, complete with hanger irons (when supplied) and oil in container.

§Hanger irons are not included with this capacity as transformer is intended for platform mounting.

¶Low-voltage windings is arranged for 230-volt two-wire and 230-115-volt three-wire operation, but the low-voltage coils cannot be connected in parallel for 115 volts.

Oil weighs approximately 7 pounds net per gallon and 8½ pounds shipping.

NOTE—With the exception of the 11,500-volt transformers all of the above transformers can be operated in bank on three-phase with the high-voltage windings connected in star or in delta. The 11,500-volt transformers are suitable only for delta connection.

SINGLE-PHASE 25-CYCLE TRANSFORMERS—Continued

FOR SUPPLYING SERVICE VOLTAGES 600 VOLTS AND BELOW—Continued

Capacity Kva.	Type	Dimension Reference Fig.	Item	Approximate Weight, Pounds Net*	Shipping†	Ordering Data: Style No. Transformer Only Class 200	Class 400	Style No. Hanger Iron	Gallons Oil	List Price
13200-12540-11880 to 220-110 Volts / 13800-13110-12420 to 230-115 Volts (Class 200)										
2.5	SK	23	7	421	610	267713	267722	109713	12	$ 215 00
5	SK	23	8	560	870	267714	267723	109714	18	269 00
10	SK	24	1	748	1100	267715	267724	109714	25	372 00
15	SK	24	4	1081	1650	267716	267725	109715	42	460 00
25	SK	24	5	1390	2120	267717	267726	109715	58	604 00
37.5	SK	22	2	1650	2445	267718	267727	129384	58	760 00
50	SK	22	6	2150	3260	267719	267728	‖	97½	891 00
75	SK	22	6	2620	3790	267720	267729	‖	97½	1125 00
100	SK	22	8	2910	4470	267721	267730	§	138	1329 00
150	SS	33	5	4400	6450	267737¶	267738	‖	190	1687 00
200	SS	33	6	5050	7500	267739¶	267740	§	230	2033 00
22000-20900-19800 to 220-110 Volts / 23000-21850-20700 to 230-115 Volts (Class 200)										
5	SK	25	2	715	1060	267306	267314	109733	26	$ 510 00
10	SK	25	4	1150	1720	267307	267315	129384	39	597 00
15	SK	25	5	1360	2070	267308	267316	129384	51	686 00
25	SK	26	1	1660	2460	267309	267111	129384	59½	812 00
37.5	SK	26	2	2035	3100	267310	267112	199217	84	960 00
50	SK	26	3	2270	3650	267311	267113	199217	108	1092 00
75	SK	26	4	2837	5000	267312	267141	‖	135	1313 00
100	SK	26	5	3307	5850	267313	267142	§	150	1512 00
150	SC	33	8	4700	7050	267749¶	267750	‖	220	1917 00
200	SC	33	10	5550	8200	267751¶	267752	§	245	2267 00
33000-31350-29700 to 220-110 Volts / 34500-32775-31050 to 230-115 Volts (Class 200)										
10	SC	31	2	900	1390	267509	267510	‖	47	$ 688 00
15	SC	31	3	1050	1850	267511	267512	§	82	763 00
25	SC	31	5	1350	2250	267513	267514	‖	90	902 00
37.5	SC	31	8	1780	3225	267515	267516	‖	150	1054 00
50	SC	31	9	1970	3600	267517	267518	§	170	1183 00
75	SC	32	3	3070	4750	267519	267520	§	160	1421 00
100	SC	33	5	3400	5250	267521	267522	‖	176	1658 00
150	SC	33	11	4970	7675	267525¶	267526	‖	260	2025 00
200	SC	33	11	5570	8200	267527¶	267528	§	245	2363 00

*Net weight includes transformer only.

†Shipping weight includes transformer boxed for shipment, complete with hanger irons (when supplied) and oil in container.

§Hanger irons are not included with this capacity as transformer is intended for platform mounting.

¶Low-voltage winding is arranged for 230-volt two-wire and 230-115-volt three-wire operation but the low-voltage coils cannot be connected in parallel for 115 volts.

Oil weighs approximately 7 pounds net per gallon and 8½ pounds shipping.

NOTE—The above transformers are suitable for delta-connection but not suitable for star-connection on the high-voltage side when banked for three-phase operation.

THREE-PHASE 25-CYCLE TRANSFORMERS

FOR SUPPLYING SERVICE VOLTAGES 600 VOLTS AND BELOW

Capacity Kva.	Type	Dimension Reference Fig.	Item	Approximate Weight, Pounds Net*	Shipping†	Ordering Data: Style No. Transformer Only	Style No. Hanger Iron	Gallons Oil	List Price
	2200–3810 Y to 440-220 Volts **2300–3984 Y to 460-230 Volts** 2400–4157 Y to 480-240 Volts			**(Class 400)**					
5	ST	29	2	450	620	267616	109713	10	$ 266 00
7.5	ST	29	3	535	740	267617	109713	13½	324 00
10	ST	29	1	735	1055	267618	234482	22½	374 00
15	ST	28	3	900	1305	267619	129384	29	467 00
25	ST	28	9	1980	2800	267620	129384	62	629 00
37.5	ST	28	9	1980	2800	267621	129384	62	797 00
50	ST	28	12	2155	3400	267622	199217	100	958 00
75	ST	28	15	2685	4270	267623	‖	144	1272 00
100	ST	28	17	3005	4900	267624	‖	175	‡1544 00

Unless otherwise specified the above three-phase transformers are connected star in the high-voltage and delta in the low-voltage to transform from a nominal line-voltage of 4000 volts. If required with the windings connected delta in the high-voltage to transform from a nominal line voltage of 2300 volts, it should be so specified on the order. Connectors for the delta connection can also be ordered separately as follows:

Connectors for 5-kva. transformer.....Style No. 280436 List price per set $5.00
Connectors for 7.5-kva. to 15 kva. transformers inclusive.....Style No. 280437 List price per set $5.00
Connectors for 25 to 100-kva. transformers inclusive.....Style No. 280438 List price per set $6.00

SINGLE-PHASE 60-CYCLE MANHOLE TRANSFORMERS

FOR SUPPLYING SERVICE VOLTAGES 600 VOLTS AND BELOW

Capacity Kva.	Type	Dimension Reference Fig.	Item	Approximate Weight, Pounds Net*	Shipping†	Ordering Data: Style No. Transformer Only Class 200	Class 400	Gallons Oil	List Price
	2200 to 220-110 Volts **2300 to 230-115 Volts** 2400 to 240-120 Volts			**(Class 200)**		2200 to 440-220 Volts **2300 to 460-230 Volts** 2400 to 480-240 Volts	**(Class 400)**		
5	SM	34	1	268	340	247122	267586	5	$ 168 00‡
7.5	SM	34	2	365	495	247123	267587	7	208 00‡
10	SM	34	3	450	610	247124	267588	10	245 00‡
15	SM	34	3	595	800	247125	267589	11½	309 00‡
25	SM	35	3	935	1270	247127	267590	17½	427 00‡
37.5	SM	35	5	1380	1880	280026	267591	31	550 00‡
50	SM	35	6	1595	2200	247130	267592	36	649 00‡
75	SM	36	1	1600	2520	191395	191396	55	816 00‡
100	SM	36	2	1910	2940	191397	191398	72	948 00‡
150	SKM	36	3	2600	4400	249303¶	267575	175	1180 00‡
200	SKM	36	5	2950	5240	249304¶	267576	225	1370 00‡

*Net weight includes transformer only.

†Shipping weight includes transformer boxed for shipment, complete with hanger irons and fuse blocks (when supplied) and oil in container.

‡Fuse blocks are not included in this price (see pages on "Auxiliary Apparatus").

§Hanger irons are not included with this capacity as transformer is intended for platform mounting.

¶Low-voltage winding is arranged for 230-volt two-wire and 230-115-volt three-wire operation, but the low-voltage windings cannot be connected in parallel for 115 volts.

Oil weighs approximately 7 pounds net per gallon and 8½ pounds shipping.

NOTE—All of the above single-phase transformers can be operated in bank on three-phase operation with the high-voltage windings in star or in delta.

THREE-PHASE 60-CYCLE MANHOLE TRANSFORMERS

FOR SUPPLYING SERVICE VOLTAGES 600 VOLTS AND BELOW

Capacity Kva.	Type	Dimension Reference Fig.	Item	Approximate Weight, Pounds Net*	Shipping†	Ordering Data Style No. Transformer Only Class 200	Class 400	Gallons Oil	List Price
2200–3810 Y to 220-110 Volts **2300–3984 Y to 230-115 Volts** 2400–4157 Y to 240-120 Volts			(Class 200)			2200–3810 Y to 440-220 Volts **2300–3984 Y to 260-230 Volts** 2400–4157 Y to 480-240 Volts		(Class 400)	
5	STM	37	1	376	500	267577	267586	8½	$ 288 00
7½	STM	37	2	455	590	267578	267587	9	333 00
10	STM	37	3	535	710	267579	267588	12	378 00
15	STM	38	1	600	810	267580	267589	15½	450 00
25	STM	38	3	963	1345	267581	267590	26½	595 00
37½	STM	38	4	1325	1840	267582	267591	40	755 00
*50	STM	38	5	1755	2500	267583	267592	58	900 00
75	STM	39	1	2015	2720	267584	267593	52	1150 00
100	STM	39	2	2205	8050	267585	267594	64	1390 00

Unless otherwise specified the above three-phase transformers are connected star in the high-voltage and delta in the low-voltage to transform from a nominal line-voltage of 4000 volts. If required with the windings connected delta in the high-voltage to transform from a nominal line voltage of 2300 volts, it should be so specified on the order. Connectors for the delta connection can be ordered as follows:

Connectors for 5-kva. to 10-kva. transformers, inclusive.....Style No. 280436 List price each $5.00
Connectors for 15-kva. to 50-kva. transformers, inclusive.....Style No. 280437 List price each $5.00
Connectors for 75-kva. to 200-kva. transformers, inclusive.....Style No. 280438 List price each $6.00

*Net weight includes transformer only.

†Shipping weight includes transformer boxed for shipment, complete with oil in container.

Oil weighs approximately 7 pounds net per gallon and 8½ pounds shipping.

OUTLINE DIMENSIONS

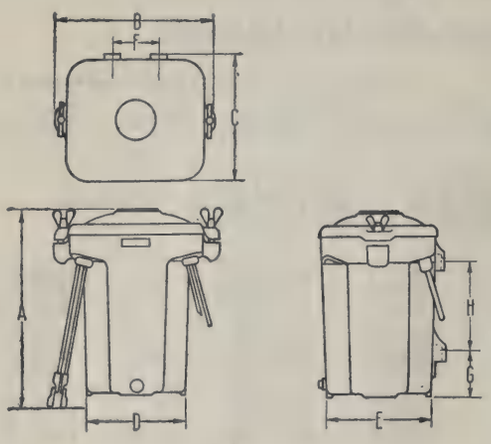


FIG. 20

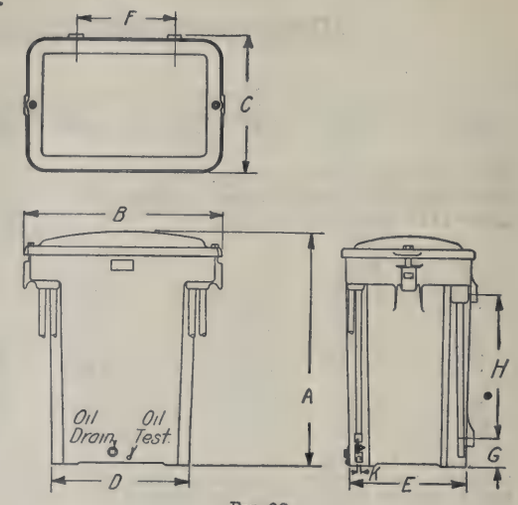


FIG. 23

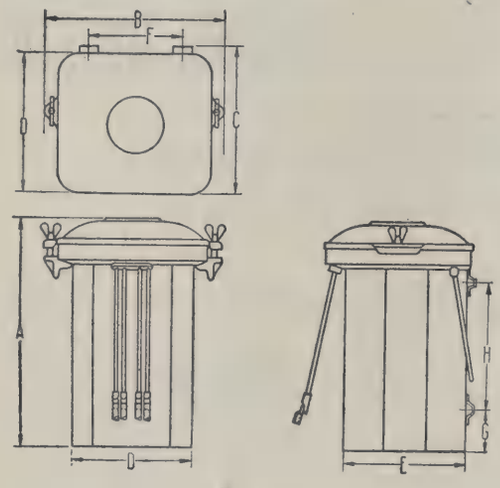


FIG. 21

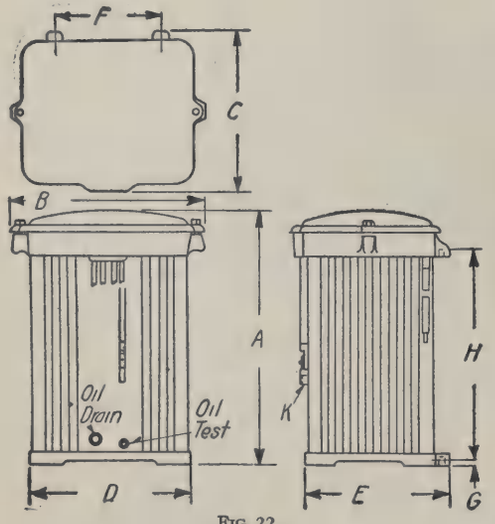


FIG. 22

Dimension Reference Item	DIMENSIONS IN INCHES CORRESPONDING TO LETTERS IN OUTLINE VIEWS							
	A	B	C	D	E	F	G	H
Fig. 20								
1	11 1/16	14 3/8	9 5/8	8 1/16	8 3/16	2 3/4	1 3/16	7
2	12 5/8	15 7/8	12	10 1/2	10 1/2	3 1/4	2 5/16	7
3	14 1/8	15 7/8	12	10 5/8	10 5/16	3 1/2	2 11/16	7
4	16 1/2	18	13 3/4	11 3/4	11 5/8	2	2 1/2	7
5	18 1/2	18	13 3/4	11 3/4	11 5/8	2	3	7
6	20 1/2	18	13 3/4	11 3/4	11 5/8	2	4 1/2	7
7	18 1/16	19 5/8	15 1/16	13 3/16	13 1/16	2	3 1/16	7
8	21	19 5/8	15 1/16	13 3/16	13 1/16	2	3 1/16	11
9	23 1/4	19 5/8	15 1/16	13 3/16	13 1/16	2	3 1/16	11
10	28 1/4	19 5/8	15 1/16	13 3/16	13 1/16	2	3 1/16	11
Fig. 21								
1	21 13/16	22 7/8	20	15 3/4	15 1/4	7 1/2	3 5/8	10
2	27 3/16	22 7/8	20	15 3/4	15 1/4	7 1/2	3 1/4	16
3	31 7/16	22 7/8	20	15 3/4	15 1/4	7 1/2	3 1/2	19 1/2
4	22 1/8	24 1/8	21 7/8	16 13/16	16 5/16	8	3 11/16	10
5	30 1/2	24 1/8	21 7/8	16 3/16	16 5/16	8	2 11/16	19 1/2
6	34 5/8	24 1/8	21 7/8	16 3/16	16 5/16	8	5 3/16	19 1/2
7	41 7/8	24 1/8	21 7/8	16 3/16	16 5/16	8	6 11/16	23
8	31 1/4	28 5/16	23 11/16	18 3/4	18 7/16	10	2 3/4	19 1/2
9	37 1/2	28 5/16	23 11/16	18 3/4	18 5/16	10	6	23
10	40 1/2	28 5/16	23 11/16	18 3/4	18 7/16	10	8	23
11	44 1/2	28 5/16	23 11/16	18 3/4	18 7/16	10	8	27
12	50 1/2	28 5/16	23 11/16	18 3/4	18 7/16	10	8	27
Fig. 22								
1	40	37 1/4	30 5/8	31 1/2	28 3/8	17	5/8	31 5/8
2	44 1/4	37 1/4	30 5/8	31 1/2	28 3/8	17	5/8	35 3/4
3	48 1/4	37 1/4	30 5/8	31 1/2	28 3/8	17	5/8	39 7/8
4	58 1/2	37 1/4	30 5/8	31 1/2	28 3/8	17	5/8	50 1/8
5	64	37 1/4	30 5/8	31 1/2	28 3/8	17	5/8	55 5/8
6	51	40 1/2	34 1/16	34 5/8	30 5/16	.....	.....	.....
7	56 1/4	40 1/2	34 1/16	34 5/8	30 5/16	.....	.....	.....
8	64 1/4	40 1/2	34 1/16	34 5/8	30 5/16	.....	.....	.....
9	69 1/4	40 1/2	34 1/16	34 5/8	30 5/16	.....	.....	.....
10	74 1/4	40 1/2	34 1/16	34 5/8	30 5/16	.....	.....	.....
11	80 1/4	40 1/2	34 1/16	34 5/8	30 5/16	.....	.....	.....
12	86 1/4	40 1/2	34 1/16	34 5/8	30 5/16	.....	.....	.....
Fig. 23								
1	18 1/2	16 1/2	11 5/8	10 5/8	9 3/8	6 1/2	3 7/8	10
2	21 3/8	18 3/8	12 1/8	12 1/2	9 7/8	8 1/2	5 5/8	10
3	23 1/8	19 3/4	13	14 1/4	10 7/8	9	6 1/8	10
4	25 1/2	22 3/8	15 1/4	15 3/4	12 7/8	9	3 3/8	16
5	31	24 5/8	17	17 1/8	14 1/4	9	5 1/2	18
6	25 7/8	22	13 1/8	12	10 3/4	9	4	16
7	27 1/4	24 1/2	15 1/4	15 3/4	12 7/8	9	5 1/8	16
8	32 5/8	25 1/2	17	17 1/8	14 1/4	9	7	18

These dimensions are for reference only. For official dimensions, apply to the nearest district office.

OUTLINE DIMENSIONS—Continued

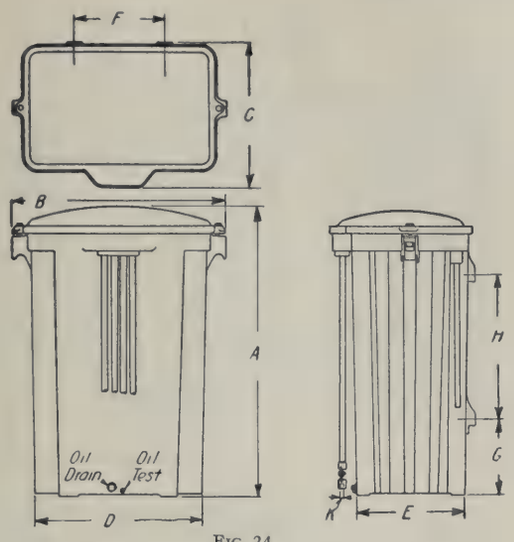


FIG. 24

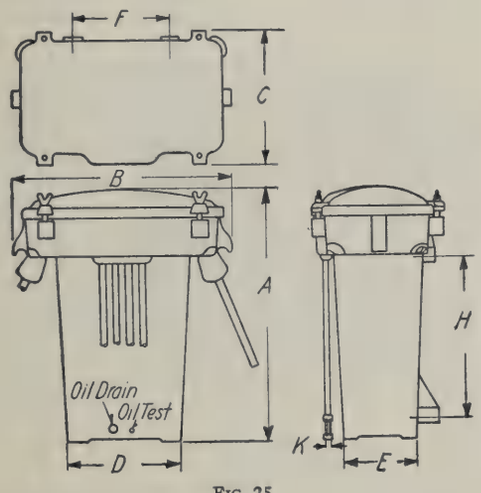


FIG. 25

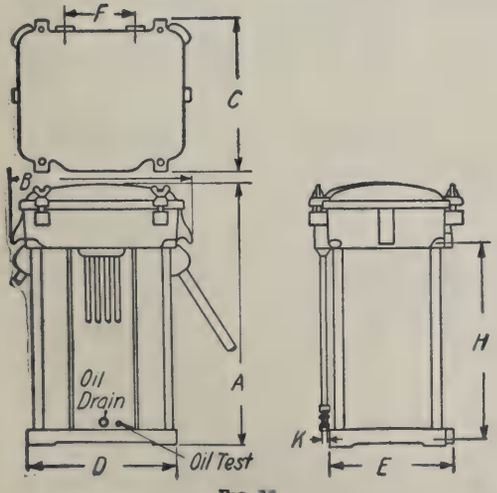


FIG. 26

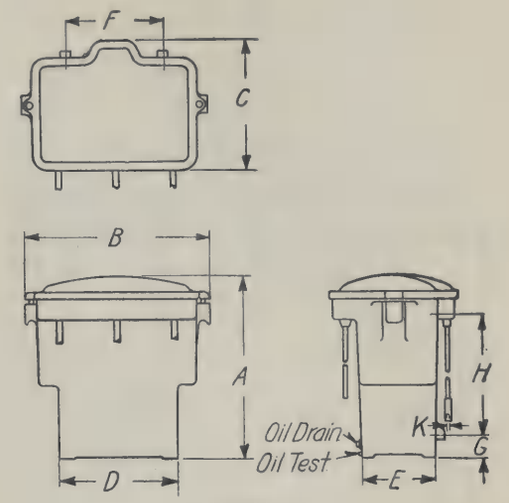


FIG. 27

Dimension Reference Item	Dimensions in Inches Corresponding to Letters in Outline Views							
	A	B	C	D	E	F	G	H
Fig. 24								
1	32	30¾	21⅝	24⅛	15¾	12	3⅞	21
2	36	30¾	21⅝	24	15⅝	12	6⅞	21
3	36⅛	33	22¾	26⅜	17⅜	15	3¾	24
4	42	33	22¾	26¼	17¼	15	7⅝	24
5	48	35½	24½	28⅜	18½	15	13¼	24
Fig. 25								
1	38⅛	29⅝	21	14⅝	13⅞	7¼	....	16
2	39 $\frac{8}{16}$	33⅛	23¾	18⅛	16⅝	9½	....	16
3	40 $\frac{13}{16}$	34	25⅜	18⅞	17⅜	10	....	16
4	42½	35	27⅜	25⅜	18⅞	15	....	20⅝
5	47½	36¾	28¾	28¼	19¾	16	....	28½
Fig. 26								
1	49	34 $\frac{11}{16}$	31⅞	30⅛	28 $\frac{9}{16}$	16	....	36½
2	56 $\frac{3}{16}$	36½	35⅜	31 $\frac{9}{16}$	31 $\frac{7}{16}$	17	....	43½
3	64	36½	35⅜	31 $\frac{9}{16}$	31 $\frac{7}{16}$	17	....	51¼
4	55	44	40¼	39	35¼	†	....	†
5	63	44	40¼	39	35¼	†	....	†
6	80	44	40¼	39	35¼	†	....	†
Fig. 27								
1	20½	20⅞	14¾	13⅜	8¼	11	2½	13½

These dimensions are for reference only. For official dimensions, apply to the nearest district office.

OUTLINE DIMENSIONS—Continued

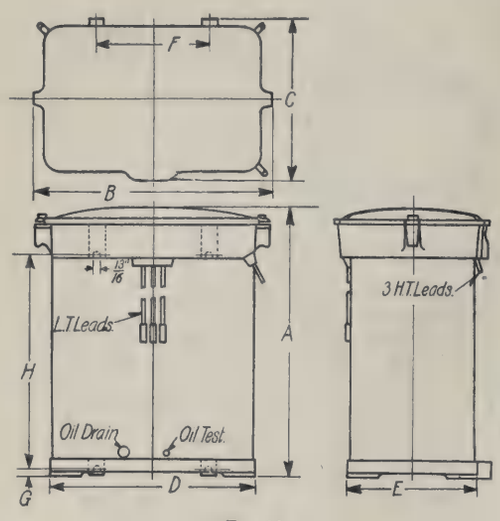


FIG. 28

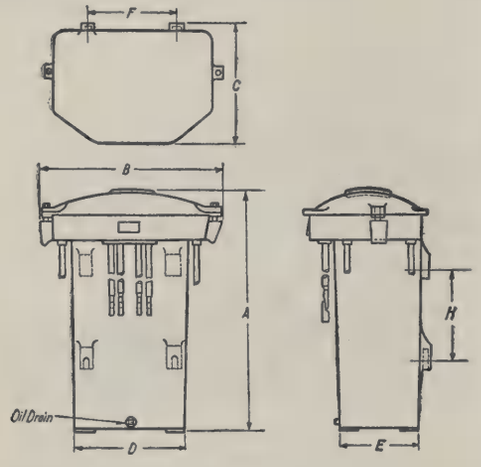


FIG. 29

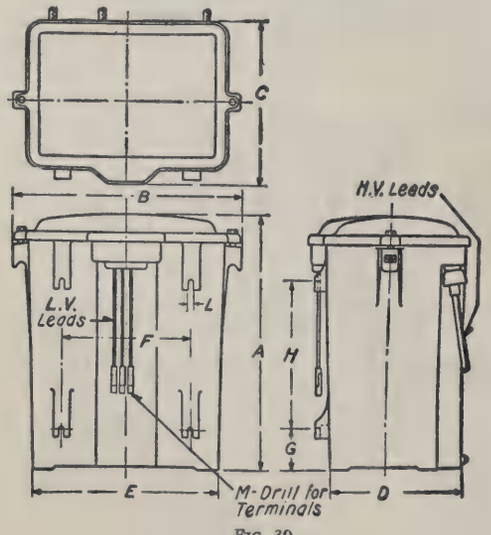


FIG. 30

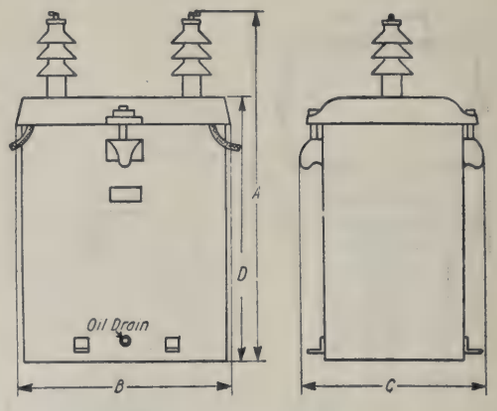


FIG. 31

Dimension Reference Item	Dimensions in Inches Corresponding to Letters in Outline Views							
	A	B	C	D	E	F	G	H
Fig. 28								
1	42 3/8	29 3/4	21 5/8	24	16 1/2	.....	.....	.....
2	31 3/8	32 1/2	22 3/4	27 1/2	21 3/8	16	5/8	23 1/8
3	42	35 1/2	26 3/4	29 1/8	23 1/8	16	5/8	32 5/8
4	45 5/8	35 1/2	26 3/4	29 1/8	23 1/8	16	5/8	36 1/4
5	38 1/4	40 3/4	28 1/8	34	23 1/8	on ap	plica	tion
6	48	40 3/4	28 1/8	34	23 1/8	on ap	plica	tion
7	56	40 3/4	28 1/8	34	23 1/8		"	
8	62	40 3/4	28 1/8	34	23 1/8		"	
9	40 5/8	45	29 1/2	38 3/8	24 1/2	21	12/32	31 3/8
10	44	45	29 1/2	38 3/8	24 1/2	21	12/32	34 3/4
11	54	45	29 1/2	38 3/8	24 1/2	21	12/32	46 3/4
12	57 1/4	45	29 1/2	38 3/8	24 1/2	21	12/32	50
13	46	51 1/4	32 3/4	45 3/8	27 5/8	.....	.....	.....
14	52	51 1/4	32 3/4	45 3/8	27 5/8	.....	.....	.....
15	58	51 1/4	32 3/4	45 3/8	27 5/8	.....	.....	.....
16	62	51 1/4	32 3/4	45 3/8	27 5/8	.....	.....	.....
17	68	51 1/4	32 3/4	45 3/8	27 5/8	.....	.....	.....
18	80	51 1/4	32 3/4	45 3/8	27 5/8	.....	.....	.....
19	65	55	35	50	31	.....	.....	.....
20	75	55	35	50	31	.....	.....	.....
Fig. 29								
1	21 5/8	25 1/2	15	15 7/8	10 1/8	10	....	11
2	24 1/2	27 1/2	16 3/8	17 3/4	11	11 1/2	....	16
3	28 3/4	29 1/4	17 1/8	19 1/4	11 3/4	12	....	....
Fig. 30								
1	29 1/4	28 1/4	19 7/8	12 3/4	23	16	3 5/8	18
2	31 3/8	29 3/4	21 5/8	16 1/2	24 3/8	18	5	16
3	37 3/8	29 3/4	21 5/8	16 1/2	24 1/8	24	5	16
4	42 3/8	29 3/4	21 5/8	16 1/2	24 1/8	24	10	16

Dimension Reference Item	Dimensions in Inches Corresponding to Letters in Outline Views			
	A	B	C	D
Fig. 31				
1	67	28	23	42
2	73	28	23	48
3	73	32	26	48
4	79	32	26	54
5	85	32	26	60
6	79	39	30	54
7	85	39	30	60
8	91	39	30	66
9	97	39	30	72
10	84	56	30	60
11	89	56	30	65
12	77	46	24	53

These dimensions are for reference only. For official dimensions, apply to the nearest district office.

OUTLINE DIMENSIONS—Continued

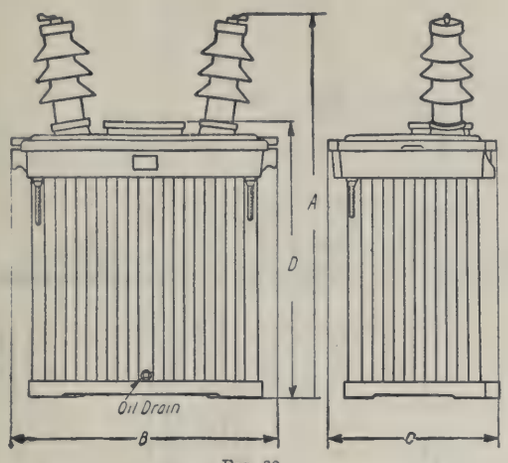


FIG. 32

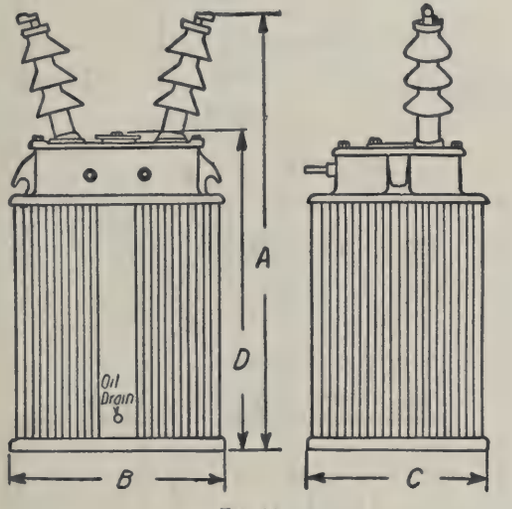
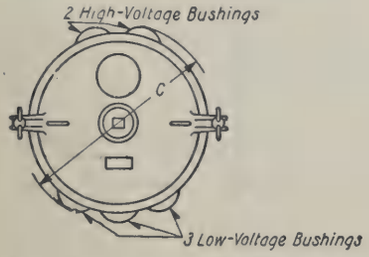


FIG. 33



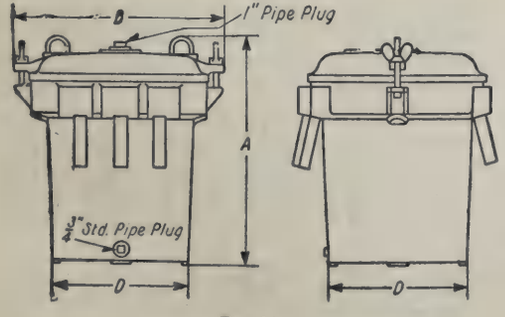


FIG. 34

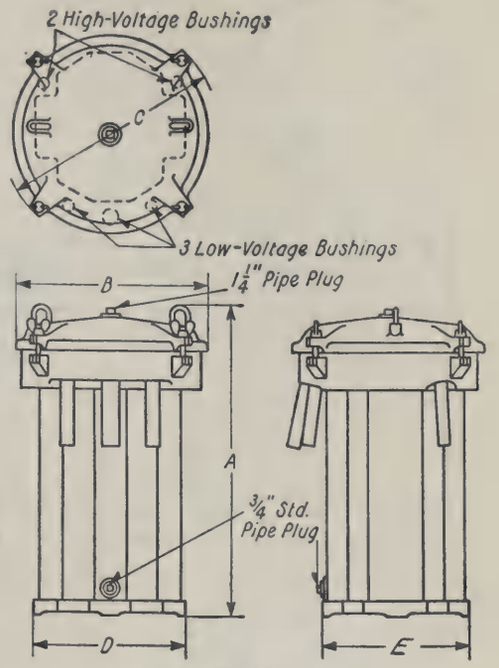


FIG. 35

Dimension Reference Item	Dimensions in Inches Corresponding To Letters in Outline Views				
	A	B	C	D	E
Fig. 32					
1	79	52	33	54	..
2	84	52	33	64	..
3	89	52	33	64	..
4	90	52	33	70	..
5	95	52	33	70	..
Fig. 33					
1	83	33	33	71	..
2	93	33	33	81	..
3	97	33	33	81	..
4	83	39	39	71	..
5	87	39	39	71	..
6	97	39	39	81	..
7	108	39	39	92	..
8	84	51	38	64	..
9	89	51	38	64	..
10	92	51	38	72	..
11	97	51	38	72	..
12	102	51	38	82	..
13	107	51	38	82	..
14	82	51	29	58	..
15	90	51	29	66	..
16	97	51	29	73	..
17	96	60	36	72	..
Fig. 34					
1	22¼	19⅞	19⅞	12¾	..
2	24⅝	20½	21¼	14	..
3	28⅝	22¾	22⅜	14⅝	..
Fig. 35					
1	30	23¾	26½	18½	18
2	36	23¾	26½	18½	18
3	36⅛	25⅛	27¼	19½	19¼
4	44⅜	25⅛	27¼	19½	19¼
5	45⅜	26⅞	29½	21⅝	21½
6	49⅝	26⅞	29½	21⅝	21½

These dimensions are for reference only. For official dimensions, apply to the nearest district office.

OUTLINE DIMENSIONS—Continued

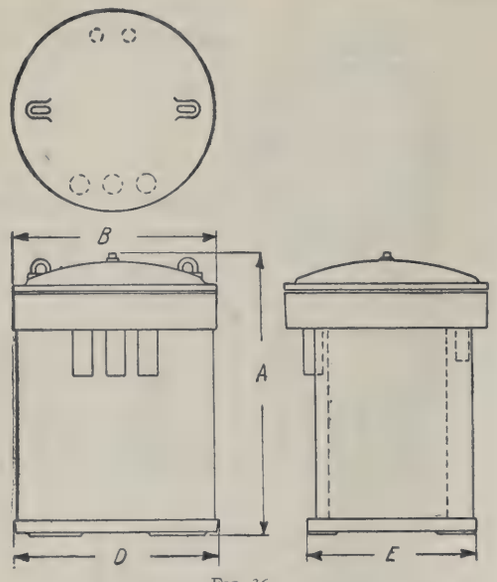


FIG. 36

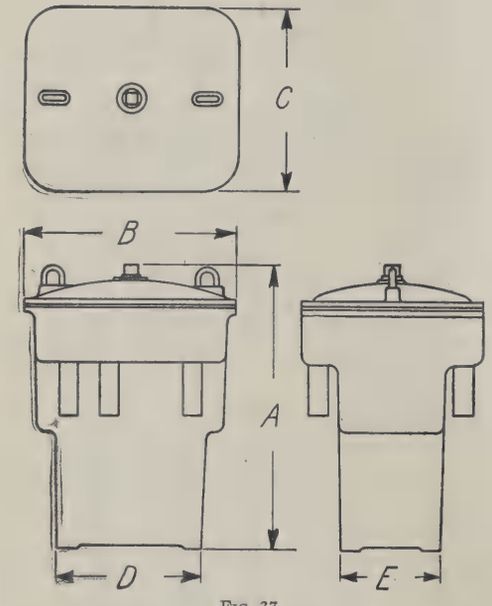


FIG. 37

Dimension Reference Item	Dimensions in Inches Corresponding to Letters in Outline Views				
	A	B	C	D	E
Fig. 36					
1	50 5/8	31 1/4	....	31 1/4	25 11/16
2	61 3/8	31 1/4	....	31 1/4	25 11/16
3	57 1/2	39 1/4	....	34 13/16	....
4	72	39 1/4	....	34 13/16	....
5	89 1/2	39 1/4	....	34 13/16	....
Fig. 37					
1	26 3/4	20 3/4	17 3/4	14 3/4	9 3/4
2	28	21 3/4	18 3/4	15 1/4	10 1/2
3	28 3/4	22 3/4	19 1/2	16 3/4	11 1/4

These dimensions are for reference only. For official dimensions, apply to the nearest district office.

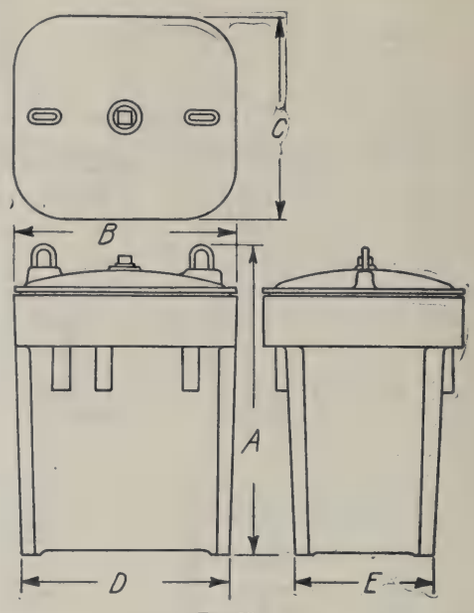


FIG. 38

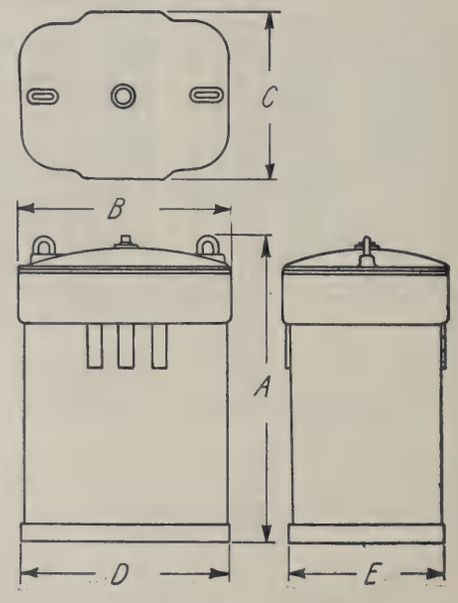


FIG. 39

Dimension Reference Item	Dimensions in Inches Corresponding to Letters in Outline Views				
	A	B	C	D	E
Fig. 38					
1	32 3/4	23 3/8	21 1/4	20	11 3/4
2	34 3/4	27 3/8	21 1/2	26	15 5/8
3	39 3/4	27 3/8	21 1/2	25 3/4	15 5/8
4	45	31 1/4	23 1/2	29 1/2	16 3/4
5	47 1/2	34	25	32 1/4	19 1/2
Fig. 39					
1	49	33 3/8	26 1/2	33 3/8	23 3/4
2	57 3/8	33 3/8	26 1/2	33 3/8	23 3/4

These dimensions are for reference only. For official dimensions, apply to the nearest district office.

OUTLINE DIMENSIONS—Continued

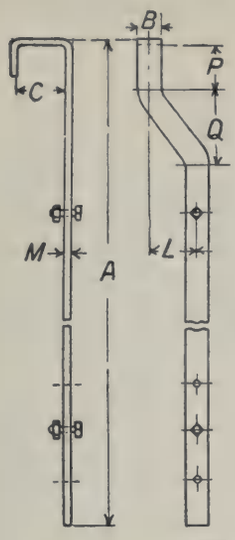


FIG. 40

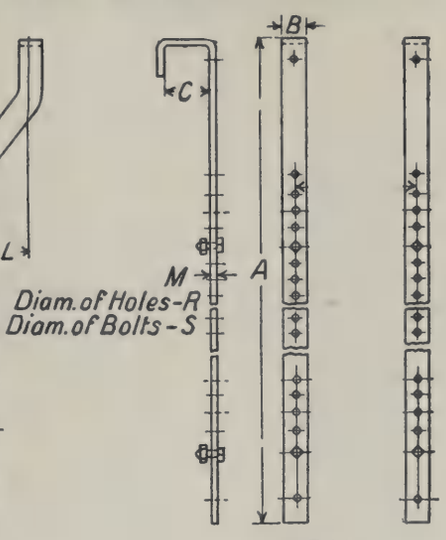


FIG. 41

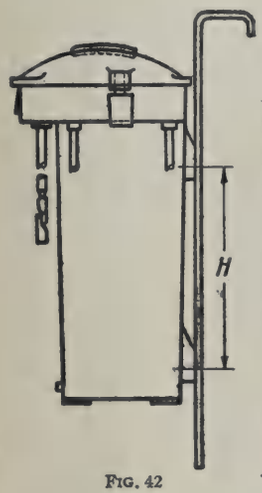


FIG. 42

Style No.	Fig.	Dimensions in Inches Corresponding to Letters in Outline Drawings									Approx. Net Wt. Per Pair, Pounds	Approx. Shipping Weight Per Pair, Pounds	Dimension H Fig. 45 Figures below give distance in inches between holes provided to mount transformers on hanger irons
		A	B	C	L	M	P	Q	R	S			
109712	40	28¼″	1¼″	4″	4½″	¼″	1″	7″	7/16″	⅜″	6	8	7″—11″
109713	40	33⅞″	1¾″	4″	4½″	⅜″	1″	7″	9/16″	½″	15	20	7″-10″-11″-16″
109714	40	43½″	2¼″	4″	4½″	½″	1″	7″	13/16″	¾″	34	34	18″—21″
109715	40	54¼″	2¼″	4″	4½″	¾″	1″	7″	13/16″	¾″	60	60	24″
109733	40	43⅜″	1¾″	4″	4½″	⅜″	1″	7″	9/16″	½″	19	23	16″
234482	40	43¾″	2¼″	4″	4½″	½″	1″	7″	9/16″	½″	30	35	19½″—23″
199217	41	64″	3″	4″	...	¾″	..	..	13/16″	¾′	81	81	43½″-44¾″-45⅝″ 46⅞″-48″-49⅛″- 50⅛″-51¼″ 23⅜″-23⅝″-23¾″ 24″-25⅝″-26⅛″- 27⅞″-28½″-28¾″ 28⅞″-29¾″-30⅝″ 31⅜″-31⅝″-32″- 32⅞″-33⅜″-34¾″ 35¾″-36½″-37″- 39⅞″-40⅝″-44¾″
129384	41	58″	3″	4″	...	¾″	..	..	13/16″	¾″	82	82	

*Note that on account of the number of holes provided, the same style hanger irons can be used in many cases to mount different size transformers.

The dimensions on this page are for reference only. For official dimensions apply to nearest district office.

STANDARDIZATION OF DISTRIBUTION TRANSFORMERS

During the past several years the subject of Transformer Standardization has received considerable attention from the American Institute of Electrical Engineers, the National Electric Light Association and the Electric Power Club. The work of the American Institute of Electrical Engineers has been devoted to the formation of rules covering methods of rating and testing while the National Electric Light Association and the Electric Power Club have directed their efforts to the standardization of commercial capacity, voltage, and frequency ratings.

The most important rules from an operating standpoint established as a result of the standardization work of the American Institute may be summarized by the statements that the maximum temperature rise of a transformer, under continuous full-load operation should not exceed 55° C above an ambient or air temperature of 40° C and that the copper loss should be measured by a wattmeter and the result corrected to a temperature of 75° C.

The most important results of the Standardization work of the National Electric Light Association and the Electric Power Club, insofar as it covers distribution transformers, are summarized in the following tabulations for single-phase and three-phase transformers. The tabulation for single-phase transformers is divided into two parts, one including transformers for supplying service voltages 600 volts and below, the other including transformers for supplying distribution voltages above 600 volts.

STANDARD TYPES, FREQUENCIES, SIZES, AND VOLTAGE RATINGS OF DISTRIBUTION TRANSFORMERS

Single-Phase, Sizes 200 Kva. and Below for Supplying Miscellaneous Lighting and Power Service

Standard Types { Oil-immersed, Self-cooled. **Standard Frequencies** { 25 cycles per second. 60 cycles per second. **Standard Sizes** in kva continuous ratings at 55°C. rise for single-phase transformers { 1, 1.5, 2, 2.5, 3, 5, 7.5, 10, 15, 25, 37.5, 50, 75, 100, 150 and 200

NOTE—See following Table for sizes that are standard for the various voltage classes.

Standard Size Limits, Voltage Ratings and Taps of Single-Phase Transformers

Standard Line Voltages	Standard Sizes in Kva. Continuous Ratings for Each Voltage Class	Standard Voltage Ratings and Taps of Single-Phase Transformers for Supplying Service Voltages 600 and Below							Standard Voltage Ratings and Taps of Single-Phase Transformers for Supplying Distribution Voltages Above 600			
		Transformer High-Voltage Ratings for Operation from Various Standard Line Voltages				Transformer Low-Voltage Ratings for Supplying Service Voltages 600 and Below			Transformer High-Voltage Ratings for Operation from Various Standard Line Voltages			Transformer Low Voltage Ratings for Supplying Nominal 2300 or 4000 Volt Distribution
		On Full Winding	Approximately on Taps						Full Winding	Approximately On 5% Tap	On 10% Tap	
440	1-2-3 to 100 incl.	**440**				.....to 220—110						
		460				.....to 230—115						
		480				.....to 240—120						
550	1-2-3 to 100 incl.	550				.....to 220—110						
		575				.....to 230—115						
		600				.....to 240—120						
2300	1-2-3 to 200 incl.	2200				.....to 220—110	.....or to 440—220	.....or to 550				
		2300				.....to 230—115	.....or to 460—230	.....or to 575				
		2400				.....to 240—120	.....or to 480—240	.....or to 600				
4600	1-2-3 to 200 incl.	2200—4400				.....to 220—110						
		2300—4600				.....to 230—115						
		2400—4800				.....to 240—120						
6600	1.5-3 to 200 incl.	6600-11430Y	6300	6000	5700	.....to 220—110	.....or to 440—220	.....or to 550				
		6900-11950Y	6585	6275	5960	.....to 230—115	.....or to 460—230	.....or to 575	6600-11430Y	6270	5940	.....to **2300**
		7200-12470Y	6875	6545	6220	.....to 240—120	.....or to 480—240	.....or to 600				
11000	2.5-5-10 to 200 incl.	11000	10450	9900		.....to 220—110	.....or to 440—220	.....or to 550				
		11500	10925	10350		.....to 230—115	.....or to 460—230	.....or to 575	11000	10450	9900	.....to **2300-4000Y**
13200	2.5-5-10 to 200 incl.	13200	12540	11880		.....to 220—110	.....or to 440—220	.....or to 550				
		13800	13110	12420		.....to 230—115	.....or to 460—230	.....or to 575	13200	12540	11880	.....to **2300-4000Y**
22000	5-10 to 200 incl.	22000	20900	19800		.....to 220—110	.....or to 440—220	.....or to 550				
		23000	21850	20700		.....to 230—115	.....or to 460—230	.....or to 575	22000	20900	19800	.....to **2300-4000Y**
33000	10 to 200 incl.	33000	31350	29700		.....to 220—110	.....or to 440—220	.....or to 550				
		34500	32775	31050		.....to 230—115	.....or to 460—230	.....or to 575	33000	31350	29700	.....to **2300-4000Y**

Transformers having low-voltage rating of 230—115 for sizes 100 kva. and below are arranged for series, multiple or three-wire service by connection of the low-voltage leads outside the transformer tank; whereas sizes 125, 150 and 200 kva. are suitable for series or three-wire service only. Transformers having low-voltage rating of 460-230 for sizes 200 kva. and below, are suitable for series or multiple service only.

NOTE—These odd taps for distribution transformers of the 6600-volt class are chosen because of present established practice.

Standard single-phase distribution transformers for supplying nominal 2300 or 4000-volt distribution and having voltage ratings listed above, will be designed for successful operation when excited on full winding at 5 per cent above their rated voltage.

Transformers having voltage rating of 6600-11430Y to 2300, are when operated in bank, suitable for transforming from 6600 to 2300; from 6600 to 4000Y or from 11430Y to 2300. They should not be used connected in "Y" on both high and low-voltage sides simultaneously to transform from 11430Y to 4000 Y as this connection may result in the presence of excessive stresses in the windings due to harmonic voltages.

NOTE—Voltage ratings in bold type will be considered the normal voltage ratings of those lines and guarantees will be made only on these normal voltage ratings. It is understood however, that where a transformer is suitable for operation at two voltage ratings or at three voltage ratings, this flexibility will be definitely indicated on the nameplate, on the connection diagram, or on a paster inside the transformer cover.

Standard transformers having voltage ratings listed above will be designed for full rated kv-a. output at any specified tap voltage (not exceeding 10 per cent range) without exceeding guaranteed temperature rise.

The voltages 2300-4000Y are nominal voltages. The exact line voltage from three-2300-volt windings, star-connected is 3985 volts.

STANDARD TYPES, FREQUENCIES, SIZES, AND VOLTAGE RATINGS OF DISTRIBUTION TRANSFORMERS—Continued

Three-Phase, Sizes 200 Kva. and Below for Supplying Miscellaneous Lighting and Power Service

Standard Types { Oil-immersed. / self-cooled.

Standard Frequencies { 25 cycles per second. / 60 cycles per second.

Standard Sizes in kva. continuous ratings at 55°C. rise for three-phase transformers { 5, 7.5, 10, 15, 25, 37.5, 50, 75, 100, 150 and 200

NOTE—See following table for sizes that are standard for the various voltage classes

Standard Size Limits, Voltage Ratings and Taps of Three-Phase Transformers

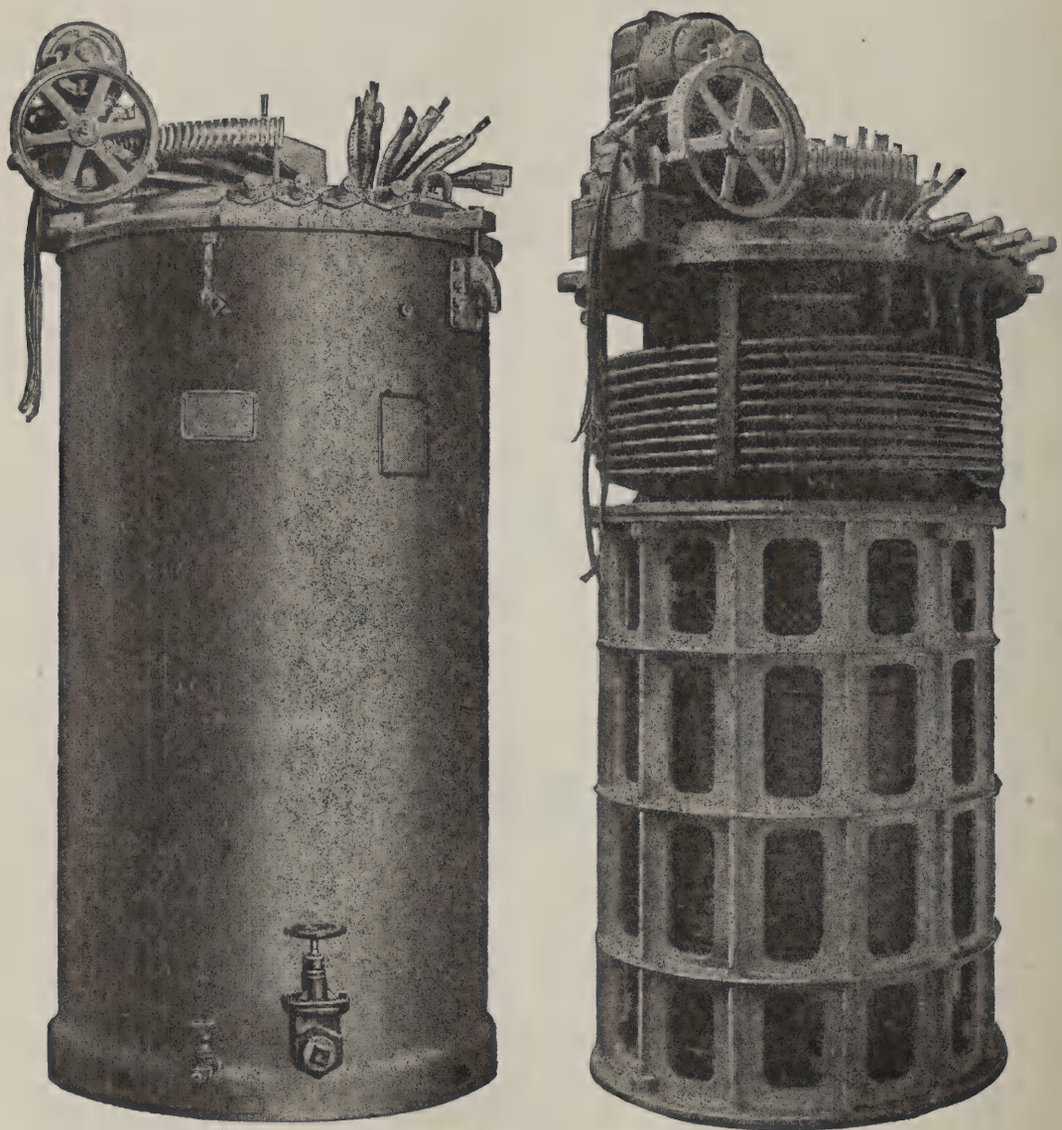
		For Supplying Service Voltages 600 and Below		
		Transformer High Voltage Ratings For Operation From Various Standard System Voltages		
Standard Line Voltages	Standard Sizes for Each Voltage Class	On Full Winding	Approximately on 10% Tap	Transformer Low Voltage Ratings for Supplying Service Voltage 600 and Below
2300	5 to 200 incl.	2200/3810Y **2300/4000Y** 2400/4150Y		to 220/440 to **230/460** to 240/480
4600	5 to 200 incl.	4400Y **4600Y** 4800Y		to 220/440 to **230/460** to 240/480
6600	10 to 200 incl.	6600Y **6900Y** 7200Y	5940 **6210** 6480	to 220/440 to **230/460** to 240/480
11000	10 to 200 incl.	11000Y **11500Y**	9900 10350	to 220/440 to **230/460**
13200	10 to 200 incl.	13200Y **13800Y**	11880 12420	to 220/440 to **230/460**
22000	15 to 200 incl.	22000Y **23000Y**	19800 20700	to 220/440 to **230/460**
33000	25 to 200 incl.	33000Y **34500Y**	29700 31050	to 220/440 to **230/460**

NOTE—All sizes of distribution transformers having low voltage ratings of 230/460 are suitable for series or multiple three-phase service only by proper connection inside of the tank.

NOTE—Voltage ratings in bold type will be considered the normal voltage ratings of these lines and guarantees will be made only on these normal voltage ratings. It is understood, however, that where a transformer is suitable for operation at two-voltage ratings or at three-voltage ratings, this flexibility will be definitely indicated on the nameplate on the connection diagram or on a paster inside the transformer cover.

Standard transformers having voltage ratings listed above will be designed for full rated kva. output at any specified tap voltage without exceeding guaranteed temperature rise.

In general standard three-phase distribution transformers are not suitable for multiple operation with a bank of standard single-phase distribution transformers as the angular displacement, turn ratio and impedance volts on which successful multiple operation depends are generally different on three-phase and single-phase transformers.



COMPLETE — REMOVED FROM TANK

ONE OF THE LARGEST WATER-COOLED FEEDER REGULATORS EVER BUILT

TYPE C INDUCTION FEEDER-VOLTAGE REGULATORS

FOR INDOOR MOUNTING

Second only to a continuous dependable supply of electrical energy, the most important characteristic in providing successful central station service is the maintenance of steady voltage. Users of electric light and power are more and more demanding a steady normal voltage at their premises—it is a fundamental requirement for good lighting, and essential for the most satisfactory supply of power.

And besides being demanded by consumers, constant normal voltage at distributing centers proves a direct source of income to the central station. During the periods of peak load the sale of a considerable amount of power is lost by reason of the decreased wattage consumption of lamps and other devices unless normal voltage is maintained at the consumer's service. And during periods of light load considerable saving can be effected in the cost of lamp renewals if the voltage is held from rising above normal, since the life of incandescent lamps is decreased rapidly by over-voltage.

Since in all modern central stations constant potential is maintained on the main bus-bars, the voltage at distributing points on the various feeders supplied from these bus-bars will inherently vary, depending upon the length, size, and arrangement of feeder and the load at each instant. In order, then, to maintain normal voltage at points of distribution, it is necessary to regulate the voltage of each feeder independently of the voltage of the other feeders.

Westinghouse type C induction feeder-voltage regulators are built both single-phase and polyphase and are used for maintaining constant normal voltage on each feeder of a transmission or distributing system, independently of all other feeders on the system. They are also finding economical use on feeder circuits on which it is desirable to increase the normal load, it being less expensive in many cases to install a regulator to obtain normal voltage under the new load conditions rather than to install a heavier feeder.

DISTINCTIVE FEATURES

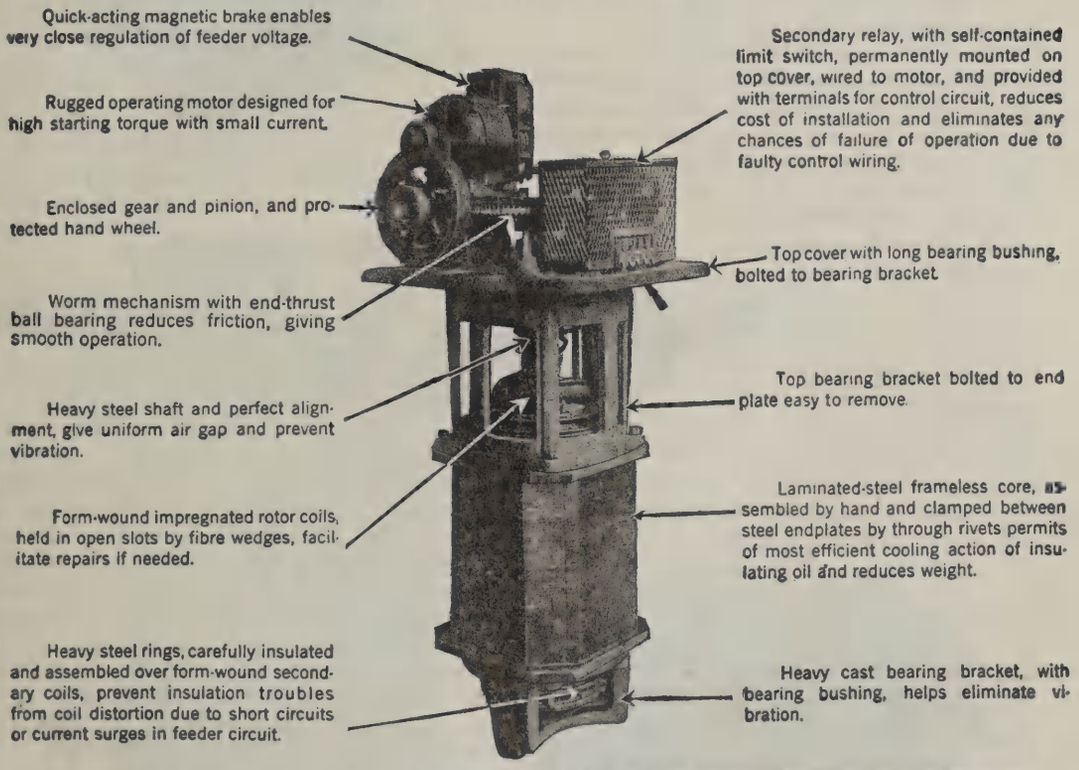

Quick-acting magnetic brake enables very close regulation of feeder voltage.
Rugged operating motor designed for high starting torque with small current.
Enclosed gear and pinion, and protected hand wheel.
Worm mechanism with end-thrust ball bearing reduces friction, giving smooth operation.
Heavy steel shaft and perfect alignment, give uniform air gap and prevent vibration.
Form-wound impregnated rotor coils, held in open slots by fibre wedges, facilitate repairs if needed.
Heavy steel rings, carefully insulated and assembled over form-wound secondary coils, prevent insulation troubles from coil distortion due to short circuits or current surges in feeder circuit.
Secondary relay, with self-contained limit switch, permanently mounted on top cover, wired to motor, and provided with terminals for control circuit, reduces cost of installation and eliminates any chances of failure of operation due to faulty control wiring.
Top cover with long bearing bushing, bolted to bearing bracket.
Top bearing bracket bolted to end plate easy to remove.
Laminated-steel frameless core, assembled by hand and clamped between steel endplates by through rivets permits of most efficient cooling action of insulating oil and reduces weight.
Heavy cast bearing bracket, with bearing bushing, helps eliminate vibration.

FIG. 1—DETAILS OF CONSTRUCTION—MOTOR-OPERATED SINGLE-PHASE TYPE C INDUCTION FEEDER-VOLTAGE REGULATOR WITH TANK REMOVED

Showing Construction that Enables Regulator to Be Removed from Tank as a Unit for Inspection and Repairs

(Capacities 5¾ to 69 Kva. 60 Cycles 2300 Volts O.I.S.C.)

In addition to the features shown in the above illustration, the following are numbered among the many distinctive features of Westinghouse induction feeder-voltage regulators:

1. They have especially high electrical performance.

2. They are of very rugged construction and operate with very low maintenance expense.

3. They are self-contained in a sheet-steel cast-in tank with welded seams. This type of tank radiates heat better, is stronger per unit weight, and is less liable to develop leaks in service, than any other construction. The tank is furnished with an oil guage and a one-inch outlet with pipe cap for drawing off the oil. A small outlet with ¼-inch pipe plug is placed in the wall near bottom of tank for drawing of samples of oil for inspection and test.

4. Compounding coils on the primary relay prevent "hunting" of the regulator and practically eliminate sparking of the relay contacts.

FIG. 2—TYPE C MOTOR-OPERATED SINGLE-PHASE INDUCTION REGULATOR, COMPLETE
(60 Cycles Kva., 2300 Volts O.I.S.C.)

OPERATION

Regulation of feeder voltage is accomplished by turning the rotor, either by hand or electrically, so as to change the relation of the rotor winding to the stator winding. Regulation is smooth and gradual in either direction throughout the entire range of the regulator. The circuit is not opened at any point, the effect of the regulator being practically the same as would be obtained by changing the generator voltage.

Theory of Operation of Single-Phase Regulator—The single-phase regulator is in effect a two-winding transformer, with the secondary winding arranged for connection in series and the primary winding arranged for connection directly across the line. With a transformer thus connected a voltage will be induced in the secondary that will add to or subtract from the feeder voltage according to the connections used.

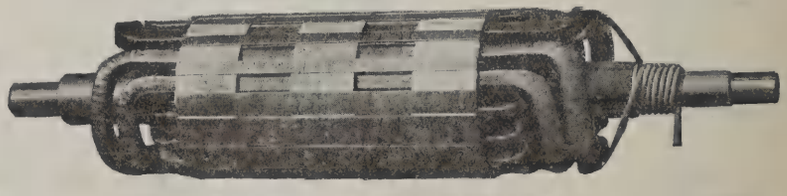


FIG. 3—SINGLE-PHASE ROTOR (PRIMARY)

With the regulator, the primary winding is the movable winding (the rotor, see Fig. 3) and the secondary the stationary winding (the stator, see Fig. 4). Now, as with a transformer, the current in the primary produces a magnetic field that induces a voltage in the secondary. The portion of this field passing through the secondary winding, and consequently the voltage induced in that winding, depends upon the angular position of the secondary with respect to the direction of the primary field.—The induced voltage is a maximum when the axes of the coils coincide; zero when the coils are at right angles to each other; and maximum in the opposite direction when the axes of the coils coincide but with primary coils reversed in position.—This induced voltage in the secondary therefore adds to or subtracts from the feeder voltage by a value varying from maximum regulation to zero, according to the position of the coils.

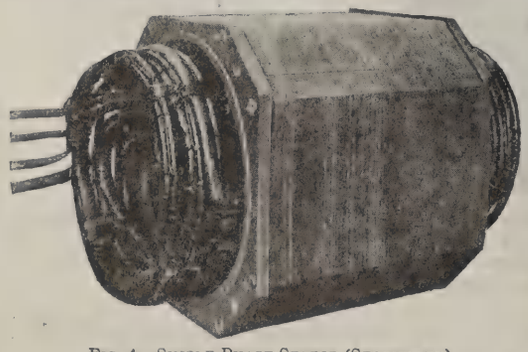


FIG. 4—SINGLE-PHASE STATOR (SECONDARY)
Showing Bracing Rings on End Turns of Coils

It is evident that a magnetic field is also set up by the line current flowing through the secondary windings (stator coils) which, if not neutralized, would produce a choking effect and lower the power

factor in the feeder circuit. This choking effect would occur whenever the primary winding (rotor) is in any position other than where the axes of the two windings coincide—the positions of maximum "buck" or "boost"—being minimum near these positions and maximum when the axes of the two windings are at right angles to each other—the neutral positions. To overcome this choking effect, a short-circuited winding is placed in partially closed slots in the rotor core and at right angles to the primary coils; this short-circuited winding acts as a secondary to the stator coils and neutralizes their choking effect. By using a large number of turns of relatively small insulated wire in the short-circuited winding, the choking effect is neutralized with a comparatively small copper loss in the short-circuited winding.

Theory of Operation of Polyphase Regulator—The polyphase regulator may be likened somewhat to a phase-wound polyphase motor. The regulator primary (rotor) is wound with a distributed winding of the same number of phases as there are phases in the feeder to be regulated and each phase is connected across a separate phase of the feeder. The regulator secondary (stator), is made up of separate windings of the same number as the primary, and each of these separate windings is connected in series with one of the feeder wires.

The primary sets up a rotating magnetic flux of constant value, which induces a constant voltage in each of the secondary windings. The induced voltage is therefore added vectorially to the feeder voltage and accordingly the feeder voltage is changed by an amount of the induced voltage proportional to the cosine of the phase angle between the feeder and regulator voltages, which is the same as the angle between windings. As the position of the rotor is changed, the phase angle between the feeder voltage and the secondary voltage correspondingly changes, and the feeder voltage is either increased or decreased as the phase angle is less or greater than 90 degrees.

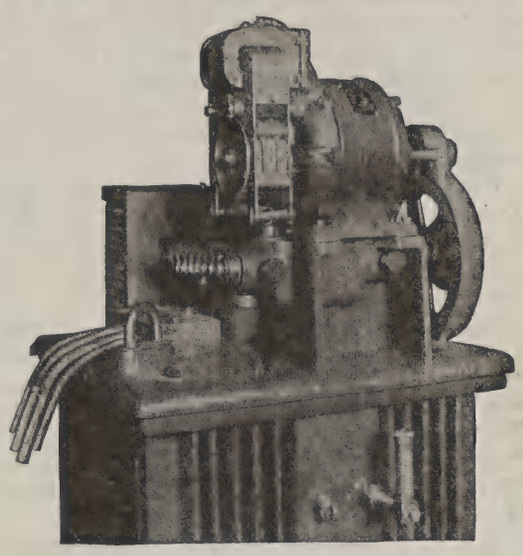


FIG. 5—MOTOR-OPERATED REGULATOR, Showing Details of Operating Mechanism

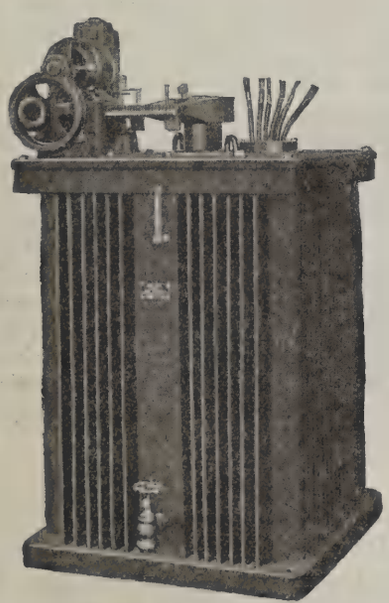


FIG. 6—THREE-PHASE O.I.S.C. MOTOR-OPERATED REGULATOR
Typical Construction Used for Capacities 60 to 100 Kva.

Since the polyphase regulator has windings distributed around the entire circumference of the rotor, these windings will also act as neutralizing windings for the various stator windings and no separate short-circuited windings, as in the case of single-phase regulators, are necessary.

Motor-Operated—In the standard regulators, the rotor is turned by a small alternating-current induction motor driven through a pinion, spur gear, worm, and worm segment (see Fig. 5). The motor is controlled non-automatically by a hand-operated switch, or by an electrically operated switch with push-button control mounted in any convenient location; or automatically by means of relays and other accessories especially made for the service. The motor-operated regulators are equipped with a hand wheel to operate them by hand in case of failure of the control circuit.

Hand-Operated—Regulators that are operated by hand can be supplied only on special order. For these a suitable hand wheel is supplied. This wheel may be connected directly to the worm shaft or mounted separately from the regulator and arranged to operate it by means of a chain and sprokets.

TYPE C INDUCTION FEEDER-VOLTAGE REGULATORS—Continued

OPERATING CHARACTERISTICS

Efficiency—The use of high-grade sheet steel in the magnetic circuit, combined with the effective mechanical construction, results in a uniformly low iron loss and therefore high "all-day" efficiency. The use of copper of liberal cross-section produces windings of low resistance, giving low copper loss and therefore high full-load efficiency. The guaranteed efficiency of any particular regulator will be supplied on request.

Temperature Rise—The windings of Westinghouse induction feeder-voltage regulators will carry their full rated current continuously with a maximum temperature rise of 55 degrees centigrade above that of the surrounding atmosphere.

Due to the distribution of windings, careful disposition of insulation, and provision for oil circulation, these regulators operate under uniform temperature rise without hot spots in the windings. Their construction is such that an extra large surface of their coils and core is exposed to the cooling action of the oil; while the tank provides a liberal heat radiating surface.

Insulation Test—Standard Westinghouse induction feeder voltage regulators are subjected to insulation test as specified in A. I. E. E. rules. All 2300-volt single-phase regulators are subjected to an insulation test of 7500-volts for one minute between iron and winding, so that they may be used on 4000-volts three-phase four-wire grounded circuits. In addition to this, an overvoltage run, with 200 per cent normal voltage, is made for five minutes.

FIG. 7—THREE-PHASE O.I.W.C. MOTOR-OPERATED REGULATOR

CONSTRUCTION

(See also description on and under Fig. 2 relating to "Distinctive Features")

Mechanical construction and design have been given special attention in Westinghouse induction feeder-voltage regulators, as these are important characteristics that largely determine the satisfactory operation, minimum maintenance expense, and durability of feeder regulators.

Insulation—Regulators operate in most cases under severe conditions of voltage and mechanical strain on the insulation of the coils. Unlike most other types of station apparatus, the regulator passes the entire load on the feeder through its secondary winding and often has no protection other than the oil circuit-breaker between the regulator and the station bus. It is therefore subject to voltage strains from surges, static, or other line disturbances; and the secondary coils receive the mechanical shock resulting from heavy current rushes due to short circuits on the feeder. These rushes of current may reach excessive values and result in violent mechanical forces in the windings, tending to distort the coils and injure the insulation.

Because of these service conditions, the coils of Westinghouse feeder regulators are carefully insulated, special care being taken to secure mechanical strength to resist bending or twisting under strain; rings formed from steel rods, taped and impregnated, being placed over the coils at both ends of the stator to rigidly brace the stator coils. (See Fig. 4.) Under the worst conditions where the regulators are installed near large generators and a destructive short circuit occurs near the regulator, even these special coil supports may not provide sufficient protection for the windings, and current limiting reactances should be provided to properly protect the regulator and feeder.

ACCESSORIES FOR MOTOR-OPERATED AUTOMATIC AND NON-AUTOMATIC OPERATION

Operating Motor

Standard regulators, single-phase or three-phase, are equipped with either two-phase or three-phase 220-volt 60-cycle operating motors. Two-phase motors are provided with three terminals for use on a two-phase three-wire circuit only. If the voltage of the motor control circuit is other than 220, transformers are necessary (see following page.)

Single-Phase Motors—On special order single-phase regulators can be supplied with 220-volt 60-

cycle single phase motors for use where a polyphase control circuit is not available; but single-phase motors are in general less satisfactory than polyphase motors for regulator service, and single-phase operating motors are therefore not recommended for use except in special cases where a polyphase control circuit cannot be provided.

Single-phase motors are not furnished for polyphase regulators.

Transformers for Control Circuit

For Voltages Higher than 220—When a 220-volt control circuit is not available, transformers must be used for providing this voltage. For each standard two or three phase operating motor two ½-kilovoltampere distribution transformers of suitable primary voltage and 220-volt secondary are recommended; and for each single-phase operating motor (on special order) one 1-kilovoltampere transformer of similar voltage ratings. Where a number of regulators are installed in the same station, one set of transformers is usually sufficient; the capacity of this set can be somewhat lower than the sum of the capacities that would be required of individual sets of transformers.

For description and prices of suitable distribution transformers, see section 4-A.

For 110-Volt Circuits—When a 110-volt 60-cycle two- or three-phase circuit is available, two (per regulator) auto-transformers, Style No. 151686 can be supplied to transform from 110 to 220 volts. These auto-transformers are listed on a following page under "Extra Accessories."

Secondary Relays

A relay switch is used to control the motor circuit so as to relieve the contacts of the primary switch from the necessity of carrying the current

FIG. 9—SEPARATE-MOUNTING SECONDARY RELAY

required to operate the motor. On the Westinghouse regulators this relay switch, called the secondary relay, is operated by a control circuit closed through a hand-operated switch when non-automatic operation is used—a push-button switch generally being used—or through a primary relay when automatically operated. It is essentially an electrically-operated double-pole double-throw switch.

The metal contacts of this relay are of the butt-type, mounted on springs; the relay is rugged in

FIG. 8—THREE-PHASE AIR-BLAST MOTOR OPERATED REGULATOR

construction and the contacts wear evenly and give long life. All parts are enclosed in an expanded metal cover with closed top that protects them mechanically while permitting ready inspection. The standard secondary relay requires a 220-volt 60-cycle operating circuit.

A secondary relay is mounted directly on the regulator top-cover (see Fig. 1) of all standard single-phase and three-phase motor-operated regulators. Special regulators of larger frames than listed herein have the secondary relay arranged for separate mounting (see Fig. 9). Non-automatic regulators can be supplied on special order without the secondary relay, but with a limit switch, only, mounted on top cover, (See prices of "Accessories.")

A Limit Switch, connected in the operating circuit and actuated by the operating mechanism of the regulator, prevents overtravel of the rotor in either direction. It is combined with the secondary relay when that relay is mounted on the regulator top-cover (see above); and when the secondary relay is mounted separately the limit switch is mounted directly on the regulator top-cover.

The voltage-regulating primary relay is in effect

ACCESSORIES FOR AUTOMATIC OPERATION

a voltmeter having two sets of contacts that control the circuits operating the secondary relay, one circuit

FIG 10—PRIMARY RELAY, STYLE NO. 163320

being closed when the voltage rises above a predetermined value and the other when it falls below another predetermined value.

The standard primary relay, Style No. 163320, (see Fig. 10) is enclosed in a metal case with dust-proof cover provided with a window permitting ready inspection of the operating parts. It has compounding coils so that as soon as a change in voltage causes either set of contacts to close they do not "chatter" but remain closed until the voltage returns to normal. Means are provided for adjusting the relay for different voltage variations and ranges.

The standard primary relay may be adjusted to operate from 90 to 140 volts (110 volts normal); a voltage transformer is necessary to reduce the voltage of the feeder circuit to relay voltage.

Fig. 12 Dry-Type Voltage Transformer

No-Voltage Device—A special primary relay having a no-voltage device can be supplied on special order. This device operates to cause the regulator rotor to be turned to the position of minimum voltage in case the power supply in the feeder circuit is interrupted. It therefore prevents the possibility of temporary overvoltage on the circuit when the power supply is again continued. This no-voltage device should always be furnished when the regulator automatic accesssories are operated from a circuit independent of the regulated circuit.

Voltage Transformer—A dry-type voltage transformer (see section 3-B on "Westinghouse Instruments and Relays") of the proper rating is used to reduce the feeder voltage to a value suitable for the primary relay. One transformer is required for each of single-phase, two-phase, or three-phase regulators.

Compensators—A compensator is a device connected to the feeder circuit at the station by means of a current transformer, and, in connection with a voltage transformer, produces at the primary relay terminals a voltage proportional to that at the distributing end of the feeder.

The types KA and KB compensators are very compact. They consist of a slate panel containing the necessary terminals and dial switches, at the back of which are mounted the reactance and resistance elements. In addition the resistance tubes for the primary-relay compounding coils are also included in the compensator, so that no external additional resistors are used. The coils and resistance tubes are protected by a strong perforated metal

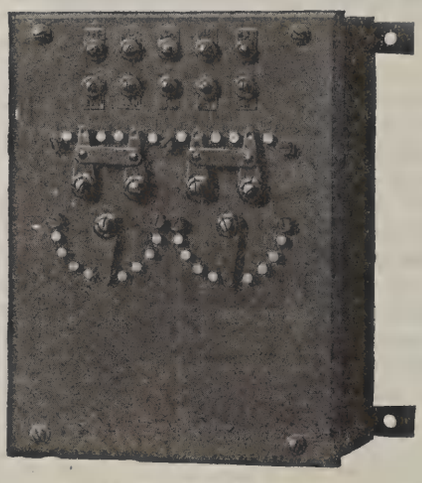


FIG. 11—TYPE KB COMPENSATOR

case and the compensator complete is arranged for wall or switchboard mounting.

Type KA—The compensator regularly furnished with the regulators is the type KA which may be set to compensate for the voltage drop at any varying load of any constant power factor. The type KA compensator will not, however, compensate correctly for a varying load at a variable power factor (see type KB). Single and three-phase type KA compensators are furnished for use with single and three-phase regulators respectively.

Type KB—On special order the type KB compensator will be substituted for the type KA. The type KB has a resistance element and a reactance element and may be set to compensate correctly for a varying load at a variable power factor. Single and three-phase type KB compensators are furnished as with type KA.

Type H—When compensation is desired for both ohmic and reactive drop at variable power factor, but where it is also desired to ground the secondary windings of the voltage and current transformers,

TYPE C INDUCTION FEEDER-VOLTAGE REGULATORS—Continued

the type H compensator (Fig. 14) must be used, as with the type KB compensator a metallic connection is made between the secondary windings of the voltage and current transformers, which, with the ground connection, would result in a short circuit.

Current Transformer—A type KA current transformer (see section 3-B on "Westinghouse Instruments and Relays") of the proper capacity is used for obtaining a value of the feeder current that is suitable for use with the compensator. For single-phase and two-phase regulators, one current transformer is used; and for a three-phase regulator using a three-phase compensator, two current transformers are required.

FIG. 13—TYPE KA COMPENSATOR

INSTRUCTIONS FOR ORDERING

Operating Data Necessary—When ordering a feeder-voltage regulator or when requesting information regarding a special regulator, the rating should be definitely determined by giving the phase, frequency, feeder current per wire, normal voltage of the circuit, and the percent of voltage regulation required.

Special Regulators—When inquiring regarding special regulators, it is important to state, in addition to the above information, whether the voltage must be raised only, lowered only, or both raised and lowered at different times. In some cases, where special regulators would be required to give the necessary regulation up and down, a standard regulator with an auxiliary transformer can be used to advantage if the regulation is in one direction only.

FIG. 14—TYPE H COMPENSATOR

Percent Regulation means the maximum percent of normal voltage that must be added to or subtracted from the feeder voltage to bring the fluctuating voltage back to its normal value. The standard regulators are designed for both "bucking" and "boosting" the feeder voltage by their rated percent regulation.

Capacity—The capacity of regulator required depends upon the load on the feeder and the regulation desired. Thus a 100-kilovoltampere circuit with 10 percent regulation will require a 10-kilovoltampere regulator.

Hand-Operation—When requesting information regarding hand-operated regulators specify if it is to be controlled at regulator or if remote-control mechanism is wanted, and if the latter, send drawings or sketches showing location of hand-wheels and regulator.

Apparatus Included in Style Number and List Price
(Indoor)
Non-Automatic Motor-Operated

Style number of the non-automatic regulator includes regulator complete with a 220-volt 60-cycle two-phase or three-phase operating motor as listed; all standard regulators have a 220-volt secondary relay and limit switch contained in one case mounted on top of the regulator. Style number of regulator does not include any other accessories than above stated.

List price includes regulator as described in the previous paragraph complete with the necessary quantity of oil.

TYPE C INDUCTION FEEDER-VOLTAGE REGULATORS—Continued

Automatic Motor-Operated

Style number of the automatic regulator is the same as that of the non-automatic. In addition to the regulator, the following accessories must be ordered for standard automatic operation.

List price includes all the apparatus to be ordered as below and the necessary quantity of oil.

Quantity	Style No.	Description
1	163320	Primary Relay (110-Volt 25 to 133-Cycles or D. C.)
1	30054	Voltage Transformer (60-cycle, 2300-volt primary, 115-volt secondary.)
1 for single-phase regulator 2 for three-phase regulator	(see section on "Instruments and Relays")	Type KA Current Transformer with primary rating same as normal feeder current and 5-ampere secondary.
1	179339 or 179968	Single-Phase Type KA Compensator (20 per cent maximum compensation). Three-Phase Type KA Compensator (20 per cent maximum compensation).

Specify on Order as Separate Items

Regulator—Give style number, capacity, voltage, and percent regulation.

Oil—Specify the gallons of oil required (total for all regulators on order). The quantity required for each regulator is given in tables.

And if Automatic Regulator is Wanted:

Accessories that are required as specified under heading "Apparatus Included in Style Number and Price—Automatic Motor-Operated." (Order each by style number where standard accessory is required.)

Distribution Transformer or Auto-Transformer—(See information on "Transformers for Control Circuit" on a previous page.)

Primary Relay with No-Voltage Device if desired in place of standard relay (See page on "Accessories for Automatic Operation").

Type KB Compensator—Style No. 179063 for single-phase or Style No. 179975 for three-phase, when compensation for both ohmic and reactive line drop is required.

Type H Compensator—Style No. 151186 for single-phase or Style No. 151190 for three-phase.

Primary Relay Resistor—Style No. 169490, must be specified if Type H Compensator is used or if compensators are omitted entirely.

FIG. 15—TYPE KA CURRENT TRANSFORMER

TYPE C INDUCTION FEEDER-VOLTAGE REGULATORS—Continued

OUT-DOOR TYPE FOR PLATFORM MOUNTING

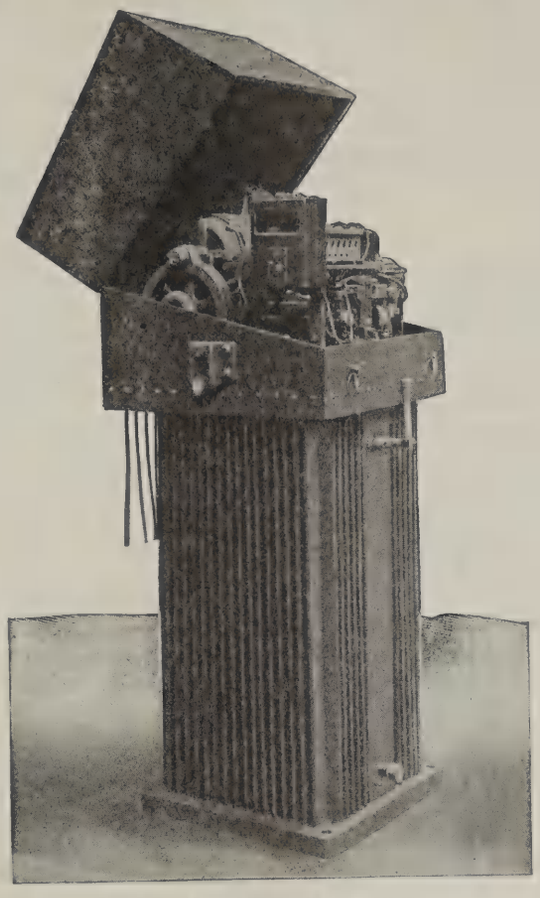


FIG. 16—OUTDOOR TYPE C REGULATOR

APPLICATION

The outdoor type C induction feeder-voltage regulators provide a means of obtaining good voltage regulation in outlying districts or on any other part of an alternating-current distribution system without the expense of housing—they fit in well with the other apparatus now being used so economically in outdoor substations and other outdoor installations.

Being entirely weatherproof and self-contained these regulators may be mounted on platforms constructed on poles or on the ground, protected by a fence or screen, in the same manner as transformers in outdoor substations. The only attention required is a general inspection for oiling the motor bearings and worm-screw mechanism, filling grease cups, and examining the relay contacts at regular intervals.

OPERATION

As these regulators are mounted outdoors and therefore will not have constant attendance, they controlled with the same relay equipment provided with standard indoor type C regulators.

CONSTRUCTION

The Westinghouse outdoor induction feeder-voltage regulator consists of a standard type C indoor regulator described on the first pages of this section, with the following modifications to adapt it for outdoor service.

A sheet steel housing is securely mounted on the top of the regulator tank, completely enclosing the regulator top cover on which, in addition to the operating motor, mechanism, and secondary relay, are also mounted the primary relay, relay resistors, and any other accessories required.

The sheet steel housing has a hinged cover to facilitate inspection of the apparatus it encloses. The edge of the top cover of the housing, when closed, extends down over the edge of the bottom part of the housing, and a shoulder with gasket on the inside edge of the top cover of the housing

TYPE C INDUCTION FEEDER-VOLTAGE REGULATORS—Continued

forms a moisture proof joint. The housing is mounted on the regulator tank in such a way that it does not in any way interfere with the easy removal of the regulator from the tank.

Mounting—These regulators are made for mounting on any substantial flat surface such as a platform between poles or on a platform on the ground; lifting lugs are provided on the sides of the housing for raising the regulator to the platform. As they are not intended for suspension from cross arms, they are not provided with mounting lugs.

Leads—The leads for connecting the regulator to the line and for the control circuit are brought out of the housing, passing vertically downward through sealed-in porcelain bushings, babbitted into the bottom flange of the housing, which extend horizontally beyond the regulator top-cover.

ACCESSORIES

Operating Motor

As with the indoor regulators, a 220-volt 60-cycle two- or three-phase motor is standard and is recommended for these regulators; but on special order single-phase regulators can be supplied with 220-volt 60-cycle single-phase motors where a polyphase control circuit is not available (see pages of this section on indoor regulators).

Transformers for Control Circuit

The information regarding the control circuit for outdoor regulators is the same as that for indoor regulators described on the first pages of this section.

Accessories for Automatic Operation

The standard regulators for automatic operation include (see "Style Number and List Price Include") a primary relay and its resistors and a secondary relay, all mounted on the regulator top-cover and enclosed by the housing.

Compensator and Current Transformer—As it is expected that the regulator will be installed at the distributing center of the feeder circuit and will therefore not have to compensate for a voltage drop to a distant feeding point, but will have to correct for variable supply voltage only, the line-drop compensator and its accompanying current transformer are usually unnecessary and are not regularly supplied with the outdoor regulators. However, these can be had on special order at an increase in price (see section 3-B on "Instruments and Relays" for current transformers) and if ordered with the regulator the necessary brackets for mounting inside of hood will be supplied.

Voltage Transformer—Usually 110-volts for the operation of the primary relay can be obtained from the distribution system controlled by the regulator, thus making the use of a separate voltage transformer unnecessary. In case 110 volts is not available, a 1-kilovoltampere type S distribution transformer is recommended for this service although a voltage transformer protected by suitable weather-proof housing will be satisfactory.

APPARATUS INCLUDED IN STYLE NUMBER AND LIST PRICE

(OUTDOOR)

Style number of regulator includes regulator complete with housing, a 220-volt 60-cycle two-phase or three-phase operating motor as listed, and the following accessories:

Quantity Per Regulator	Description
1	Primary Relay (110-volts)
1	Secondary Relay and Limit Switch (220-volts)
1 (Set)	Resistors for Primary Relay.
1	3-P. S. T. Knife Switch with 30 amp. enclosed fuses for 220-volt polyphase control circuit.

Style number does not include oil which must be ordered separately.

List price includes the regulator as described under style number below, and necessary oil which must be specified as a separate item on the order.

Voltage transformer, current transformer, and line drop compensator are not included in style number or list price. For style number and list price of the first two, see section 3-B on "Instruments and Relays;" for description of the line-drop compensator, see pages of this section on Indoor-Mounting Regulators, prices on request.

TYPE C INDUCTION FEEDER-VOLTAGE REGULATORS—Continued

PRICES

STANDARD REGULATORS OIL INSULATED SELF-COOLED FOR 60-CYCLE 2300-VOLT CIRCUITS

Indoor Mounting

Regulator Capacity Kva.	Feeder Capacity Amperes	Per Cent Regulation‡	Frame No.	Gallons Oil	Approx. Wt., Lbs. Net*	Approx. Wt., Lbs. Shipping†	Style No. Motor-Operated Regulator With: Two-Phase Motor	Style No. Motor-Operated Regulator With: Three-Phase Motor	List Price Motor-Operated Non-Automatic	List Price Motor-Operated Automatic
For Single-Phase Circuits										
5¾	25	10	4E	42	1025	1470	248694	219092	$ 670 00	$800 00
11½	50	10	4D	45	1200	1770	248695	219093	730 00	860 00
17¼	75	10	4C	40	1375	1920	248696	219094	855 00	980 00
23	100	10	4A	45	1730	2340	248697	219095	940 00	1080 00
34½	150	10	8C	63	2075	2880	248698	219096	1115 00	1250 00
	300	5								
46	200	10	12B	100	2475	3675	248699	219097	1380 00	1510 00
	400	5								
57½	125	20	12B	90	3200	4310	248700	219098	1620 00	1760 00
	250	10								
69	150	20	13A	150	4100	5810	248701	241549	2005 00	2150 00
	300	10								
For Three-Phase Circuits										
10	25	10	4A	44	1550	2130	248702	240947	1195 00	1340 00
20	50	10	12A	85	2700	3745	248703	240948	1478 00	1620 00
30	75	10	12B	94	2900	4045	248704	240949	1745 00	1860 00
40	100	10	13B	120	3400	4840	248705	240950	2112 00	2275 00
60	150	10	14A	160	4930	6785	279456	279453	2505 00	2650 00
80	200	10	16A	220	6030	8465	279457	279454	2885 00	3025 00
100	250	10	16B	280	6630	9655	279458	279455	3385 00	3550 00

Outdoor Mounting

For Single-Phase Circuits										
5¾	25	10	4E	42	1180	1625	266988	266984	.....	963 00
11½	50	10	4D	45	1350	1925	266989	266985	.....	1023 00
17¼	75	10	4C	40	1550	2100	266990	266986	.....	1150 00
23	100	10	4A	45	1880	2500	266991	266987	.....	1250 00

Indoor Mounting

*Net weight includes regulator without oil or accessories for automatic operation. Net weight of oil is approximately 7½ pounds per gallon.

†Shipping weight includes regulator and necessary oil but does not include shipping weight of accessories for automatic operation. Automatic accessories for single-phase regulators weigh approximately 135 pounds; for three-phase regulators up to 40 kva., 180 pounds; and for three-phase regulators 60 to 100 kva., 200 pounds.

‡Percentage that regulator will add to and take from feeder voltage.

Outdoor Mounting

*Net weight includes regulator without oil but with all accessories covered by style number. Weight of oil is approximately 7½ pounds per gallon.

†Shipping weight includes regulator and necessary oil and weight of containers.

See "Instructions for Ordering"

Special Regulators

In addition to the standard regulators listed above, regulators of the following characteristics can be supplied on special order, prices on request. Read carefully information given under "Ordering Data Necessary" under the heading of "Instructions for Ordering" on a previous page before making inquiry.

Larger-capacity regulators than those listed above.

Other Voltages—Regulators for operation on feeders of other voltages than that listed above.

Single-Phase Operating Motors—Single-phase regulators can be supplied with single-phase operating motors but single-phase motors are not recommended for this class of service.

Two-Phase Regulators, also two single-phase regulators with one operating motor on an operating shaft common to both regulators, can be supplied for two-phase operation.

Other Frequencies—Regulators for operation on frequencies other than listed above.

Hand-Operated regulators.

Air-Blast Cooled Regulators (See Fig. 8).

Water-Cooled Regulators (See Fig. 7).

TYPE C INDUCTION FEEDER-VOLTAGE REGULATORS—Continued

PRICES OF ACCESSORIES

Additions to List Prices of Standard Regulators for Extra Accessories

Description	Style No.	Addition to List Price* of Regulator
Auto-transformers to step up available 110-volt 60-cycle two or three-phase circuit to 220 volts suitable for motor-control circuit (order two per regulator) . .	151686	$40 00 per pair
Primary Relay with No-Voltage Device substituted for standard primary relay	238610	No Addition
Type KB Compensator substituted for type KA Compensator { Single-Phase / Three-Phase	179063 / 179975	No Addition
Type H Compensator substituted for type KB Compensator { Single-Phase / Three-Phase	151186 / 151190	12 00 / 12 00

Deductions from List prices of Standard Regulators for Omission of Accessories

Description	Style No.	Deduction From List Price* of Regulator
Primary Relay	163320	$70 00
Secondary Relay—Cover Mounting	236633	45 00
Type KA Compensator { Single-Phase / Three-Phase	179339 / 179968	35 00 / 35 00
Voltage Transformer	30054	22 50
Current Transformer, Type KA, 25 to 300 Amperes		18 00

Prices for Accessories Furnished Separately

Description	Style No.	List Price*
Primary Relay { Standard / Including No. Voltage Device	163320 / 238610	$82 00 / 92 00
Secondary Relay { Separate Mounting / Cover Mounting	146029 / 236633	50 00 / 65 00
Type KA Compensator { Single-Phase / Three-Phase	179339 / 179968	35 00 / 35 00
Type KB Compensator { Single-Phase / Three-Phase	179063 / 179975	45 00 / 45 00
Type H Compensator { Single-Phase / Three-Phase	151186 / 151190	57 00 / 57 00
Primary Relay Resistor	169490	11 00
Auto-Transformers to step up available 110-volt, 60-cycle, two- or three-phase current to 220-volts for motor-control circuit	151686	20 00

*Regular discounts on Feeder Voltage Regulators applying.

NOTE—For prices on Instrument Transformers, see Section 3-B. See "Instructions for Ordering."

Order by Style Number

For list of automatic accessories included see "Apparatus Included in Style Number and List Price" on previous pages.

TYPE C INDUCTION FEEDER-VOLTAGE REGULATORS—Continued

OUTLINE DIMENSIONS

Standard Motor-Operated Regulators

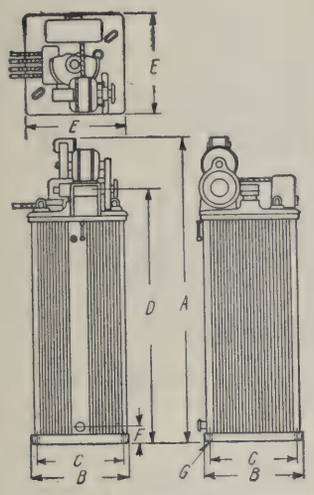


FIG. 17 INDOOR

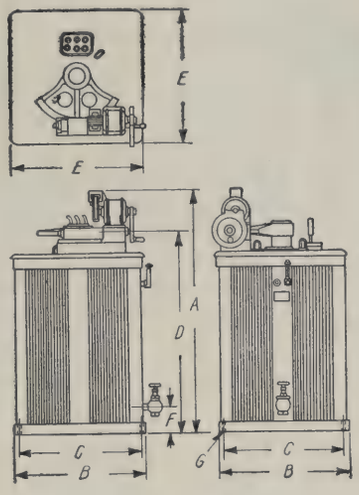


FIG. 18 INDOOR

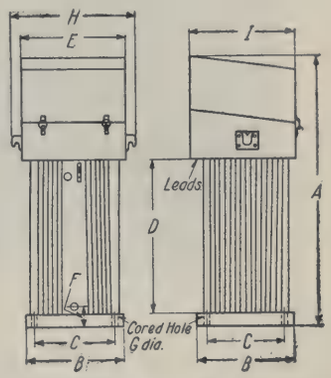


FIG. 19 OUTDOOR

Frame No.	Fig.	Dimensions in Inches Corresponding to Letters in Outline Views								
		A	B	C	D	E	F	G	H	I
4-A	17	61 11/16	22 7/8	20 5/8	49 1/4	22 7/8	4 1/4	7/8	..	....
4-C	17	56 11/16	22 7/8	20 5/8	44 1/4	22 7/8	4 1/4	7/8	..	....
†4-D	17	53 1/16	21	*	40 5/8	22 7/8	2 1/2	*	..	....
†4-E	17	50 1/16	21	*	37 5/8	22 7/8	2 1/2	*	..	....
8-C	17	69 1/16	24 5/8	22 3/8	57 1/8	24 1/2	4 1/4	7/8	..	....
12-A	17	69 3/8	27 5/8	25 1/8	57 1/8	27 7/8	4 1/4	1 1/8	..	....
12-B	17	75 3/8	27 5/8	25 1/8	63 1/8	27 7/8	4 1/4	1 1/8	..	....
13-A	17	83	33	29 1/2	70 1/2	31 3/8	7 3/4	1 1/8	..	....
13-B	17	78	33	29 1/2	65 1/2	31 3/8	7 3/4	1 1/8	..	....
14-A	18	72 3/4	39	36 1/2	60 1/8	39 1/2	7 3/4	1 1/8	..	....
16-A	18	80 3/8	42 5/8	39 5/8	67 1/8	42 3/8	7 1/2	1 1/8	..	....
16-B	18	86 3/8	42 5/8	39 5/8	73 1/8	42 3/8	7 1/2	1 1/8	..	....
4-A	19	65	22 7/8	20 5/8	38 1/4	24	4 1/4	7/8	29	26 1/2
4-C	19	59 1/2	22 7/8	20 5/8	31 3/4	24	4 1/4	7/8	29	26 1/2
†4-D	19	56 1/2	21	*	31	24	4 1/2	*	29	26 1/2
†4-E	19	53 1/2	21	*	31	24	4 1/2	*	29	26 1/2

†Tank walls are not corrugated.
*No holes in base.
These dimensions are for reference only. For official dimensions apply to the nearest district office.

TYPE C INDUCTION FEEDER-VOLTAGE REGULATORS—Continued

AUXILIARIES

For Automatic Operation of Single-Phase and Polyphase Induction Regulators

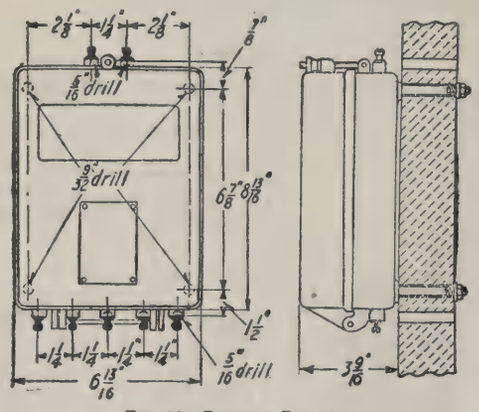


FIG. 20—PRIMARY RELAY

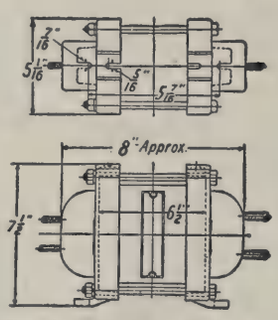


FIG. 21—DRY-TYPE VOLTAGE TRANSFORMER

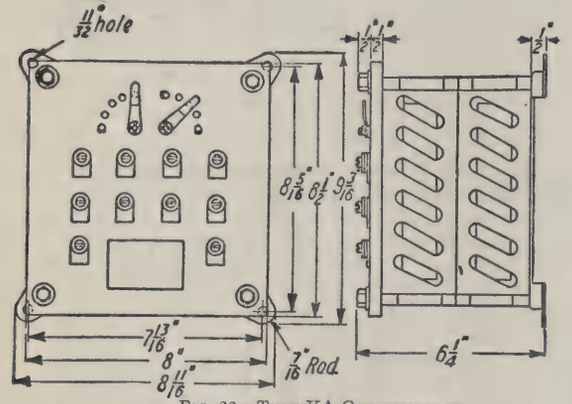


FIG. 22—TYPE KA COMPENSATOR
(Resistance for primary relay is mounted in compensator case)

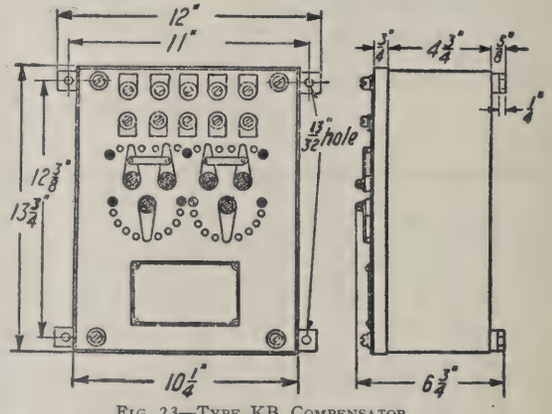


FIG. 23—TYPE KB COMPENSATOR
(Resistance for primary relay is mounted in compensator case)

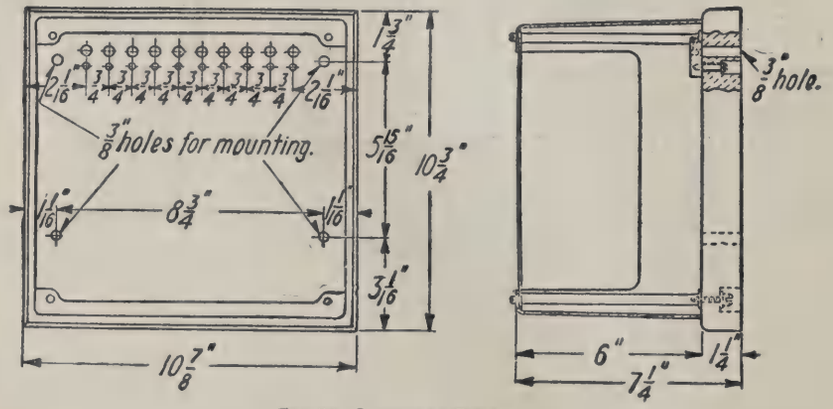


FIG. 24—SECONDARY RELAY

(For regulators as shown in Fig. 17, separate secondary relay is not required, as it is made integral with top of regulator)

These dimensions are for reference only. For official dimensions apply to the nearest district office.

For dimensions of Type KA Current Transformers see section 3-B on "Instruments and Relays".

TYPE S BALANCE COILS

A balance coil is an auto-transformer used for obtaining a number of lower-voltage circuits from an alternating-current distributing circuit.

Three-Wire—Type S balance coils are listed for obtaining from a 220-volt two-wire circuit a three wire 110-volt distribution system, as shown in Fig. 2.

Five-Wire—Type S balance coils are listed for obtaining from a 440-volt circuit a five-wire distribution system, as shown in Fig. 3.

Capacity—The rated kilovoltampere capacities of these coils represent the maximum unbalancing allowable between any two circuits. The balanced load does not pass through the balance coil. It is the general practice, where the degree of unbalance is not known, to use a balance coil with a capacity of approximately 25 per cent of the total maximum capacity of the circuit upon which it is used.

Construction—Type S balance coils are built with type S construction (see section 4-B on "Distribution Transformers").

FIG. 1

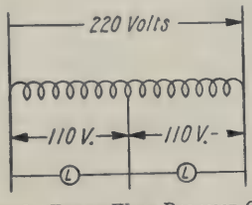


FIG. 2—THREE-WIRE BALANCE COIL

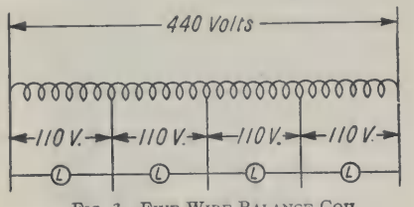


FIG. 3—FIVE-WIRE BALANCE COIL

PRICES—Type S Balance Coils

Capacity‡ Kva.	Dimension Reference Fig.	Item	Approx. Wt., Lb. Net*	Shipping†	Ordering Data: Style No. Balance Coil	Style No. Hanger Iron	Gal. Oil	List Price
Three-Wire, 220-110 Volts, **230-115 Volts,** 240-120 Volts								
60 Cycles								
1	4	1	59	70	258721	109712	¾	28 00
2	4	1	59	70	258722	109712	¾	38 00
3	4	1	59	70	258723	109712	¾	46 00
5	4	2	105	135	279264	109712	1¾	64 00
7.5	4	3	132	175	258725	109712	1¾	83 00
10	4	3	132	205	258726	109712	1¾	102 00
15	4	7	233	325	135957	109713	4½	137 00
25 Cycles								
1	4	1	59	70	138837	109712	¾	40 00
2	4	2	105	135	138839	109712	1¾	56 00
3	4	2	105	135	138840	109712	1¾	72 00
5	4	6	205	275	138842	109713	3½	100 00
7.5	4	8	320	425	138843	109713	7	132 00
10	4	9	395	540	138844	109713	9¾	161 00
15	4	10	520	710	138845	109733	14	203 00
Five-Wire, 440-330-220-110 Volts, **460-345-230-115 Volts,** 480-360-240-120 Volts								
60 Cycles								
1	4	1	59	75	249436	109712	¾	55 00
2	4	2	105	135	249437	109712	1¾	79 00
3	4	3	132	175	249438	109713	1¾	104 00
5	4	7	233	325	249439	109713	4½	145 00
7.5	4	9	395	540	249440	109713	9¾	192 00
10	4	9	395	540	249441	109713	9¾	233 00
15	4	11	680	990	249442	109714	19¾	275 00

*Net weight is of balance coil only. Oil weighs approximately 7 pounds per gallon.

†Shipping weight includes balance coil boxed for shipping and necessary oil in container. Shipping weight of oil is approximately 8 pounds per gallon.

‡The maximum unbalancing allowable between any two circuits.

These can be used with satisfactory performance on any voltage within 10 per cent greater or less than normal.

(See "Ordering Instructions" on Following Page)

TYPE S BALANCE COILS—Continued

Hanger Irons

Style number and price include one set of hanger irons.

Mounting	Approx. Wt., Lb Per Pair Net	Shipping	Style No.	List Price
Pole*	6	8	109712	$1 35
Pole*	15	20	109713	2 20
Pole*	24	34	109714	4 00
Pole*	19	23	109733	2 50

*Hanger irons for mounting balance coils on wall can be supplied on special order, prices on request. When ordering specify "Similar to Style No.....(give style number of pole mounting hanger iron) except for wall mounting."

ORDERING INSTRUCTIONS

Style number includes balance coil only. **List Price** includes balance coil complete with necessary oil but not with hanger irons or fuse blocks, which must be ordered separately.

When ordering specify as separate items:

BALANCE COIL—Give style number, capacity and voltage.

OIL—Give total of oil required for all balance coils on order. The quantity required for each coil is shown in table.

HANGER IRONS—Order by style number shown in table, one set for each coil ordered.

FUSE BLOCKS—Where fuse blocks are desired these should be ordered at prices shown on page of the section on "Fuse Blocks." (Order two per balance coil).

OUTLINE DIMENSIONS

Balance Coils

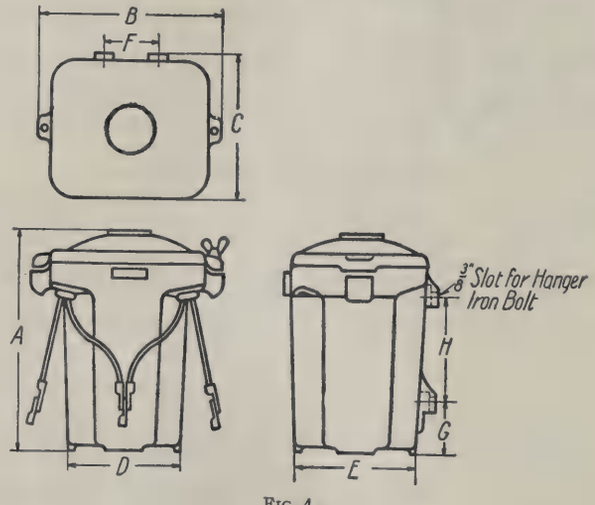


Fig. 4

Dimension Reference		Dimensions in Inches							
Fig.	Item	A	B	C	D	E	F	G	H
4	1	11 1/16	14 3/8	9 5/8	8 1/16	8 1/16	2 3/4	1 3/16	7
4	2	12 3/4	15 7/8	12	10 1/2	10 1/2	3 1/4	2 3/16	7
4	3	15 7/8	15 7/8	12	10 5/8	10 5/16	3 1/2	4 1/16	7
4	4	14 1/4	13 1/2	11 3/8	10 1/2	9 3/4	4 3/4	3 5/8	7
4	5	15 7/8	13 7/8	11 1/2	10 7/8	10 3/8	4 3/4	4	7
4	6	17 3/4	16 1/4	13 3/4	12 3/8	11 5/8	3 3/4	3 1/2	10
4	7	20 3/8	16 1/4	13 3/4	12 3/8	11 5/8	3 3/4	4 3/8	10
4	8	23 7/8	17 1/4	15 1/8	13 5/16	12 7/8	5	2 7/8	16
4	9	27 7/8	18	16 1/4	13 11/16	13 11/16	5	4 7/8	16
4	10	32 1/8	20 1/4	17 1/4	15 3/4	14 1/2	5	7 1/8	16
4	11	30 7/8	25 3/4	....	20 1/2	17	6 7/8	5 5/8	18

These dimensions are for reference only. For official dimensions apply to nearest district office.

Hanger Irons

Outline dimensions of hanger irons are given in section 4-A on "Distribution Transformers."

INSULATION-TESTING EQUIPMENT

The facility with which alternating current can be transformed to high voltages has led to its general adoption as a means for testing the dielectric strength of insulation. Certain alternating-current phenomena also make possible apparatus for testing armatures and coils for open-circuits, short-circuits, and other defects that may occur during manufacture or may develop in service.

Standardization of equipment for insulation testing is difficult on account of the variation in requirements, but it has been found desirable to standardize on certain apparatus for general commercial testing where the only tests required consist of voltage tests of the dielectric strength ("breakdown tests") of insulating material, parts of apparatus, or complete apparatus. In this class of testing, the amount of current flowing through the high-voltage winding of the testing outfit due to leakage through the material under test is negligible and except on the larger apparatus and materials, the charging current is also small. Consequently, the kilovoltampere rating and physical dimensions of the outfits need not necessarily be large. When, however, it is desired to test lead-covered cables or other material having considerable electrostatic capacity, an outfit of higher kilovoltampere rating must be used.

Six types of standard insulation testing outfits are listed, depending on the maximum voltage required and also, to some extent, on the class of tests to be made. These types are as follows:

Portable bench-type—maximum voltage 2,000.
Portable carriage-type—maximum voltage 16,000.
Portable truck-type—maximum voltage 50,000.
Stationary or portable outfit for general testing maximum voltage 50,000.
Armature testing outfits.
Coil testing outfits.

FIG. 1—O.I.S.C. TESTING TRANSFORMER—150 KVA. 400,000 VOLTS 50 CYCLES

INSULATION TESTING-GENERAL

The testing voltage required depends on the working voltage of the apparatus or on the dielectric strength of the material to be tested. It is therefore desirable, in testing equipments that are to be used for a large variety of apparatus or materials, to have means for varying the testing voltage. The range of adjustment required is determined by the tests contemplated.

The kilovoltampere capacity required of an insulation testing transformer depends on the electrostatic capacity of the apparatus to be tested, the testing voltage, and the frequency of the testing circuit. The standard testing equipments listed on the following pages are of capacities recommended for general insulation testing. For testing cables or apparatus of appreciable electrostatic capacity, the kilovoltampere capacity of the testing outfit required depends largely on the characteristics of the particular cable to be tested.

The capacity required of a testing outfit can usually be approximated from the formula:

$$Kva. = IE \times 10^{-3} = 6.28\, C\, F\, E^2 \times 10^{-9}.$$

Where E = the test voltage.
F = frequency in cycles per second.
I = current flowing in test circuit.
C = electrostatic capacity of the apparatus tested, in microfarads.
$Kva.$ = rating of the testing transformer in kilovoltamperes.

From this it can be seen that the size of the outfit required depends on the square of the test voltage. Hence, if a transformer is large enough to test a given piece of apparatus at maximum voltage, it will in all probability be large enough to test similar apparatus at lower voltages obtained by means of taps at reduced capacity.

INSULATION-TESTING EQUIPMENTS—Continued

Variation of Testing Voltage

The standard insulation-testing outfits listed herein are provided with reduced capacity voltage taps, their number and arrangement being such that a suitable range of testing voltage may be obtained. In the low-voltage outfits (up to 16,000 volts) the taps are made in the high-voltage winding and connections made to contact points on dial switches. The higher-voltage outfits have a regulating transformer, the primary of which is connected to the low-voltage supply circuit, and the secondary provided with taps; a dial or drum switch is used for connecting the secondary to the low-voltage winding of the testing transformer. By thus avoiding the use of taps or series-multiple connection in the high-voltage winding of testing transformers for higher voltages, a high factor of safety in insulation strength is obtained, which is very desirable in a testing transformer because of the varied nature of the service.

Measurement of the testing voltage can be made by various methods, depending upon the degree of accuracy required.

For ordinary insulation testing outfits of small capacities and relatively low voltage, exact measurement of the testing voltage is not necessary; the product of the ratio of transformation and the approximate supply voltage will give the value of the testing voltage that for all practical purposes is sufficiently accurate. The dials of all the low-voltage outfits described and listed on the following pages indicate the testing voltage based on normal supply voltage.

When testing cables, or other such load having considerable condenser effect, more accurate methods must be employed, the most generally used being the spherical spark gap recommended by the A. I. E. E. Standardization Rules, or the direct-reading device developed by the Westinghouse Company and known as the "crest voltmeter," both of which are described and listed on another page of this section.

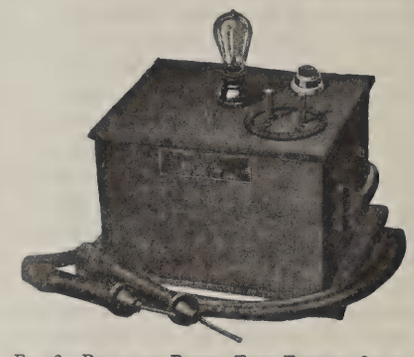


FIG. 2—PORTABLE BENCH-TYPE TESTING OUTFIT
½ KVA., 2000 VOLTS

Terminals—For testing materials, the shape of the testing terminals should conform as nearly as possible with the shape of the conductors that the material is to insulate. The use of terminals with sharp edges should be avoided, as these may give rise to concentration of electrostatic flux at the edge which would make the tests unreliable.

PORTABLE BENCH TYPE

The small 2000-volt outfit illustrated in Fig. 2 consists of a transformer mounted in a small wooden box and operated without oil. It is of such size that it may be placed on a work bench, table, or the floor, and is provided with handles to make it easily portable.

The testing voltage can be varied in 100-volt steps up to 2000, quickly adjusted by means of two dial switches placed inside the cover to prevent accident. The dials of these switches indicate the testing voltage on the basis of normal supply voltage. No skill is required in using this outfit and, using ordinary care, tests may be quickly made. To change the dial setting for the different testing voltages it is necessary to open the cover, which operation automatically opens the low-voltage circuit and protects the operator should he neglect to open the snap switch.

A snap switch is provided in the low-voltage circuit to disconnect the outfit from the line; a pilot lamp is also provided to indicate when the outfit is energized. A fuse in the low-voltage circuit gives indication of the failure of the insulation under test.

Rubber insulated flexible testing leads and terminals with insulated hand grips are supplied. An extension cord and plug (not furnished with the outfit) may be used for connecting the outfit to the supply circuit.

PRICES

For Use on 25 and 60-Cycle Circuits

Style number and list price include testing outfit complete as described.

Max. Testing Voltage	Capacity Kva.	Approx. Wt. Lb. Net	Approx. Wt. Lb. Shipping	Approx. Dimensions, Inches Floor Space	Approx. Dimensions, Inches Over-all Height	ORDERING DATA Style No. 110-Volt Low Voltage	ORDERING DATA Style No. 220-Volt Low Voltage	List Price
2000	0.5	65	107	15 x 16	15	107494	107493	$220 00

Order by Style Number

PORTABLE CARRIAGE TYPE

For many tests requiring higher voltages and greater transformer capacity than can be obtained from the bench-type outfit, the carriage-type outfit is most suitable. (See Fig. 3). The transformer operates without oil and is enclosed in a wooden box, mounted on a two-wheel carriage, thus being easily portable.

The testing voltage is varied by means of taps on the high-voltage side of the transformer and connected to contacts on two regulating dial switches mounted within the box. The dial switches are operated by insulated shafts extending out of the box and provided with hand grips similar to a valve stem. Pointers on the outside of the box indicate the testing voltage on the basis of normal supply voltage. Any testing voltage from zero to maximum can be obtained in equal steps, the values of which are shown in the table of prices. But, as the dial switches are connected in the high-voltage circuit, the transformer should be disconnected from the line when adjusting the test voltage. For this reason this outfit cannot be used for applying an uninterrupted increasing test voltage such as is generally used in determining the break-down point of insulating material.

A knife switch and carbon circuit-breaker in the low-voltage circuit are used for connecting the outfit to the supply circuit. A pilot lamp indicates whether the outfit is energized; and the circuit-breaker, the failure of the insulation under test. At very low testing voltage, however, the current in the primary on failure of the material under test may not be sufficient to trip the breaker; in such cases it is advisable to use fuses in the low-voltage circuit to indicate failure.

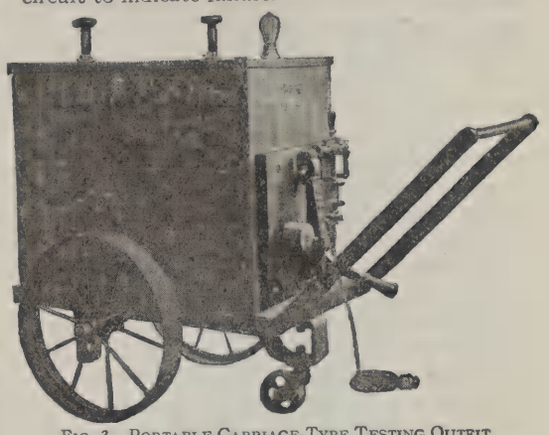


FIG. 3—PORTABLE CARRIAGE-TYPE TESTING OUTFIT
5 KVA. 10,000 VOLTS

Heavily rubber-insulated testing leads and terminals are supplied. The terminals have insulated hand grips. Twelve feet of flexible lamp cord and a separable attachment plug are provided for connection to the supply circuit.

Special Safety Switch—As a precaution to prevent unauthorized persons from operating these outfits, a safety switch can be added *on special order*. This is a push switch so mounted and connected that when the lid of the test box is closed the primary circuit of the transformer is opened; opening the lid automatically closes the circuit. A padlock can be attached to this lid.

PRICES

For Use on 25 and 60-Cycle Circuits

Style number and list price include standard outfit as described. The special safety switch will be furnished on these outfits on special order.

Max. Testing Voltage	Capacity Kva.	Volts Per Step	Approx. Wt. Lb. Net	Approx. Wt. Lb. Shipping	Approx. Dim. Inches Floor Space	Approx. Dim. Inches Over-all Ht.	ORDERING DATA — Style Nos. — 110-Volt Low-Voltage	ORDERING DATA — Style Nos. — 220-Volt Low-Voltage	List Price
3000	2	250	500	913	27 x 47	37	107496	107495	$475 00
6000	2.5	200	525	1022	28 x 58	44	107498	107497	550 00
10000	5	100	600	1132	28 x 58	44	107500	107499	610 00
12000	5	200	600	1132	28 x 58	44	107502	107501	635 00
16000	5	200	725	1315	34 x 59	42	107504	107503	700 00
Net addition to list price for special safety switch, not including padlock									8 00

Order by Style Number

PORTABLE TRUCK TYPE

Especially Adjusted for Oil Testing

The portable truck-type illustrated in Fig. 4 is an outfit for general insulation testing where only a small kilovoltampere capacity is required. The variation of the testing voltage can be accomplished in this outfit without opening the circuit. The outfit is therefore well adapted to testing for the breakdown point of insulating material where an uninterrupted increasing voltage must be applied. Its maximum voltage rating is sufficiently high for testing all insulating oils as outlined on another page of this catalogue.

The transformer of this outfit is of the oil-insulated core type contained in a sheet-steel tank with a heavy wooden cover. Four iron casters are provided on the bottom of the tank to facilitate moving.

Variation of the testing voltage is accomplished by means of a regulating rheostat connected in the low-voltage circuit. This rheostat provides sixty voltage steps of approximately equal percentage, from zero to maximum; that is, the increment in voltage increases with the testing voltage.

For indicating the test voltage, a type SM voltmeter, connected in the low-voltage circuit, is mounted on the top cover. This meter is calibrated to read approximately the testing voltage direct and is supported by springs for protection against jarring when the outfit is moved from place to place. The testing transformer is designed to operate on any frequency from 25 to 60-cycles, but since the voltmeter must be calibrated for the frequency on which it is to be used, in ordering the outfit the frequency must be specified.

One end of the high-voltage winding of the transformer is permanently grounded inside the tank and also brought to a binding post on the corner of the wooden cover; the other end is connected to a terminal passing up through a porcelain bushing on the cover and provided with a binding post. This binding post is at a convenient height for connecting to the oil testing cup, Style No. 263621 (Fig. 14, described and listed on another page); it is a common practice when testing oil to place this cup on the cover of the outfit just back of the terminal.

A snap switch is provided in the low-voltage circuit for connecting to the supply circuit, a pilot lamp indicates when connection is made. A single-pole type F carbon circuit-breaker is provided in the low-voltage circuit to protect the outfit when failure of the insulation under test occurs. A porcelain fuse block with plug cutouts is also provided in the low-voltage circuit. No cord is supplied for connection to the supply circuit but convenient terminal binding posts are provided.

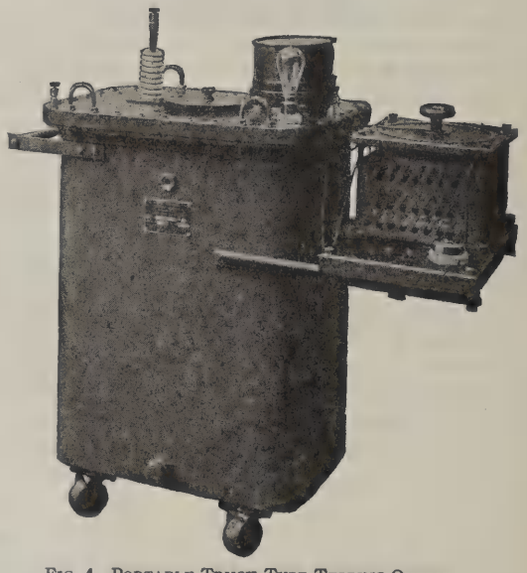


FIG. 4—PORTABLE TRUCK-TYPE TESTING OUTFIT—2 KVA. 50,000 VOLTS

PRICES

For Use on Frequencies of 25-Cycles and Higher

Style number and list price include testing outfit complete as described. List price also includes necessary oil.

Max. Testing Voltage	Capacity Kva.	Low-Voltage	Approx. Wt. Lb. *Net	Approx. Wt. Lb. Shipping†	Approx. Dimensions Inches Floor Space	Approx. Dimensions Inches Over-all H'ght	Gal. Oil	Ordering Data Style No.	Ordering Data List Price
50,000	2	220	500	985	43 x 18	43	30	236433	$810 00
50,000	2	220–110	530	1015	43 x 18	43	30	236434	830 00
Deduction from list price for omission of type F Carbon Circuit-Breaker									20 00

*Net weight is of outfit only. Oil weighs approximately 7 pounds per gallon.

†Shipping weight includes outfit complete, boxed for shipping, and the necessary oil in container. Shipping weight of oil is 8 pounds per gallon.

Order by Style Number

HIGH-CAPACITY TYPE

For General Insulation Testing

An outfit of larger capacity than those listed on former pages is illustrated in Fig. 5. This outfit is also well adapted for oil testing; and, having greater kilovoltampere capacity than the oil testing outfit, it is especially adapted for general insulation testing.

This outfit consists of a testing transformer of the core type mounted in a boiler-iron tank, a regulating transformer suspended above the testing transformer from the cover of the tank, both immersed in oil; and a slate panel containing the accessories, mounted on the cast-iron top of the boiler iron case. One end of the winding is grounded and the other end is brought out in a suitably insulated terminal. On special order this outfit may be mounted on an angle-iron truck frame provided with small iron wheels and handle.

On the slate panel are mounted: terminals for the supply wires; a double-pole knife switch for connecting to the supply circuit; cartridge fuses, a carbon-break circuit-breaker, a type TM voltmeter and the regulator handwheel. Back of the panel are mounted the voltmeter resistor, a regulating dial, and the preventive resistance.

The primary winding of the regulating transformer is connected directly to the supply circuit and the secondary has a number of taps brought up through the cover and connected to the dial contacts. Twenty steps of testing voltage, 2500 volts per step, are thus obtainable. Preventive resistances are connected so that the full range from 0 to 50,000 volts may be obtained by merely turning the handwheel and without opening the circuit.

FIG. 5—HIGH-CAPACITY-TYPE TESTING OUTFIT
7.5-KVA. 50,000 VOLTS

PRICES

For Use on Circuits of 220-110 Volts and of Frequencies of 25 Cycles and Higher

Style number and list price include testing outfit complete as described. List price also includes necessary oil.

Max. Testing Voltage	Capacity Kva.	Approx. Wt. Lb. Net*	Approx. Wt. Lb. Shipping†	Approx. Dimension Inches Floor Space	Approx. Dimension Inches Over-all H'ght	Gal. Oil	ORDERING DATA Style No.	ORDERING DATA List Price
50,000	7.5	1500	2000	26 x 31	77	90	236435	$1200.00
Addition to list price for mounting outfit on truck								75.00

*Net weight is of outfit only. Oil weighs approximately 7 pounds per gallon.

†Shipping weight includes outfit complete, boxed for shipping, and necessary oil in container. Shipping weight of oil is approximately 8 pounds per gallon.

Order by Style Number

HIGH-VOLTAGE EQUIPMENTS

General

The variation in requirements for high-voltage testing is such that standardization of complete outfits is not practical. Some of the details, however, have been standardized by the Westinghouse Electric & Manufacturing Company and a general description of the apparatus is given on the following pages.

For most high-voltage testing, large kilovolt-ampere capacity is not required and the smallest kilovoltampere capacity for which a transformer may be economically designed is usually large enough. For cable testing, however, on account of the high electrosatic capacity involved, a large kilovoltampere capacity of transformer is required. This point must be given careful consideration as the capacity required for testing a cable system may amount to several thousand kilovoltamperes.

For testing purposes, it is usually necessary to have some means of regulating the testing voltage. There are several methods in general use, some of which are described on pages following. A complete testing equipment consists of a testing transformer, regulating apparatus, switchboard control panel, and voltage measuring device.

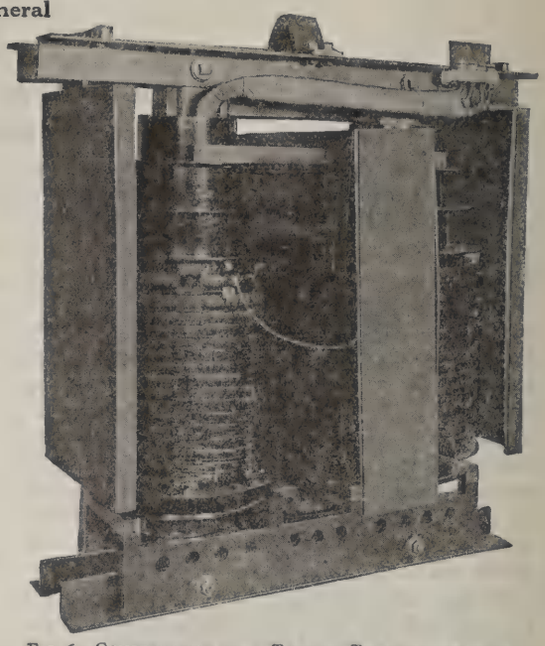


FIG. 6—CONSTRUCTION OF A TESTING TRANSFORMER FOR 50,000 TO 300,000 VOLTS

TESTING TRANSFORMERS

On account of the intermittent service, it is usually not necessary to give a testing transformer a continuous rating as in the case of power transformers. The usual practice is to consider the service requirements equivalent to full rated load for four hours. In the case of testing transformers, this time rating is usually a function of the voltage rather than of the load. Therefore, when operating at full voltage, the time rating must not be exceeded no matter what the amount of the load.

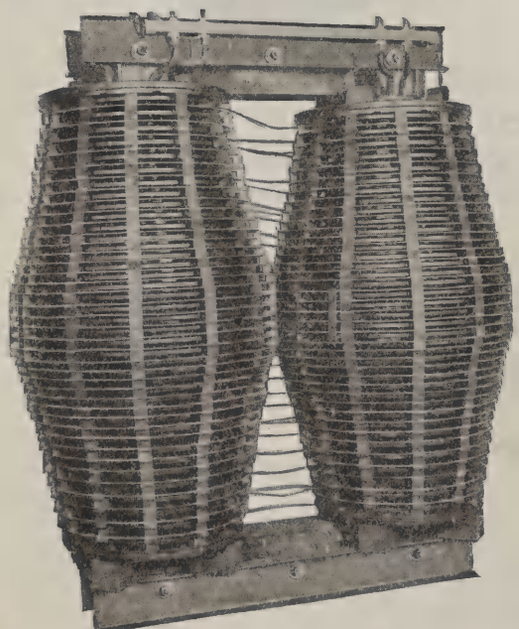


FIG. 7—COMPLETELY ASSEMBLED COILS AND IRON OF TESTING TRANSFORMERS OF 150-KVA. 400,000-VOLT CAPACITY

When prices are desired on outfits for high-voltage testing it is essential to specify the kilovoltampere rating desired, the maximum testing voltage range or variation of testing voltage, and maximum length of time the transformer will be under load.

For cable testing, if the kilovoltampere capacity necessary is unknown, either data should be obtained from the cable manufacturer giving the electrostatic capacity in microfarads for a definite length of cable, or test should be conducted to determine this data. It is essential also to specify the electrostatic capacity of the cable with the conductors connected in the same order that will be followed in making tests with the testing outfit; usually one or more of the following dielectric tests are made on a three conductor cable:

1. Between one conductor and each of the others in turn.
2. Between each conductor in turn and the other two grounded to the lead sheath.
3. Between each conductor and the lead sheath.

Since each of these tests will show a different charging current with the same impressed voltage, it is obvious the methods proposed should be specified.

Since most high-voltage testing must (or may) be done with one end of the high-voltage winding

grounded, it is considered standard practice by the Westinghouse Company to bring out only one high-voltage terminal through the case, the other high-voltage terminal being grounded permanently inside the case. This arrangement permits the use of graded insulation and requires only one high-voltage outlet terminal, thus resulting in a saving in cost. It is an important fact that the cost and mechanical proportions of a testing transformer are determined by the voltage stress above ground. As an illustration, it may be considered that a transformer having the middle point of its high-voltage winding grounded and both high-voltage terminals insulated is only comparable in cost with a transformer having one-half the high-tension voltage, but with one end grounded and one end insulated.

Westinghouse high-voltage testing transformers are of the core-type construction. Up to 300,000 volts, the ordinary form of core-type construction or connection of coils, such as shown in Fig. 6 is used. For voltages above 300,000 volts, the distributed type of winding is used, as shown in Fig. 7. The partly assembled core and coils of this same transformer are shown in Fig. 8. This distributed type of winding is an exclusive Westinghouse feature, by the use of which a uniform distribution of voltage stress between windings is obtained. In both types of windings, the turns adjacent to the terminals have reinforced insulation as a protection

FIG. 9—HAND-OPERATED DRUM-CONTROL SWITCH FOR VARYING VOLTAGE OF TESTING TRANSFORMERS (128 POINTS)

against voltage surges, and the high-voltage windings are sub-divided into a large number of coils to keep down the voltage stress between coils. The insulating barrier between high and low-voltage windings consists of one or more co-axial micarta cylinders.

Another exclusive Westinghouse feature is the

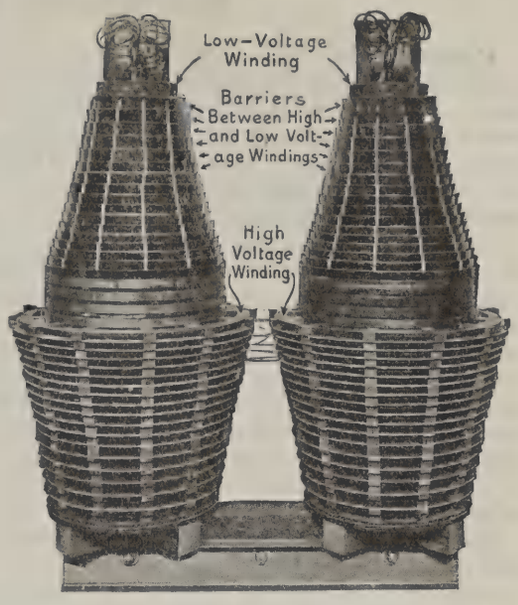


FIG. 8—PARTLY ASSEMBLED COILS AND IRON OF TESTING TRANSFORMER SHOWN IN FIG. 7

well known condenser-type outlet bushing that is supplied on transformers above 75,000 volts. On top of the condenser bushing is mounted a static shield to prevent the concentration of static field on the bushing and to increase the voltage to which the bushing may be raised before corona appears. For voltages above 100,000 a choke coil is mounted above the static shield as additional protection to the high-voltage winding against surges. A transformer with bushing complete is shown in Fig. 1.

The following voltages are considered standard by the Westinghouse Company on the Westinghouse high-voltage testing transformers: 50,000, 75,000, 100,000, 150,000, 200,000, 250,000, 300,000, 400,000, 500,000.

VOLTAGE-REGULATING DEVICES

The methods that are in most common use for varying the testing voltage of testing transformers are: step-by-step regulator, induction regulator, and motor-generator set. A combination of the first two methods can often be used to advantage.

The step-by-step type of control consists of a regulating transformer having the required number of taps that are connected in succession by means of a regulating dial switch or drum controller to the low-voltage side of the testing transformer. This transformer is usually of the O.I.S.C. type of construction with the sheet iron cast-in type of tank. A 128-point drum controller is shown in Fig. 9. This drum is operated by a hand wheel and, when used with a regulating transformer having the necessary taps, will provide 128 equal voltage steps from zero to maximum on the high-voltage side of the testing transformer.

INSULATION-TESTING EQUIPMENTS—Continued

Motor-Operated Drum Controller—For more elaborate equipment, the drum shown in Fig. 10 is used. It is motor-operated and controlled by an electrically-operated switch mounted on top of the drum beside the motor. This switch is similar to the secondary relay used on Westinghouse induction feeder-voltage regulators (see first pages of this section) and can be controlled by two small single-pole knife or push button switches; one to raise and the other to lower the voltage. When used with the proper regulating transformer this drum will provide from zero to maximum 480 equal voltage steps of the testing voltage. The operation is entirely automatic; that is, as long as the motor circuit is closed the drum will continue to raise or lower the testing voltage, until either the maximum or zero voltage is reached, when the motor circuit is automatically opened by a limit switch.

The induction-type of control consists of an induction feeder-voltage regulator (see pages on "Induction Feeder-Voltage Regulators") having both its primary and secondary wound for the supply voltage and the low-voltage of the testing transformer wound for a voltage equal to double the supply voltage. When the regulator is in position of maximum buck the resultant voltage is zero since the secondary voltage equals the primary voltage but in the reverse direction. As the regulator is turned the voltage is gradually raised till rotor is in maximum boost position; the resultant voltage is then the sum of the primary and secondary or twice the supply voltage. Since this is the normal voltage of the testing-transformer primary, the full testing voltage is then obtained. In this way the testing voltage is varied from zero to maximum in a smooth curve.

For this method the Westinghouse standard induction feeder-voltage regulator construction is used and either hand or motor operated regulators can be furnished. The kilovoltampere capacity of the regulator as outlined above should be one-half the capacity of the testing transformer.

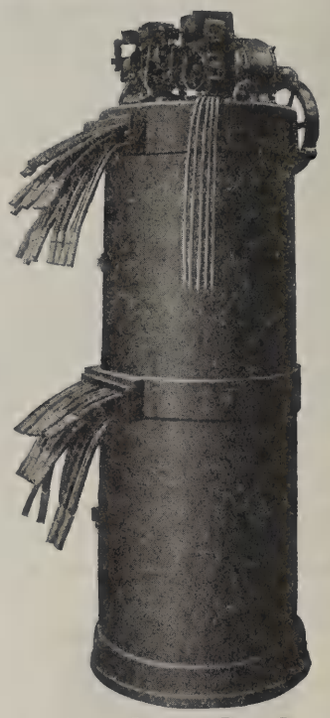


FIG. 10—MOTOR-OPERATED DRUM-CONTROL SWITCH FOR VARYING THE VOLTAGE OF TESTING TRANSFORMER IN A CONTINUOUS CURVE FROM ZERO TO MAXIMUM

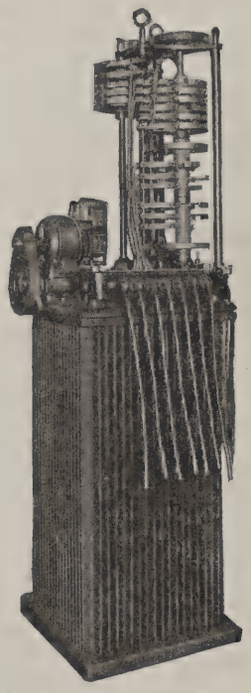


FIG. 11—COMBINED INDUCTION AND DRUM-TYPE REGULATOR FOR VARYING VOLTAGE OF TESTING OUTFIT IN A SMOOTH CURVE FROM ZERO TO MAXIMUM

The motor-generator control consists of a motor generator set, the generator of which has a wide range of voltage, adjustable by means of field control. Usually a standard set is satisfactory with field rheostat capacity sufficient to lower the voltage to desired minimum.

The combined induction and drum type of control is shown in Fig. 11 and consists of an induction regulator upon which is mounted a drum controller. The controller and regulator are geared together and operated by a small polyphase motor similar to that used on standard Westinghouse induction feeder voltage regulators. The coils of the induction regulator and the taps of the regulating transformer, with which the regulator is used, are connected to the fingers of the drum controller in such a way that the voltage is raised or lowered in a smooth curve; the induction regulator operating

between taps of the regulating transformer. This method gives a smooth unbroken curve to the voltage regulation without the bad effect of a large series inductance, since the induction regulator is of small relative capacity. As in the case of the 480-point motor-operated drum controller, this device automatically raises or lowers the testing voltage, cutting out when either limit is reached.

Prices—Voltage Regulating Devices

Style number and list price include the apparatus as described but without regulating transformer. Necessary oil is included in price of the combination, Style No. 238938.

Description	Number Steps	Capacity, Amps.	Approx. Net Wt. Lb.	Approx. Dimensions Floor Space	Over-all Height	Gal. Oil	Ordering Data Style No.	List Price
Hand-operated drum controller	128	100	400	25½" diam.	3'–6"	..	178843	$ 475 00
Motor-operated drum controller	480	200	830	24" diam.	6'–3"	..	238937	1175 00
Motor-operated combination of drum controller and induction regulator	Infinite	100	2350*	25" x 25	8'–0"	55	238938	On Request
Induction regulator Motor-generator set	Prices and complete information on request.							

*Net weight does not include oil. Oil weighs approximately 7 pounds per gallon.

CONTROL PANELS

No exact description can be given of the control panel since it must be arranged to suit the individual requirements. It is usual practice, however, to provide a black slate panel, of convenient size, mounted on pipe frame. A circuit-breaker is provided thereon and connected in the supply circuit to protect the equipment from short circuits, and also to indicate failure of material under test. This breaker is usually of the oil-switch type, but where capacity permits, a carbon breaker and two-pole knife switch may be used. It is good practice to furnish also an ammeter and a voltmeter connected to the supply circuit. These are not only convenient but strongly recommended. A pilot lamp is used in order that operator may know when the supply circuit is closed.

Unless otherwise specified, price for outfit above 50,000 volts will include control panel as described above.

VOLTAGE-MEASURING DEVICES

Where accuracy is not essential or where the kilovoltampere capacity of the load is negligible, a voltmeter connected to the primary of the testing transformer and calibrated in terms of the testing voltage, is satisfactory. These conditions, however, are rarely ever fulfilled in service when making high voltage tests and more scientific methods are necessary. The Westinghouse Company offers two devices of the latter class, the spherical spark gap and the crest voltmeter, both recommended by the A. I. E. E.

Spherical Spark Gaps

The spherical spark gaps are constructed of two non-arcing metal spheres mounted vertically in suitable wooden frame work. As these spheres are formed in dies and are accurately machined and polished, they are very much more accurate than spun spheres. The lower sphere is at ground potential while the upper sphere is connected to the line through a resistor. Suitable micrometer adjustment is provided so that the separation of the spheres may be accurately determined.

All sizes, 125 to 500 millimeters inclusive, are of the same type of construction as shown in Fig. 12. The 50 millimeter size is built horizontally, and on account of its light weight is portable without the necessity of castors.

The following are the voltage ranges of the standard sizes:

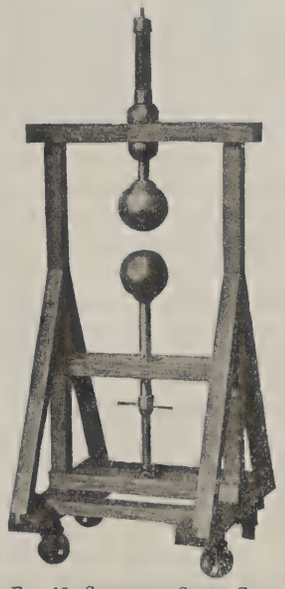


FIG. 12—SPHERICAL SPARK GAP

Diameter of Sphere Millimeters	Range in Kilovolts
50	10– 75
125	30–160*
250	60–280*
375	70–350
500	80–400*

*Range recommended by A. I. E. E. Rules for 1915.

For Prices see Section 3-B.

FIG. 13—CREST-VOLTMETER OUTFIT

Crest-Voltmeter Outfit

The crest-voltmeter outfit, illustrated in Fig. 13, provides a convenient and accurate method of measuring high voltages and is especially adapted for use with testing equipments. It is used in connection with the condenser-type bushing of the transformer and can be furnished for measurement of any voltage for which a condenser bushing can be built. It is standard practice to furnish condenser-type bushings with all testing transformers having voltages of 75,000 and higher and by special arrangement, transformers with voltages as low as 30,000 may be equipped with the condenser bushing.

Furthermore, the crest-voltmeter outfit can be used in connection with any Westinghouse transformer now in service that is equipped with a condenser bushing. To do this, however, a slight change must be made in the mounting of the bushing on the transformer and the calibration of the meter must be made by an engineer from the East Pittsburgh Works.

Operation—The principle upon which this device operates is that the average value of the half wave of the charging current in a condenser bushing, which charging current flows into and out of the bushing when the latter is subjected to a voltage strain, is proportional to the crest of the voltage wave. The charging current is rectified by means of small mercury bulbs and measured by a sensitive direct-current milli-ammeter that is calibrated in terms of the high-voltage alternating-current voltage. The deflection of the meter is proportional to the maximum value of the voltage wave; and, since the meter is a direct-current instrument, all the scale divisions are approximately equal. This makes it possible to read low voltages on the scale with the same accuracy as the higher voltages, a very important and desirable feature in insulation testing.

The readings of the crest-voltmeter are not affected by the electrostatic capacity of the testing load, by changes in the amount of the testing load, or by atmospheric conditions; they are, however, affected by the frequency of the supply circuit and for this reason a frequency meter is supplied. The readings of the crest voltmeter vary directly with the frequency so that a correction can easily be made for any variation in frequency from that for which it is calibrated.

The readings are theoretically correct for all voltage waves having not more than one maximum and one minimum value per cycle, and are practically correct for all other commercial wave-shapes to be found.

Construction—The complete equipment of the crest-voltmeter outfit consists of a small slate panel mounted on pipe framework, as shown in Fig.13, and upon the panel is mounted a frequency meter, a direct-reading highly sensitive milli-ammeter specially calibrated to read crest voltages, two small rectifier bulbs, and a change-over switch.

This device can be furnished, as stated above, for voltages of from 30 kilovolts up. The normal voltage is determined by the normal voltage of the transformer with which it is to be used. For prices see section 3-B.

OIL TESTING CUP

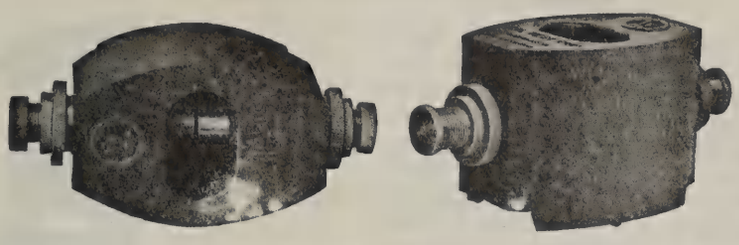


FIG. 14—OIL TESTING CUP

The usual method of determining the suitability of an oil for insulating purposes is to test its dielectric strength by means of a spark gap immersed in the oil. (See instructions for testing oil on another page of this section). Various devices have been used for this purpose which requires a comparatively large sample of oil and a rather high voltage for their successful operation. Consequently, there has been a distinct demand for a device that would give reliable indications with a minimum sample of oil and relatively low testing voltage. The device now offered by the Westinghouse Electric and Manufacturing Company is entirely new and is the result of extensive research work over a period of years, followed by an actual trial of the completed device for one year in our own commercial test department and research laboratories. (See Fig. 14.)

The maximum voltage required for reliable testing is 25,000 volts. Any oil requiring a higher voltage to discharge through it, across the standard gap of this apparatus is in better condition than can be maintained regularly in commercial practice. Higher voltages may be used if available, but it is seldom that 30,000 volts will be required to discharge across the standard gap through any insulating oil.

The gap terminals are flat disks, one inch in diameter, with square edges. The standard gap is 0.10 inch. The gap is locked in position after setting against a feeler guage. No further adjustments will be necessary until the terminals require removal for dressing the surfaces. This will not be necessary until after a long interval. All metal parts are of brass, except the steel feeler guage, which is attached to one of the binding posts and is concealed in a hollow in one of the spark gap terminals when not in use. This binding post is stamped with the letter "G" on its flat surface. The containing vessel is of one piece of moulded material.

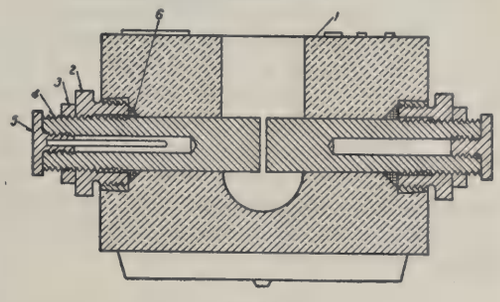


FIG. 15

1—CUP
2—PACKING GLAND
3—LOCK-NUT
4—ELECTRODE
5—GAP-GAUGE AND BINDING POST
6—PACKING

Style number and list price include testing cup and spark gap complete as described.

APPROX. WT., LB. Net	Shipping	Dimensions	Style No.	List Price
6½	12	8½ x 4 x 4¾"	263621	$75 00

ARMATURE-TESTING EQUIPMENTS

The armature-testing outfit, illustrated in Fig. 16 consists of a laminated iron core in which an alternating magnetic flux is set up by connecting the terminals of its exciting coil to a source of alternating current. When either a direct-current or an alternating-current wave-wound (two-circuit)* armature of the commutator type is placed against the face of this core, which is shaped to fit an armature, an alternating flux passes through the armature core. If the armature winding is correct, the electromotive forces generated counterbalance each other and no current passes through the winding.

Detection of Faults—Passing a piece of metal or a knife blade around the commutator short-circuits in succession each of the coils that have one side under the testing pole. If there is no fault in the winding a decided spark occurs as the knife blade leaves each bar. Absence of spark between two bars indicates either a short-circuit, an open-circuit, or a reversed coil in the winding.

A short-circuit or reversed coil will cause a local current in the coil, which will generate a flux around the slots in which the coil lies. Such a local flux can be detected by running a piece of sheet iron held lightly over the surface of the armature, bridging from one tooth to the next successively. The local flux caused by a short-circuit or reversed connection will attract the piece of iron when it bridges across the slot containing the defective coil. If no such local flux is detected, the fault disclosed by the sparking test is due to an open-circuit.

FIG. 16—PORTABLE ARMATURE-TESTING EQUIPMENT

The core is mounted on a stand provided with wheels or on a stationary stand. It is used in a vertical position close to the armature. Two sizes are made, one for armatures up to 12 inches in diameter and one for armatures 12 inches or more in diameter.

PRICES

For Use on 25 and 60 Cycle Circuits

Style number and list price include the equipment complete as described. No extension cord for connecting to supply circuit is furnished.

Type	For Armature, Diameter	Approx. Wt. Lb. Net	Approx. Wt. Lb. Shipping	Approx. Dimen. Inches Floor Space	Approx. Dimen. Inches Over-all Height	Ordering Data Style Nos. 110-Volt	Ordering Data Style Nos. 220-Volt	List Price
Portable	Up to 12 inches	200	430	20⅜ x 24½	55⅜	107509	107510	$315 00
Portable	12 Inches and larger	260	490	18¾ x 26½	51½	107505	107506	340 00
				Wall Space	Over-all Height			
Stationary	Up to 12 inches	80	110	14⅜ x 18	11¼	107511	107512	190 00
Stationary	12 Inches and larger	100	147	14⅜ x 20	9¾	107507	107508	210 00

Order by Style Number

*There are two main classes of armatures, known familiarly as "lap-wound" or "multiple" and "wave-wound" or "two-circuit" armatures. In the first class equalizer connectors are used to connect points of the same potential. Where one side of such an armature is excited by this testing equipment the entire armature will appear to be short-circuited due to the equalizer connections, and because of this condition the spark at the commutator is very weak. This same effect is produced by the connections to the slip rings in the armatures for rotary converters or three-wire generators. This testing equipment is therefore suitable only for use with wave-wound (two-circuit) armatures.

COIL-TESTING EQUIPMENTS

A device for locating faults in armature and field coils before the winding is put in place is illustrated in Fig. 17. Its use saves further labor on a defective coil. The apparatus consists of an E-shaped electromagnet with a detachable yoke. The exciting coil is on the middle leg of the **E**. On the back of the **E**, between the middle leg and each outside leg are wound two small coils so connected that the electromotive forces induced in them oppose and accurately balance each other, so that under normal conditions no current flows.

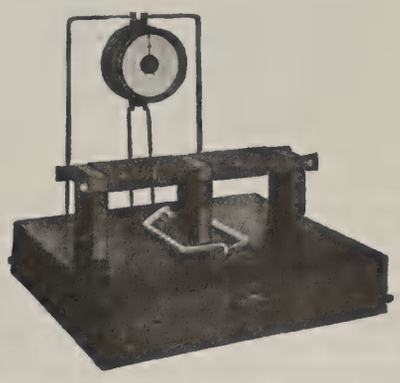


FIG. 17—COIL TESTING EQUIPMENT WITH WATTMETER

Operation—The field or armature coil to be tested is placed over one of the outer legs of the **E** and the yoke is omitted. If the tested coil is without fault it has no effect on the flux distribution. If, however, a short circuit exists, a current is induced in the tested coil which so alters the distribution of the flux that more passes through one of the detecting coils than through the other, inducing higher voltage in one than in the other, and thus causing a current to flow through them. Such current can be detected by means of a zero-center wattmeter or by means of a telephone receiver. In this test the volts per turn in the coil under test are approximately 0.3 or 0.6, depending on which tap in the exciting coil is used.

To locate a short-circuit in a coil by burning it out, the coil is placed on the middle leg of the **E**, the detachable yoke put in place as shown in Fig. 17, and the exciting coil connected to the line for a short time.

PRICES

Style number includes outfit complete except wattmeter. The list price, however, includes a wattmeter of the proper style number, but does not include wattmeter leads.

Volts	Approx. Net Wt. Pounds	Approx. Dimensions Inches		ORDERING DATA Style Nos.		
		Floor Space	Over-all Height	Outfit	Wattmeter	List Price
110	275	27 x 30	14½	107513	164353	$310 00
220	275	27 x 30	14½	107514	164354	310 00
Deduction from list price for omission of wattmeter						30 00
Addition to list price for special telephone receiver						6 00

OIL DRYING AND PURIFYING OUTFITS—Continued

The filter paper thus takes up all the moisture and screens out all sediment from the oil. After passing through the filter paper, the oil flows along the grooves formed by the pyramid surface to the opening *b* in the corner of the plates and thence out through the outlet *B*. The pyramid surface is well adapted for its purpose, as the tops of the pyramids, being flush with the rim of the plates and spaced close together, support the filter paper against the working pressure, and the grooves readily permit the oil to pass through.

Filter Paper—The filter paper used is a special grade of white blotting paper about .025 inch thick. It is prepared from wood pulp and contains no coloring matter or chemicals that might injure the oil. Five sheets, cut to the proper size, 12⅞ inches square for the class A outfits and 7¾ inches square for the class B outfits, and with holes punched to correspond with the holes in the filter plates and frames, are used between each plate and the adjacent frame.

To obtain best results in treating the oil it is absolutely necessary that the filter paper when first placed in the filter press be entirely free from moisture. Filter paper will invariably absorb moisture if exposed to the air for any length of time and for this reason every precaution must be used in handling the paper. The standard paper is carried in packages containing one ream (480) sheets) carefully wrapped in waxed paper and covered with heavy wrapping paper. Before using the paper in the filter press, however, it must be thoroughly dried out under heat, and for this purpose the drying oven described below is used.

Pump—Rotary-gear positive-pressure pumps are used for these outfits. These pumps are strong, light, and of simple construction. A wire-mesh strainer, arranged so that it may be easily removed for cleaning, is connected in the piping to remove from the oil the large particles of sediment before the oil enters the pump. A by-pass is connected around the pump and provided with a relief valve set for approximately 100 pounds pressure. If the pressure should rise to this value due to clogging of the filter, the valve opens and allows a part of the oil to circulate back through the pump, thus relieving the pressure. These pumps will develop considerable suction, and the oil to be treated may be readily drawn from a tank fifteen to twenty feet below the level of the outfit, (in this case, however, the pump must be primed.)

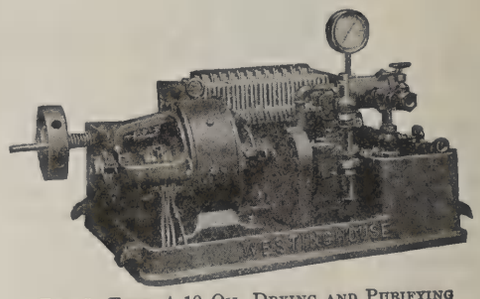


FIG. 5—TYPE A-10 OIL DRYING AND PURIFYING OUTFIT

Mechanical Details—These outfits, as shown in the illustrations, are very compact and require little space. Lifting lugs or eyebolts are provided for convenience in handling. On special order the outfit may be mounted on four casters for portable service.

Composition metal gate valves and malleable-iron fittings are used in the piping connections. The brass by-pass valve may readily be opened for inspection or in case of clogging. The piping is arranged so that the oil may be pumped out of a tank below the level of the outfit as well as by gravity feed. A brass pressure gauge is mounted between the filter press and the pump.

The outfits are finished with steel-colored engine enamel. The workmanship and material used throughout are of the best and the outfits are not only of very substantial construction but present a neat and finished appearance.

FIG 6—ELECTRIC DRYING OVEN, OPEN

Drying Ovens

The electric oven for drying the filter paper before use in the filter press is shown in Fig. 6. The oven is substantially built of sheet-iron with double walls. Adjustable slides are provided in the top of the oven for regulating the temperature and the circulation of air through the oven.

These ovens are furnished in three sizes, designated by types A-30, A-10 and B, to correspond to the sizes of filter paper. The type A ovens are used for large size paper that is used with the type A filter presses. The type B oven is used with both sizes of the type B filter press.

The filter papers are held in a vertical position in a rack and supported by rods through the holes in the corners of the papers. When the door in the front

OIL DRYING AND PURIFYING OUTFITS—Continued

The best and quickest method for filtering a quanity of oil is to pump all the oil from the tank through the filter and into another tank that is dry and clean. If care is taken to change the filter papers before they become saturated, absolutely clean dry oil will be obtained If the second tank for holding the oil is not available or if it is desired to filter the oil of a transformer while in service, the oil may be pumped from the bottom of the tank through the filter, and returned to the top of the same tank. This operation should be continued until the oil in the tank shows a sufficiently high dielectric strength.

Where a large amount of oil must be filtered, the time may be shortened by using two filter presses and pumping from the bottom of the transformer tanks as stated above, one press being run while the other is being recharged.

FIG. 2—FILTER-PRESS PLATE

APPARATUS

There are five standard sizes, divided into two classes, according to the size of the filter paper. The three larger sizes are rated at 10, 20, and 30 gallons per minute and are designated by the class letter A with their capacity in gallons suffixed. The two smaller sizes are rated at 2.5 and 5 gallons per minute and are designated as class B, the capacity in gallons suffixed. Thus, type A-20 is the 20-gallon class A outfit, and type B-5 is the 5-gallon class B outfit.

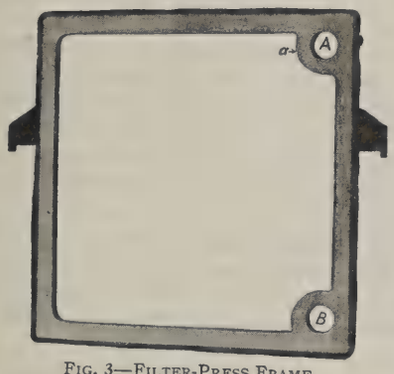


FIG. 3—FILTER-PRESS FRAME

The complete outfit consists of filter press, motor, pump, oil strainer, pressure gauge, and piping. The sizes up to and including 10 gallons per minute are mounted on a neat iron base cast with a high rim that forms an enclosure and serves as a drip pan. The 20 and 30-gallon per minute sizes are mounted on a structural iron base and have a sheet-metal drip pan.

Filter Press—The filter press proper is made up of a series of flat cast-iron plates and frames (see Figs. 2 and 3) assembled alternately, with the filter papers between them. By means of a screw and lever and a movable cast-iron end block, the plates, frames, and papers are forced tightly together. Except for a carefully machined rim around the edge, which serves to form a joint to prevent the escape of the oil, the plates, as shown in Fig. 2, are cast with small pyramids on both surfaces.

The plates and frames are cast with holes *A* and *B* in two of the corners. Supporting lugs are cast at the sides, and the plates have handles on the top edge. When the plates and frames, with the filter papers between them, are assembled, the holes *A* and *B* form respectively the inlet and outlet for the oil. Cored openings *a* and *b* connect respectively with the holes *A* in the frames and the holes *B* in the plates.

The oil entering under pressure at the top corner through the inlet formed by holes *A* in the frames, plates, and filter papers, enters by means of the opening *a* in the frames and fills each of the chambers formed between each set of two filter packs, (see Fig. 4). From these chambers there is no outlet opening and the oil is consequently forced through the filter papers that form the sides of the chamber

FIG. 4—ASSEMBLY OF ONE FILTER-PRESS PLATE AND ONE FILTER-PRESS FRAME, SHOWING FORMATION OF OIL CHAMBERS BETWEEN EACH TWO FILTER PAPERS

OIL DRYING AND PURIFYING OUTFITS

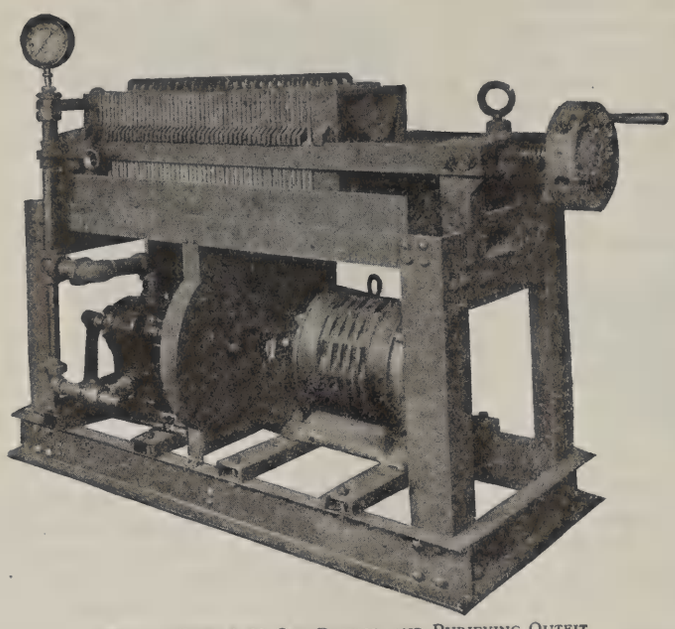


FIG. 1—TYPE A-30 OIL DRYING AND PURIFYING OUTFIT

APPLICATION

It is becoming the general practice of central stations and other large users of transformers, oil circuit-breakers, electrolytic arresters, and feeder regulators to make periodic inspection and tests of the insulating oil and to dehydrate and purify oil that has absorbed moisture or sediment. This practice reduces the failure of apparatus from burnouts with consequent interruptions to the service, and also economizes in the use of oil. To successfully treat oil in large quantities with a minimum of expense has necessitated the development of special apparatus that will be reliable and effective in operation.

After careful investigation of the problem of reclaiming all insulating oils whose deterioration has been caused by physical changes, or the presence of moisture, carbon, or other foreign substances, (see pages of this section on "The Storage, Handling, Filtering, Dehydrating and Testing of Insulating Oil"), the Westinghouse Company has developed a special type of filtering outfit for this service.

Capacity—The capacity of these outfits, with oil pressure and filtering area fixed, depends upon the viscosity of the oil and its condition as regards freedom from dirt. With fairly clean oil at ordinary room temperature, the capacity of the outfits will vary from normal to about 15 per cent above normal, depending upon the viscosity of the oil, which varies with the temperature. It is found that the best results are obtained when the oil temperature is between 25 and 75 degrees Centigrade. The average working pressure of these outfits is 60 pounds per square inch. By using larger pumps giving higher working pressure, the capacity of the outfits can be increased but the best results are obtained with the more moderate pressure.

Other Classes of Service—While the principal class of service for which these outfits are developed is for the treatment of insulating oil, there are numerous other applications for which they are well fitted. Insulating varnishes, compounds, etc., that have a sufficiently low viscosity may be cleaned and dehydrated. Machine oil of all kinds, petroleum, benzine, etc., may be effectively cleaned and dehydrated.

OPERATION

In this outfit, the oil to be purified is forced through several layers of specially prepared filter paper. The sediment is strained out by the first layer of paper and the moisture is taken up by the capillary action of the paper.

The filtering outfit is made ready for operation by placing a set of five sheets of filter paper, that have been thoroughly dried in the electric oven, (see following pages), between each filter plate and frame. Holes in the filter paper line up with holes A and B (Figs. 2 and 3) in the plate and frames.

If the oil contains only a small amount of water, all sediment and water should be removed by passing the oil once through the outfit. If any moisture remains, it indicates that the filter papers are saturated with moisture and must be renewed. No rule can be given as to how often the filter paper should be changed, as this depends entirely upon the amount of water and dirt in the oil. The usual procedure is to run the outfit for a period of one-half hour or so (if the oil is not in very bad condition) and then shut down; remove one sheet from the inlet side of each set of filter papers, and put in a new sheet on outlet side of each set. Frequent tests of the dielectric strength of the oil (see pages of this section on "The Storage, Handling, Filtering, Dehydrating and Testing of Insulating Oil"), should be made during this procedure, however. It may sometimes be found necessary with very wet or dirty oil to recharge the outfit with a full set of papers before the five sheets of each set have been removed in succession.

OIL DRYING AND PURIFYING OUTFITS—Continued

of the oven is opened, the rack may be withdrawn and the filter paper conveniently inserted or withdrawn. The paper should be dried for about 24 hours before being used, but this time can be decreased, depending upon the condition of the paper and degree of heat.

Ovens are listed for four different voltage ranges and may be used equally well on either alternating or direct-current circuits. Three heats are obtainable by means of a rotary snap switch mounted on the front of the oven. It will usually be found desirable, however, to use the high heat.

The input of the ovens will vary from low heat to high heat as follows:—type A-30 from 400 to 1600 watts; type A-10 from 200 to 800 watts and type B from 100 to 400 watts.

PRICES

Filter Press Outfits

Style number and list price include the outfit complete with motor but do not include the drying oven. With the Class A outfits, three packages of filter paper (480 sheets per package) are included and with Class B outfits, two packages.

Motor					Sheets of Paper Required per Charge	Net Weight Pounds	Shipping Weight Pounds		
Voltage	Phase	Cycles	H. P.	Style No.				Style No.	List Price
TYPE A-30									
110	2	25	5	.....	240	2000	2200	229752	$940 00
220	2	25	5	212325	240	2000	2200	229753	940 00
440	2	25	5	212326	240	2000	2200	229754	940 00
110	3	25	5	.....	240	2000	2200	229755	940 00
220	3	25	5	212328	240	2000	2200	229756	940 00
440	3	25	5	212329	240	2000	2200	229757	940 00
110	1	60	5	.....	240	2000	2200	232193	990 00
220	1	60	5	.....	240	2000	2200	232194	990 00
440	1	60	5	.....	240	2000	2200	.....	990 00
110	2	60	5	170961	240	2000	2200	229758	890 00
220	2	60	5	170962	240	2000	2200	229759	890 00
440	2	60	5	170963	240	2000	2200	229760	890 00
110	3	60	5	170917	240	2000	2200	229761	890 00
220	3	60	5	170918	240	2000	2200	229762	890 00
440	3	60	5	170919	240	2000	2200	229763	890 00
115	D.C.	D.C.	5	.....	240	2000	2200	229764	970 00
230	D.C.	D.C.	5	143697	240	2000	2200	229765	970 00
550	D.C.	D.C.	5	.....	240	2000	2200	229766	970 00
TYPE A-20									
110	2	25	3	.....	180	1800	2000	232176	800 00
220	2	25	3	246629	180	1800	2000	232177	800 00
440	2	25	3	.....	180	1800	2000	232178	800 00
110	3	25	3	.....	180	1800	2000	232179	800 00
220	3	25	3	246631	180	1800	2000	232180	800 00
440	3	25	3	246632	180	1800	2000	232181	800 00
110	1	60	3	.....	180	1800	2000	232182	870 00
220	1	60	3	.....	180	1800	2000	232183	870 00
440	1	60	3	.....	...	1800	2000	.....	870 00
110	2	60	3	170955	180	1800	2000	232184	755 00
220	2	60	3	170956	180	1800	2000	232185	755 00
440	2	60	3	170957	180	1800	2000	232186	755 00
110	3	60	3	170909	180	1800	2000	232187	755 00
220	3	60	3	170910	180	1800	2000	232188	755 00
440	3	60	3	170911	180	1800	2000	232189	755 00
115	D.C.	D.C.	3	143688	180	1800	2000	232190	810 00
230	D.C.	D.C.	3	143690	180	1800	2000	232191	810 00
550	D.C.	D.C.	3	143692	180	1800	2000	232192	810 00

Portability—On special order and at an addition to list price of **$30.00,** four casters can be mounted on the base of any of these outfits, thus adapting them to portable service.

Order by Style Number

OIL DRYING AND PURIFYING OUTFITS—Continued

PRICES OF FILTER PRESS OUTFITS—Continued

Motor					Sheets of Paper Required Per Charge	Net Weight	Shipping Weight		
Voltage	Phase	Cycles	H. P.	Style No.				Style No.	List Price
Type A-10									
110	2	25	2	.....	140	1500	1700	172852	$545 00
220	2	25	2	212311	140	1500	1700	172853	545 00
440	2	25	2	.....	140	1500	1700	172854	545 00
110	3	25	2	.....	140	1500	1700	172855	545 00
220	3	25	2	212314	140	1500	1700	172856	545 00
440	3	25	2	212315	140	1500	1700	172857	545 00
110	1	60	2	173517	140	1500	1700	232174	605 00
220	1	60	2	173517	140	1500	1700	232175	605 00
440	1	60	2	.....	140	1500	1700	.....	605 00
110	2	60	2	225158	140	1500	1700	172858	535 00
220	2	60	2	225159	140	1500	1700	172859	535 00
440	2	60	2	225160	140	1500	1700	172860	535 00
110	3	60	2	225161	140	1500	1700	172861	535 00
220	3	60	2	225162	140	1500	1700	172862	535 00
440	3	60	2	225163	140	1500	1700	172863	535 00
115	D. C.	D. C.	2	143681	140	1500	1700	172864	605 00
230	D. C.	D. C.	2	143684	140	1500	1700	172865	605 00
550	D. C.	D. C.	2	143686	140	1500	1700	172866	605 00
Type B-5									
110	2	25	1	.....	140	700	850	232159	355 00
220	2	25	1	225194	140	700	850	232160	355 00
440	2	25	1	.....	140	700	850	.....	355 00
110	3	25	1	.....	140	700	850	232161	355 00
220	3	25	1	225197	140	700	850	232162	355 00
440	3	25	1	.....	140	700	850	.....	355 00
110	1	60	1	198556	140	700	850	232163	380 00
220	1	60	1	198557	140	700	850	232164	380 00
440	1	60	1	.....	140	700	850	.....	380 00
110	2	60	1	212591	140	700	850	232165	350 00
220	2	60	1	212591	140	700	850	232166	350 00
440	2	60	1	212593	140	700	850	232167	350 00
110	3	60	1	212594	140	700	850	232168	350 00
220	3	60	1	212595	140	700	850	232169	350 00
440	3	60	1	212596	140	700	850	232170	350 00
115	D. C.	D. C.	1	172410	140	700	850	232171	375 00
230	D. C.	D. C.	1	172411	140	700	850	232172	375 00
550	D. C.	D. C.	1	.....	140	700	850	232173	375 00
Type B-2½									
110	2	25	½	225179	90	650	775	172877	300 00
220	2	25	½	225180	90	650	775	172878	300 00
440	2	25	½	.....	90	650	775	.....	300 00
110	3	25	½	.....	90	650	775	172879	300 00
220	3	25	½	225183	90	650	775	172880	300 00
440	3	25	½	.....	90	650	775	.....	300 00
110	1	60	½	198550	90	650	775	232157	310 00
220	1	60	½	198551	90	650	775	232158	310 00
440	1	60	½	.....	90	650	775	.....	310 00
110	2	60	½	212556	90	650	775	172881	290 00
220	2	60	½	212557	90	650	775	172882	290 00
440	2	60	½	212558	90	650	775	172883	290 00
110	3	60	½	212559	90	650	775	172884	290 00
220	3	60	½	212560	90	650	775	172885	290 00
440	3	60	½	212561	90	650	775	172886	290 00
115	D. C.	D. C.	½	260095	90	650	775	198049	305 00
230	D. C.	D. C.	½	160096	90	650	775	198050	305 00

Portability—On special order and at an addition to list price of **$30.00,** four casters can be mounted on the base of any of these outfits, thus adapting them to portable service.

Order by Style Number

OIL DRYING AND PURIFYING OUTFITS—Continued

DRYING OVENS

Style number and list price include oven complete with rack, suspension rods, heating elements, and snap switch. No extension cord for connecting to supply line is provided. The type A-30 oven is used with the types A-30 and A-20 oil treating outfits, the type A-10 oven is used with the type A-10 outfit, and the type B oven is used with the type B-5 and B-2½ outfits.

Oven Type	Voltage	Watts	Approx Wt.—Lbs. Net	Approx Wt.—Lbs. Shipping	Style Number	List Price
A-30	100-112	1600-800-400	200	375	226571	$255 00
A-30	113-125	1600-800-400	200	375	226572	255 00
A-30	200-225	1600-800-400	200	375	226573	255 00
A-30	226-250	1600-800-400	200	375	226574	255 00
A-10	100-112	800-400-200	80	150	175509	120 00
A-10	113-125	800-400-200	80	150	175510	120 00
A-10	200-225	800-400-200	80	150	175511	120 00
A-10	226-250	800-400-200	80	150	175512	120 00
B	100-112	400-200-100	40	75	175513	95 00
B	113-125	400-200-100	40	75	175514	95 00
B	200-225	400-200-100	40	75	175515	95 00
B	226-250	400-200-100	40	75	175516	95 00

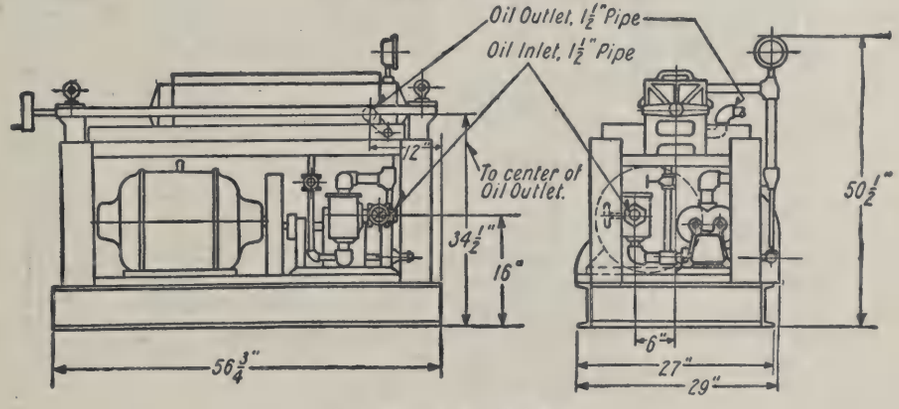
FILTER PAPER

Three reams of filter paper are furnished without additional charge with all type A filter press outfits, and two with all type B filter press outfits. Extra paper will be furnished in standard packages of one ream (480 sheets) per package, at the following list prices:—

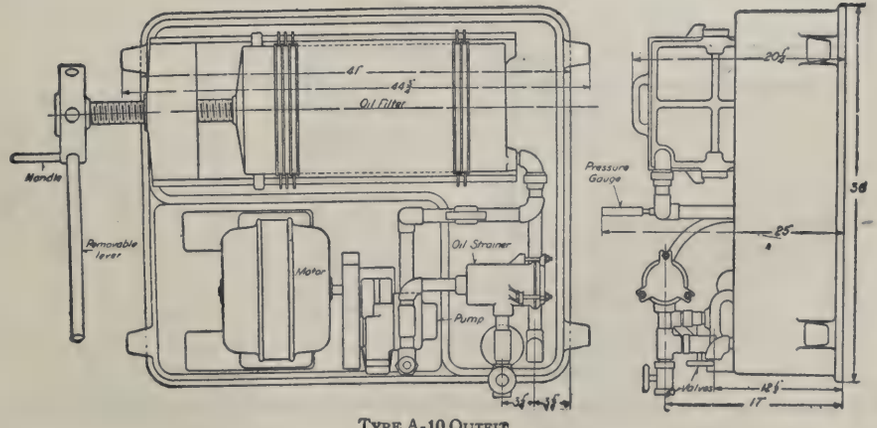
Type of filter Press Outfit	Approx. Net Wt.—Lbs.	Style No.	List Price
A-30	44	178647	$12 00
A-20	44	178647	12 00
A-10	44	178647	12 00
B- 5	13	178766	6 00
B- 2½	13	178766	6 00

Order by Style Number

OUTLINE DIMENSIONS

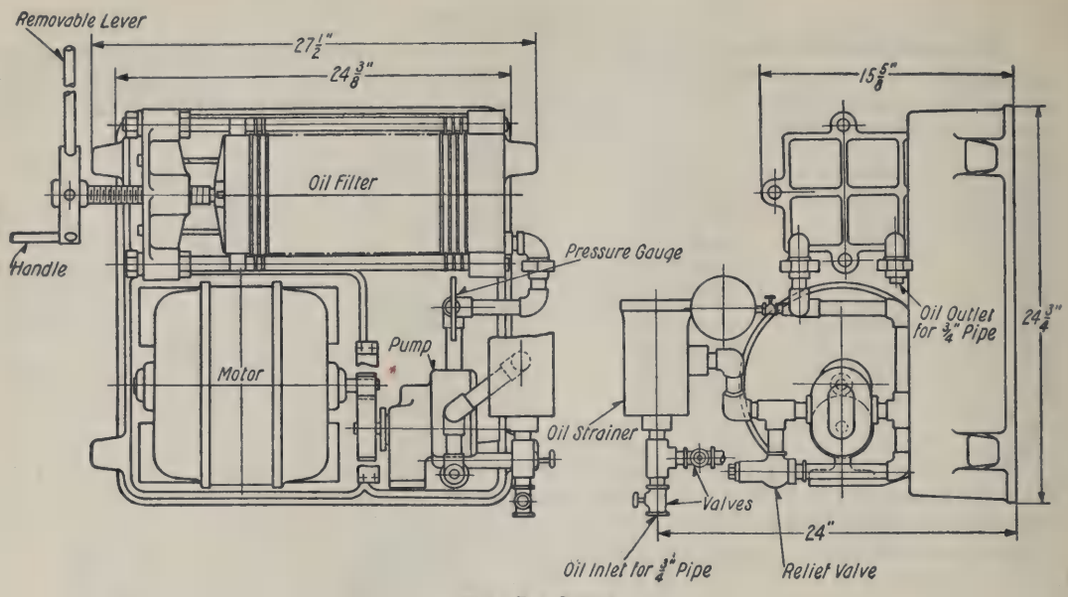


TYPES A-30 AND A-20 OUTFITS

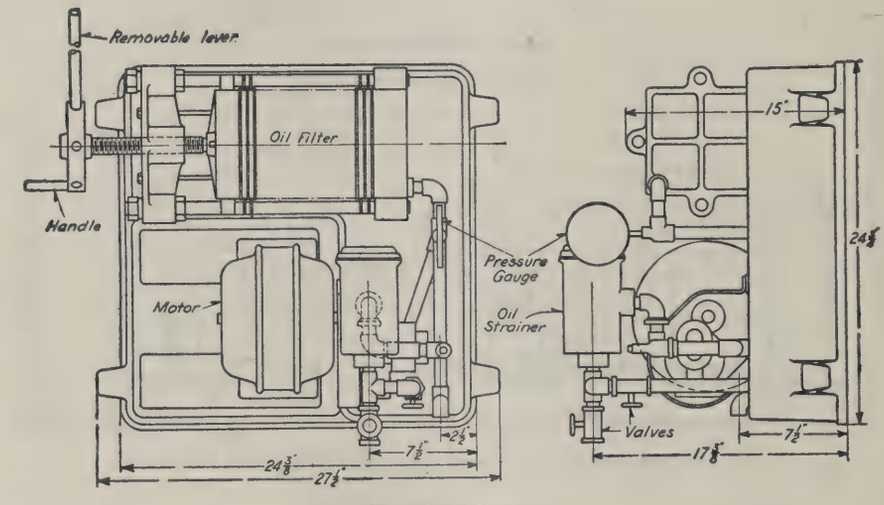


TYPE A-10 OUTFIT

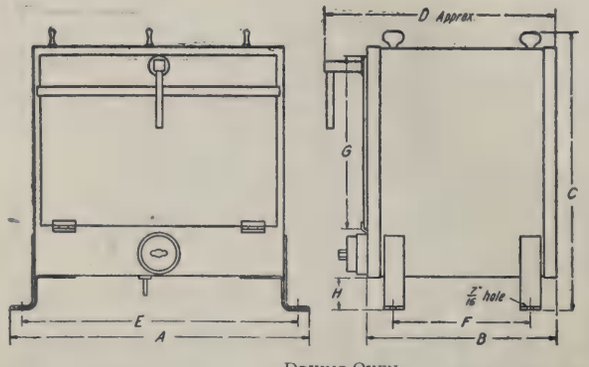
OIL DRYING AND PURIFYING OUTFITS—Continued



TYPE B-5 OUTFIT



TYPE B-2½ OUTFIT



Type	Inches A-30	Inches A-10	Inches B
A	49⅝	26⅜	18⅛
B	16⅞	16⅝	11¾
C	22⅝	22	16¾
D	19½	19¼	14
E	48⅛	24⅞	16⅝
F	13¾	13½	8¼
G	15⅝	15⅝	10⅜
H	1¼	1¼	1¼

DRYING OVEN

These dimensions are for reference only. For official dimensions apply to nearest district office.

THE STORAGE, HANDLING, FILTERING, DEHYDRATING, AND TESTING OF INSULATING OIL

STORAGE, HANDLING, AND FILTERING

Storage

All Westinghouse insulating oil is shipped either in the tank with the apparatus, in soldered tin cans, or in steel drums provided with screw bungs which are sealed before shipment. All oil in drums that are not sealed, should be tested before using. Drums should always be placed on their sides for storage, never turned up on end, as such a position allows water to collect in the head around the bung. If at all possible, it is advisable to store drums in a closed room; if stored out of doors, protection from the weather should invariably be provided.

Handling

Too great precaution cannot be taken to insure the thorough drying out of all apparatus before filling with oil, and during the actual transferring of the oil from the drums to the tank every care must be taken to prevent any moisture getting into either the oil or the apparatus. A drum of cold oil when taken into a warm room will invariably "sweat" and the resulting moisture on the outer surface may mix with the oil as the latter flows from the drum. Before breaking the seal, the drum should, therefore, be allowed to stand long enough to reach room temperature. All vessels used for transferring the oil should be carefully inspected to see that they are absolutely dry and free from metallic or carbonaceous particles.

Filtering

Immediately before placing the oil in the transformer or switch tanks, care must be taken to remove thoroughly any particles of foreign matter, scale, etc., that may have adhered to the interior of the drum too firmly to be removed by the washing and drying the drum receives at the oil refinery before filling, but have become loosened by the continual swashing of the oil during transit. This matter can be conveniently removed by using a funnel of large size with the top completely covered with two layers of any ordinary finely woven cotton cambric, that has been thoroughly washed and dried to remove the sizing, and passing the oil through this as a filter. The oil will pass through this filter more rapidly if slightly warm. The funnel may be made to discharge directly into the tank of the electrical apparatus, if not, the oil must not be returned to an empty drum unless the drum is known to be thoroughly clean and dry.

The thoroughness with which the filtering has been done may be determined by measuring the dielectric strength of the oil with the testing cup and spark gap as described on a previous page (see "Insulation-Testing Equipments").

PURIFYING AND DEHYDRATING

To obtain the best service from oil for cooling and insulating transformers, high-tension switches, induction regulators, circuit-breakers, electrolytic lightning arresters, and similar apparatus, it is necessary to employ some method of cleaning and dehydrating the oil from time to time, or the oil must be discarded periodically and replaced by new oil free from dirt and moisture.

Both the capacity and the voltage of transformers and other oil-insulated apparatus have been steadily increasing, making it necessary that the oil used be of extremely high quality as regards its purity and freedom from moisture. It is well-known that the presence of moisture in transformer oil, even in the most minute quantities, very seriously affects the dielectric strength of the oil. Carefully conducted tests made by the Westinghouse Company have shown that .001 to .005 of 1 per cent (one part in 100,000 to 20,000) will reduce the dielectric strength below the standard test value of 22,000 volts between discs 1-inch in diameter with edges spaced 0.10 inches apart. (see "Testing" on following page). Fine particles of carbon, dust, or other foreign matter in suspension also reduce the dielectric strength and, in addition, form undesirable deposits, thus necessitating that the oil be kept free from sediment as well as moisture.

The transformer and switch oils now recommended and supplied are remarkably stable chemically, and are subject to but very slight change due to chemical causes. Switch oils, however, from the nature of their service, suffer deterioration in time from the presence of carbonized particles of switch contacts and also of the oil itself. Both transformer and switch oils, moreover, are susceptible to moisture and, even with the best care in handling and in operation, will absorb water, though probably at a very slow rate. Various abnormal conditions which occasionally arise, such as transformer burn-outs, accidents in cooling coils in water-cooled transformers, and severe or improper operation of switches, may seriously impair the dielectric strength of the oil so that provision should be made for suitably treating the oil after such conditions.

The foregoing emphasizes briefly the necessity of maintaining oil in a perfectly clean and dry condition, if successful operation is to be assured.

Detecting Moisture

The extremely small amount of moisture that will seriously lower the dielectric strength of oil cannot be detected by settling or by the well known "hot metal" test. It can be detected only by the use of the testing cup and spark gap as described on the following page under "Testing."

Removing Moisture

Moisture may be most effectively and economically removed by passing the oil through the Westinghouse Oil-Filtering and Drying Outfit as described in this section. It is not advisable to use other methods, such as passing hot dry air through the oil, on account of the difficulty of thoroughly removing all moisture from the air; or heating the oil for a considerable period of time, on account of the liability of injuring the oil during this heat treatment.

TESTING

The only known satisfactory method of determining the insulating value of oil is to measure its dielectric strength in a device built for this purpose. (See Westinghouse Oil Test Cup described and listed on another page of this section on Insulation-Testing Equipments).

The following precautions are required for using this device to prevent obtaining results that will cause the condemnation of good oil:

First, the gap should be adjusted and locked in place. Then thoroughly rinse with benzine or gasoline. If wiping with cloth is necessary, it must be dry and all such cleaning must be followed by thorough rinsing until all fibers of cotton have been eliminated. Then give a final rinsing with the oil to be tested immediately before placing the test sample in the apparatus.

The temperature of both oil and testing apparatus should be as close together as possible and shall be between 20° C. and 30° C. Lower temperatures are likely to yield low breakdown values and higher temperatures high values. Guarantees on oil are generally based on temperatures between these limits.

The oil level for apparatus with disk electrodes shall not be less than ¾ of an inch above the electrodes. A depth of 1 inch is preferable.

The testing transformer shall have at least one k. v. a. capacity.

Second, pour the test sample into the testing device and allow it to stand until all minute air bubbles have had time to escape. This will be two or three nimutes.

Third, apply the testing voltage starting at a low value and increasing steadily without opening the circuit at about 3000 volts per second until breakdown takes place.

Fourth, after breakdown, jar the testing device, but do not agitate the oil sufficiently to cause it to take up air bubbles. Jarring will tend to loosen particles of carbonized oil from between the electrodes. Jarring will not remove all this carbon but the remainder will be driven off by the next application of voltage before the breakdown value is reached. Do not introduce any device into the oil for stirring, as it is likely to cause low breakdown voltages by introducing minute particles of foreign matter, moisture or air bubbles.

Fifth, repeat "Third" and "Fourth" until five breakdowns have been obtained and use the average value as the breakdown voltage of the oil.

NOTE—Sometimes a small bright spark passes across the gap but does not form an arc or cause circuit-breakers or fuses to open the testing circuit. Such discharges should be disregarded in recording results. They are not likely to occur if sufficient time is allowed for all air to escape before applying voltage. It is better to make tests on several samples of oil if the first sample has a low breakdown value. If the tests on any one sample from the same tank, or other container, yield satisfactory results and the tests on other samples are low, the latter may be disregarded as having been caused by contamination in taking from the container or by insufficient cleaning of the testing device.

MICA INSULATION

The mica products listed in this section are those developed for use in Westinghouse Electrical apparatus.

Mica of good grade is one of the best insulators known to the electrical industry and is extensively used. However, its real effectiveness is dependent upon its purity and freedom from metallic spots or streaks which act as conducting films and seriously impair if not entirely destroy its dielectric strength. Further than this, service requirements differ; in some an extremely soft mica is best, in others a hard mica is suitable, while in others flexibility is the essential requirement.

To meet these conditions Westinghouse Research Engineers have made a careful study of mica, its properties, and the different classes of apparatus to which its use is adapted; the result being the materials listed below, among which will be found a product specially developed to meet every requirement of repair shop or factory.

No. 210 Amber Mica Plate

This is a plate built up of selected splittings of amber mica from the Westinghouse Company's Canadian mines (which is the softest mica known) and Westinghouse mica bond; steam pressed, dry baked, milled to exact thickness, and carefully gauged and inspected.

Uses—The most satisfactory material available for commutator segments and used in all Westinghouse commutators that are not undercut. For commutator work the mica segments must wear down evenly with the copper bars.

No. 210 amber mica plate is not suitable for moulding.

No. 207 White Mica Plate

A white mica plate similar in every way to the No. 210 mica plate except that splittings of white mica are used.

Uses—For segments of commutators that are undercut. Used on all undercut Westinghouse commutators.

No. 207 mica plate is not suitable for moulding.

No. 251 White Mica Plate

A white mica plate so bonded as to become very flexible when heated.

Uses—For moulding bushings, washers, turbo cells, commutator V-rings, channels for armature slots, corner cells, etc. No. 251 mica plate is not suitable for commutator segments.

No. 237 Flexible Mica

An unpressed white mica sheet built up with flexible bond. The mica splittings are very thin to give flexibility, and the bond is such that the flexibility is retained for a long time without drying out. The splittings used are built uniformly and carefully overlapped, thus making a plate of superior insulating properties.

Uses—For bending around sharp corners without heating, armature slot insulation, coil wrappers, etc

No. 224 Japanese-Paper-and-Mica

A white mica sheet built up with flexible bond. The mica splittings are very thin to give flexibility and the bond is such that the flexibility is retained for a long time without drying out. The mica is covered on both sides with Japanese paper.

Uses—This is especially suitable for coil wrappers.

No. 229 Treated-Cement-Paper-and-Mica

A white mica flexible sheet built upon .008-inch treated cement paper and covered with Japanese paper. The mica splittings used are very thin giving great flexibility, and very large, giving uniformity and few joints, while the treatment of the cement paper gives uniformly high dielectric strength and prevents moisture absorption.

Uses—Especially suitable for coil wrappers where very high dielectric strength is required.

No. 232 Fishpaper-and-Mica

White mica flexible sheet differing from No. 229 only in thickness; built upon fishpaper and covered with Japanese paper. The mica splittings used are very thin, giving great flexibility, while the fishpaper which is extremely tough adds mechanical strength.

Uses—Especially suitable for cell insulation and coil wrappers because of its toughness.

No. 240 Cambric-and-Mica

A white mica flexible sheet built upon .006-inch treated cambric and covered with Japanese paper. This gives a product of maximum mechanical strength with minimum thickness. Supplied in both sheet and tape form.

Uses—For insulating wrappers where flexibility and maximum strength are required.

No. 241 and No. 308 Fullerboard-and-Mica

A white mica flexible sheet built upon .007-inch fullerboard. This is a product of high mechanical strength.

Uses—For transformer and field coil insulation.

No. 228 Mica Tape

A white mica tape built up with special bond in a continuous sheet with Japanese paper on both sides and cut to tape widths.

Uses—Where sheet material is not adaptable, such as in insulating closed coils and sharp bends.

No. 209 Heater Mica

This mica plate is made from special mica splittings of large size bonded with a high heat resisting cement.

Uses—For insulation in electrical heating apparatus.

Mica Tubes

Mica tubes made from very thin flexible mica splittings bound together with special bond and Japanese paper.

Uses—For insulating grid resister tie-rods and similar applications.

MICA INSULATION—Continued

PRICES

Sizes shown below are standard and carried in stock. Any of the products listed will be furnished in practically any size or shape or built to any thickness required without appreciable delay.

A slight additional charge will be made for special sizes, shapes and thickness.

Material	Standard Sheet, inches	Standard thickness, inches	Approx. lbs. per sheet	List price per Pound
*No. 210 Amber Mica Plate	24x36	.010	.8	$3 90
*No. 210 Amber Mica Plate	24x36	.015	1.2	3 90
*No. 210 Amber Mica Plate	24x36	.020	1.6	3 90
*No. 210 Amber Mica Plate	24x36	.025	2.	3 00
*No. 210 Amber Mica Plate	24x36	.030	2.4	3 00
*No. 210 Amber Mica Plate	24x36	.032	2.6	3 00
*No. 210 Amber Mica Plate	24x36	.035	2.8	3 00
*No. 210 Amber Mica Plate	24x36	.040	3.2	3 00
*No. 210 Amber Mica Plate	24x36	.045	3.6	3 00
*No. 210 Amber Mica Plate	24x36	3/64	3.8	3 00
*No. 210 Amber Mica Plate	24x36	.050	4.0	3 00
*No. 210 Amber Mica Plate	24x36	.060	4.8	3 00
*No. 210 Amber Mica Plate	24x36	1/16	4.10	3 00
*No. 210 Amber Mica Plate	24x36	.010	.70	2 25
*No. 207 White Mica Plate	24x36	.015	1.05	2 25
*No. 207 White Mica Plate	24x36	.020	1.40	2 25
*No. 207 White Mica Plate	24x36	.025	1.75	2 00
*No. 207 White Mica Plate	24x36	.030	2.10	2 00
*No. 207 White Mica Plate	24x36	1/32	2.18	2 00
*No. 207 White Mica Plate	24x36	.035	2.45	2 00
*No. 207 White Mica Plate	24x36	.040	2.8	2 00
*No. 207 White Mica Plate	24x36	.045	3.15	2 00
*No. 207 White Mica Plate	24x36	3/64	3.22	2 00
*No. 207 White Mica Plate	24x36	.050	3.50	2 00
*No. 207 White Mica Plate	24x36	.060	4.20	2 00
*No. 207 White Mica Plate	24x36	1/16	4.36	2 00
*No. 207 White Mica Plate	24x36	3/32	6.54	2 00
*No. 207 White Mica Plate	24x36	1/8	8.72	2 00
No. 251 White Mica Plate (Moulding)	24x36	.010	.66	2 40
No. 251 White Mica Plate (Moulding)	24x36	.015	1.00	2 40
No. 251 White Mica Plate (Moulding)	24x36	.020	1.33	2 40
No. 251 White Mica Plate (Moulding)	24x36	.025	1.66	2 00
No. 251 White Mica Plate (Moulding)	24x36	.030	1.98	2 00
No. 251 White Mica Plate (Moulding)	24x36	1/32	2.05	2 00
No. 251 White Mica Plate (Moulding)	24x36	.035	2.31	2 00
No. 251 White Mica Plate (Moulding)	24x36	.040	2.66	2 00
No. 251 White Mica Plate (Moulding)	24x36	.045	2.99	2 00
No. 251 White Mica Plate (Moulding)	24x36	3/64	3.06	2 00
No. 251 White Mica Plate (Moulding)	24x36	.050	3.32	2 00
No. 251 White Mica Plate (Moulding)	24x36	1/16	4.62	2 00
No. 251 White Mica Plate (Moulding)	24x36	3/32	6.15	2 00
No. 251 White Mica Plate (Moulding)	24x36	1/8	9.24	2 00
No. 237 Flexible Mica	24x36	.005	.42	5 00
No. 237 Flexible Mica	24x36	.010	.85	4 00
No. 237 Flexible Mica	24x36	.015	1.26	3 25
No. 237 Flexible Mica	24x36	.020	1.70	3 25
No. 237 Flexible Mica	24x36	.025	2.12	3 25
No. 237 Flexible Mica	24x36	.030	2.55	3 25
No. 237 Flexible Mica	24x36	1/32	2.72	3 25
No. 237 Flexible Mica	24x36	1/16	5.44	3 25
No. 237 Flexible Mica	24x36	1/8	10.88	3 25
No. 224 Japanese Paper and Mica	24x36	.004	.16	3 40
No. 224 Japanese Paper and Mica	24x36	.006	.37	3 40
No. 224 Japanese Paper and Mica	24x36	.008	.76	3 40
No. 229 Cement Paper and Mica	40x36	.015†	1.17	1 60
No. 232 Fish Paper and Mica	40x36	.012‡	1.16	2 00
No. 240 Treated Cambric and Mica	25x52	.013**	1.05	2 65
No. 241 Fullerboard and Mica	36x40	.010§	1.01	1 50
No. 308 Fullerboard and Mica	36x40	.015§	1.40	1 50
No. 209 Heater Mica Plate	22x27 1/2	.010	.7	5 00
No. 209 Heater Mica Plate	22x27 1/2	.012	.84	5 00
No. 209 Heater Mica Plate	22x27 1/2	.015	1.05	5 00
No. 228 Mica Tape	3/4" wide	.004	.6 (57 yards)	2 10
No. 228 Mica Tape	3/4" wide	.006	.6 (57 yards)	2 10
No. 240 Treated Cambric and Mica Tape	3/4" wide	.013	1.13(61 yards)	3 00

*For commutator work, only plate milled exact to thickness is furnished.
†Thickness of paper .008.
‡Thickness of paper .004.
**Thickness of cambric .006.
§Thickness of fullerboard .007.

MICA TUBES

Inside Dia.	Outside Dia.	List Price Per Foot
3/8	1/2	$0 28
3/8	5/16	42
3/4	5/8	55
1/2	5/8	32
1/2	11/16	50
1/2	3/4	67
5/8	3/4	39
5/8	13/16	58
5/8	7/8	81
3/4	7/8	44
3/4	13/16	67
3/4	1	92

MICARTA

Micarta is the trade name of a remarkable material made by the Westinghouse Electric & Manufacturing Company. While primarily an insulating material, it is also a superior product for many other purposes. Its superior properties have caused a vast quantity of micarta to be used in the Westinghouse Works in many forms and for many purposes. The rapid growth in the sales of this material indicates how readily its remarkable properties appeal to the designing engineer.

Applications—A few specific applications may be given as follows:

Insulating bushings of all kinds—No. 213.

Noiseless gears and pinions for automobile lighting and ignition outfits and for timing outfits in electric switch mechanisms—No. 213 or 21-H.

Spools for spark coils and magnet winding—No. 213 or 323.

Insulating washers of all kinds—No. 213 or 217.

On wireless telegraph apparatus—No. 213 or 21-X.

On automatic telephone and telegraph apparatus—No. 213 and No. 21-X

High voltage arc extinguishers—No. 213.

Conduits for automobile wiring—No. 213.

Bus-bar insulation—No. 213.

On fire-alarm apparatus—No. 213 or 21-X.

Brushholder insulation—No. 213.

Water meter discs—No. 213.

Dry plate holders—No. 323.

Advertising specialties—No. 213 or 323.

Switches and circuit-breakers—No. 213.

Cable bushings—No. 213.

Expulsion tubes—No. 53.

Automobile switches and specialties—Nos. 213, 323, 217 or 327.

Barriers, bases, supports, etc., for junction boxes—No. 213.

Electrical specialties—No. 213.

Valve washers for oil pumps—No. 121.

Pinions on cranes, punch presses, pump motors, and other machines where noiseless operation is desired—No. 21-H.

Rail joint insulation—No. 21-D.

All applications where an insulating material in the form of plate, tubing, or rod having high dielectric and mechanical strength or resistance to action of water, chemicals, etc., is required.

Special attention is called to the application of No. 21-H Bakelite Micarta for gears and pinions. The structural and wearing qualities of this grade of micarta make it preferable to rawhide and other non-metallic material which are used for gears and pinions, where, because of noise, the use of metal gears or pinions is undesirable.

Its mechanical strength is such that in most cases no metal shrouds or bushings are required. It is very tough and fibrous and will withstand impact test equal to steel.

No. 21-H micarta gears and pinions may safely be used in all kinds of service within the limit of strength of similar ones made of cast iron.

See Circular 1579A.

Bakelite Micarta

Applications—Bakelite micarta is a form of micarta made in various grades in plates, tubes, and rods, all having the same general characteristics but differing in specific points to adapt them to different kinds of service.

General Characteristics—Bakelite micarta of all grades has high dielectric and mechanical strength. It is a hard, compact material which will not warp, expand, or shrink with age or with exposure to the weather. It takes a high polish and is accurate in thickness within close limits. It is infusible and remains unaffected by heat until a temperature is reached that is sufficiently high to carbonize the material (see paragraphs following). It will stand an electric arc better than hard fibre, hard rubber, or any moulded insulation of resinous material. The co-efficient of expansion is low—about .00002 per degree Centigrade.

Bakelite micarta is insoluble in practically all the ordinary solvents such as alcohol, benzine, turpentine, weak solutions of acid or alkali, hot water, and oils. It is not affected by ozone, a feature that makes it superior to hard rubber, resins, etc., for electrical purposes. It is water-resisting and non-hygroscopic.

No. 213 Bakelite Micarta Plate—Brown

Applications—As the mechanical strength is very high, this material is recommended for all applications where high mechanical strength is required, or for general application on account of its electrical and mechanical qualities.

Characteristics—No. 213 is the standard Bakelite micarta plate, brown in color, which has the following characteristics:

Will stand for short periods temperatures as high as 140 degrees Centigrade.

Sizes, $\frac{1}{64}$ to 2 inches thick, standard sheets 36x36 inches, can be cut to any required dimensions.

Can be sawed to size, also drilled and tapped across the grain.

Can be punched with simple dies in thicknesses to $\frac{1}{8}$ inch.

Takes a good polish.

No. 323 Bakelite Micarta Plate—Black

No. 323 is an insulating plate of the same characteristics as No. 213 except black in color. It is a good substitute for hard rubber and similar materials for miscellaneous insulating purposes.

No. 21-X Bakelite Micarta Plate—Tan

An extremely dense and non-hygroscopic material to be used in applications where minimum moisture absorption is required.

Characteristics—No. 21-X is bakelite micarta plate of somewhat higher grade than the standard No. 213. Its characteristics are:

Will stand for short periods temperatures as high as 140 degrees Centigrade.

Sizes, $\frac{1}{8}$ to 2 inches thick, standard sheets 36x36 inches, can be cut to any required dimensions.

Can be sawed to size, drilled and tapped across the grain, takes an excellent polish.

Thin sheets are more brittle than No. 213.

No. 32-X Bakelite Micarta Plate—Black

No. 32-X is an insulating plate of the same characteristics as No. 21-X except black in color. It takes an excellent polish either with or across the grain.

No. 217 Bakelite Micarta—Tan

Application—This material is recommended especially for making punchings or where drilling, tapping, or considerable machining is required.

No. 217 is a bakelite micarta plate possessing more toughness and is more nearly homogeneous than the No. 213 or 21-X grades. It is moisture resistant but not to the same extent as the No. 21-X grade. It will stand a temperature of 125° Centigrade for short periods.

Sizes $\frac{1}{32}$ inch to 2 inches thick, standard sheets 36x36 inch, can be cut to any required dimensions. It can be drilled and tapped with and across the grain and takes a high polish.

In drilling, the drill should be ground slightly off center and run at high speed with slow feed.

No. 327 Bakelite Micarta—Black

No. 327 is an insulating plate of the same character as 217 except black in color. It takes an excellent polish and has the same applications and characteristics as No. 217 plate.

No. 21-D Bakelite Micarta Plate

Application—The chief feature of No. 21-D plate is its toughness. It is recommended for general insulating purposes where an insulator of high mechanical strength is required.

Characteristics—No. 21-D is much less brittle than the other micarta plates. It punches better and does not shatter.

Will stand temperatures as high as 140 degrees Centigrade.

Sizes, $\frac{1}{16}$ to 3 inches thick, up to approximately 35 inches by 36 inches.

No. 21-H Bakelite Micarta

This Grade Supersedes the No. 21-D Grade for Gearing Applications

No. 21-H Bakelite Micarta is a Bakelite Composition Material developed especially for use in the manufacture of gears and pinions. Gearing made from No. 21-H Bakelite Micarta is noiseless in operation and this quality in combination with its strength, resiliency and wearing properties make it of particular value for this application.

No. 21-H Bakelite Micarta does not absorb oil or water and gears made from it may be run in hot oil with satisfactory results.

No. 21-H Bakelite Micarta may also be used for many mechanical and electrical purposes requiring great strength and good machining qualities or where drilling and tapping with the grain are necessary.

Bakelite Micarta Rods

Bakelite Micarta rods are turned from the same material as is used in No. 217 (tan) and 327 (black) plate.

Micarta Tubing

No. 213 Bakelite Micarta Tubing

Is the standard micarta tubing. It has the general characteristics of bakelite micarta.

It will stand for short periods a temperature as high as 140° Centigrade.

This tubing can be machined but not threaded.

No. 323 Bakelite Micarta Tubing

This tubing is the same as the No. 213 grade except that it is black in color.

No. 403 Micarta Tubing

Another form of micarta tubing, not a bakelite product, is also furnished. This has the same electrical properties as No. 213 Bakelite Micarta tubing but differs in its chemical and thermal properties. No. 403 Micarta tubing is not affected by oil but is acted on by chemicals and heat in very much the same way as ordinary resin, and is affected by alcohol, benzine, turpentine, water and other solvents. However, there are many applications where No. 403 Micarta tubing is just as satisfactory as No. 213 Bakelite Micarta tubing.

This tubing will stand for short periods of time temperatures as high as 100° Centigrade. If subject to higher heat under stress, distortion may occur.

Application—This grade of tubing can be used for applications where good insulation is desired and where it will not be subject to high temperatures under stress or to severe moisture conditions.

No. 53 Micarta Tubing

This tubing is similar to the No. 403 grade in electrical properties.

It will stand a temperature of approximately 60° Centigrade. At higher temperature it tends to soften and collapse.

It is affected more by solvents and water than the No. 403.

It is not affected by oil and may therefore be used to advantage in transformer applications.

No. 121 Moulded Bakelite Micarta Pump Values

We have recently developed a material to be used for pump valves which has given remarkable results in service. This material is known as No. 121 Bakelite Micarta. It is made from cotton fibre and bakelite, both of which are heat resisting. In this combined form the material is non-hygroscopic and is not affected by oil, weak solutions of acids or alkalis or by similar solvents. All of these properties make it especially suitable for pump valves.

No. 121 Bakelite Micarta is much stronger than materials used heretofore and does not shrink, swell, or warp. Being very strong and tough and of a fibrous nature it stands up in service much longer than rubber and other compositions generally used for this application.

This material is not affected by high pressures and may be used under temperature up to approximately 110 degrees Centigrade.

No. 121 Bakelite Micarta pump valves are especially valuable for use in mine pumps where subject to the corrosive action of the chemicals n mine water. They are also recommended for ioil and gasoline pumps as well as regular water pumps where hard valves can be used.

No. 21 C Bakelite Micarta

No. 21C Bakelite Micarta has been developed to meet the demand for a more efficient friction material. It is made with cork as a base in combination with bakelite.

As a friction material, No. 21C Bakelite Micarta is superior to any known substance.

It has a high friction coefficient, at least double that of leather on iron. The value of this coefficient under normal working conditions is from .35 to .40. Running against well prepared steel plates without lubrication, the coefficient may be .5 or slightly higher. This high coefficient of friction has a decided bearing on the design and operation of the clutch. Either the clutch can be made smaller and consequently cheaper, or it can be made to operate satisfactorily under very much reduced pressures, which greatly simplifies the problem of thrust bearings.

Lubrication of No. 21C Bakelite Micarta has very little effect on the frictional properties. Naturally, the coefficient is decreased somewhat as long as an oil film is maintained, but in nothing like the same proportion as other materials. Some of the hard woods, for example, have a good coefficient when run dry, but with a small amount of lubricant the friction drops off more than half. This is not true with No. 21C Bakelite Micarta. It does not become oil soaked, and is but slightly affected by moisture.

It is durable and does not become glazed.

It is stronger and more firm than other frictions, either natural or prepared. It is operating satisfactorily in automobile disc clutches where other forms of cork disintegrate quickly.

As compared to cork inserts, it gives approximately three times the frictional area with the same limiting dimensions.

The pick-up is smooth and gradual under all conditions of lubrication and the disengagement is absolute.

Since both cork and bakelite are heat-resisting elements it will stand an extraordinary amount of heat without damage. With other forms of prepared cork friction, heat causes the bond to flow and allows the material to disintegrate. The bakelite bond in No. 21C Bakelite Micarta friction cannot be melted or softened by the effect of heat. Neither can it be dissolved in oil, water or any known chemical or combination of chemicals.

No. 21C Bakelite Micarta is supplied in a variety of forms to meet the requirements of the trade. For cone clutch applications it is supplied in sheets. For disc clutch service it is supplied either in the form of molded rings to be riveted on to the steel plates, or it can be molded directly on the steel plates, in which case no riveting or assembling is required. For spur frictions it is supplied in the form of molded rings for mounting on metal hubs or spiders.

MICARTA—Continued

LIMITATIONS IN DIMENSIONS OF MICARTA TUBING

Minimum Wall Thickness

Inside Diameter, Inches	Minimum Thickness, Inches
3/16 to 1	3/64
1 to 10	1/16
10 to 16	3/32
16 to 20	1/8
20 to 36	1/4

Inside Diameter

3/16 to 3 inch in steps of 1/32 inch.
3 to 5 inch in steps of 1/16 inch.
5 to 10 inch in steps of 1/8 inch.
10 to 16 inch in steps of 1/4 inch.
16 to 20 inch in steps of 1/2 inch.
20 to 36 inch in steps of 1 inch.

Maximum Standard Lengths

Inside Diameters, Inches	Maximum Length, Inches
3/16 to 7/16	18
3/4 to 36	36 to 45

Standard length tubing will be cut into short lengths at nominal additional charge. Waste in such cutting is charged for at regular price.

Some special shapes of tubing, as rectangular, hexagonal, etc., can be furnished under special arrangements.

Bakelite Micarta Special Formed Shapes

We are prepared to manufacture Bakelite Micarta in Special Formed Shapes such as channels, angles, collars, spool ends, etc., to meet the requirements for various applications. This material will have substantially the same characteristics as our standard Bakelite Micarta Plate. Prices will be quoted on application.

Instructions for Ordering

In ordering Bakelite Micarta Plate care should be taken to specify grade required. Standard sheets should be ordered whenever possible. In ordering tubing, inside diameter, outside diameter and length should be specified. If no specific length is given tube will be shipped in varying lengths above one foot.

Restrictions

We own patents covering the use of Bakelite Micarta for gearing applications, therefore, Bakelite Micarta for gearing applications will be sold only to those companies regularly licensed under our patents, Nos. 1167742 and 1167743, dated January 11, 1916.

No. 21-H Bakelite Micarta is most generally used for gears; however, other grades except No. 21-D may be used and this restriction covers all grades.

PHYSICAL CHARACTERISTICS OF BAKELITE MICARTA PLATE

	Grades				
	213 323	21X 32X	21D	217 327	21 H
	Pounds, per Square Inch				
Bending Test Flatwise					
Max. Fibre Stress	25,000	18,000	17,000	22,000	25,000
Bending Test Edgewise					
Max. Fibre Stress	20,000	16,000	18,000	20,000	25,000
Compression Test Flatwise					
Ult. Compressive Strength	42,000	34,000	37,000	35,000	10,000
Elastic Limit	28,000	18,000	15,000	15,000	35,000
Compression Test Edgewise					
Ult. Compressive Strength	22,000	20,000	21,000	20,000	20,000
Elastic Limit	14,000	12,000	12,500	14,000	15,000
Tensile Test					
Ult. Tensile Strength	15,000	9,000	10,000	10,000	10,000
Elastic Limit	12,000	7,000	6,000	7,000	9,000
Modulus of Elasticity	1,400,000	1,400,000	1,100,000	1,200,000	1,500,000
General					
Specific Gravity	1.36	1.36	1.36	1.36	1.36
Weight, lbs. per square inch	.05	.05	.05	.05	.05
Coefficient of expansion	.00002	.00002	.00002	.00002	.00002

PHYSICAL CHARACTERISTICS OF MICARTA TUBING

	Grades		
	213-323	403	53
Tensile Strength (lbs. per sq. inch)	4,000	3,000	3,000
Compression Strength (lbs. per sq. inch)	13,000	10,000	10,000
Specific Gravity	1.12	1.12	1.05

ELECTRICAL PROPERTIES OF BAKELITE MICARTA

Breakdown Voltage	*Breakdown Voltage per Mil. of Thickness
213, 323, 403 or 53 Plate or Tubing	900
21X or 32X Plate	800
21D Plate	150
217 or 327 Plate	600
21H	400

*These values are based on one minute tests on plate 1/8 inch thick.

PRICES

Bakelite Micarta Plate

Thickness Inches	Approx. Weight of 36″ x 36″ Plate* Lb.	Oz.	List Price†
No. 213 (Brown)			
1/32	1	1	$1 70 per lb.
1/16	2	2	1 45 per lb.
1/8 to 2	..	..	1 35 per lb.
No. 323 (Black)			
1/32	1	1	$1 80 per lb.
1/16	2	2	1 60 per lb.
3/32	3	3	1 50 per lb.
1/8 to 2	..	..	1 45 per lb.
No. 21-X (Tan)			
1/8 to 2	..	..	$1 45 per lb.
No. 32-X (Black)			
1/8 to 2	..	..	$1 50 per lb.

Thickness Inches	Approx. Weight of 36″ x 36″ Plate* Lb.	Oz.	List Price†
No. 21-D‡			
1/16 to 3	..	..	$1 45 per lb.
No. 217 (Tan)			
1/32	2	2	$1 45 per lb.
1/64 to 2	..	..	1 35 per lb.
No. 327 (Black)			
1/32	2	2	1 60 per lb.
1/16	3	3	1 50 per lb.
1/8 to 2	..	..	1 45 per lb.
No. 21-H			
1/32 to 2	..	..	1 15 per lbs.

Estimate weights of all grades at 20 cubic inches per pound or on the basis of one pound one ounce per 1/64 inch of thickness. Sheets of any thickness between the maximum and minimum thicknesses specified above can be supplied.

*Standard sizes of Plates are:

36″x36″			
36″x18″	36″x12″	24″x12″	18″x12″
24″x24″		18″x18″	12″x12″

†If plates of sizes other than standard are required, they will be cut from nearest standard size, but charge will be made for entire sheet from which special sized sheet is cut. For example, if customer orders plate 23″x11″ he will be furnished piece cut to this size, but will be charged for sheet 24″x12″.

Bakelite Micarta Plate is manufactured to close variations in thickness. However, where it is required within especially close variations a slight additional charge will be made.

‡Plates are approximately 35 by 36 inches.

Bakelite Micarta Rod

Dia. Inches	Approx. Weight Per 10 Ft. Lb.	Oz.	List Price Per Foot
1/4	0	4 1/2	$0 25
5/16	0	7 1/4	29
3/8	0	10 1/2	34
1/2	1	2 1/2	48
5/8	1	13	66
3/4	2	10	96
7/8	3	9	1 28
1	4	10	1 50

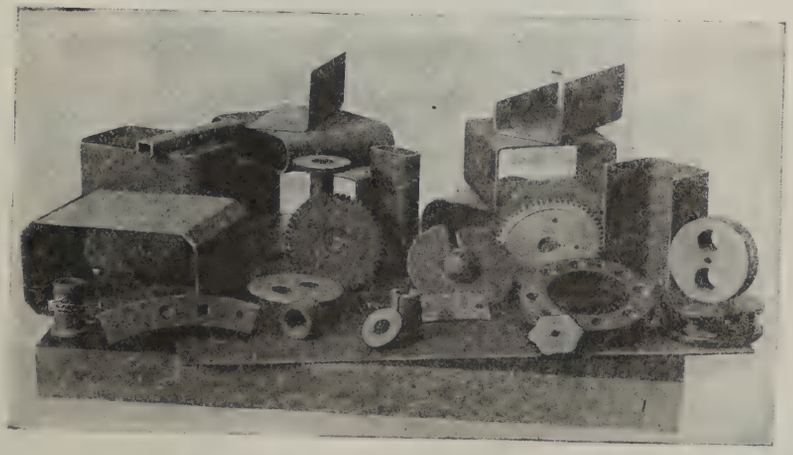
Dia. Inches	Approx. Weight Per 10 Ft. Lb.	Oz.	List Price Per Foot
1 1/8	5	14	$1 85
1 1/4	7	4	[illegible] 35
1 3/8	[illegible]	13	2 85
1 1/2	10	7	3 70
1 5/8	12	5	4 70
1 3/4	14	4	7 00
1 7/8	16	6	[illegible] 35
2	18	10	11 70

Standard length of rod up to 1/2-inch diameter is 12 inches; 1/2-inch up to 2 inches approximately 36 inches. Rods are made with variation in diameter of not over 1/64″ plus but not less than the specified diameter.

No. 121 Bakelite Micarta Valve Discs

Style No.	Outside Diameter Inches	Inside Diameter Inches	Thickness Inches	List price Each
290816	2	11/32	5/16	$0 30
290817	2 1/4	3/16	1/4	30
290818	2 1/2	1/16	1/2	38
290819	3	1/2	1/2	43
290820	3 1/2	5/8	1/2	50
290821	4	5/8	1/2	65
290822	4 1/2	5/8	5/8	75
290823	5	5/8	5/8	88
290824	6	3/4	5/8	1 15

The sizes specified above are carried in stock. Other sizes which may be required can be supplied on short notice.



Examples of Shapes in Which Bakelized Micarta Can Be Machined

Micarta Tubing

Nos. 213, 323, 403 and 53

Inside Diameter Inches	LIST PRICE PER FOOT — WALL THICKNESS—INCHES							
	5/64	1/16	3/32	1/8	5/32	3/16	7/32	1/4
1/4	$0 28	$0 30	$0 33	$0 41	$0 47	$0 53	$0 58	$0 67
5/16	29	31	34	43	49	56	61	71
3/8	29	32	35	44	50	58	64	78
7/16	30	32	36	46	53	60	66	80
1/2	30	34	37	48	55	63	70	81
9/16	31	35	39	45	56	65	72	83
5/8	28	31	36	47	57	66	73	85
11/16	29	32	38	49	59	69	76	88
3/4	30	33	39	51	62	71	79	92
13/16	31	34	40	52	64	74	82	95
7/8	32	34	41	54	66	76	85	98
15/16	33	35	42	56	68	78	88	1 02
1	34	36	44	57	70	81	90	1 05
1 1/16	34	37	45	59	72	84	93	1 08
1 1/8	.....	44	56	72	85	97	1 07	1 18
1 3/16	.....	45	58	74	87	99	1 10	1 21
1 1/4	.....	46	59	75	89	1 02	1 13	1 25
1 5/16	.....	47	60	77	92	1 04	1 15	1 28
1 3/8	.....	48	62	78	94	1 06	1 18	1 31
1 7/16	.....	49	63	80	95	1 09	1 21	1 34
1 1/2	.....	50	64	82	97	1 12	1 24	1 37
1 9/16	.....	50	65	83	99	1 14	1 27	1 40
1 5/8	.....	51	67	85	1 01	1 16	1 30	1 44
1 11/16	.....	52	68	86	1 03	1 18	1 32	1 47
1 3/4	.....	53	69	88	1 05	1 21	1 35	1 50
1 13/16	.....	53	70	90	1 07	1 23	1 38	1 53
1 7/8	.....	54	71	91	1 09	1 26	1 41	1 57
1 15/16	.....	55	73	93	1 11	1 28	1 44	1 60
2	.....	56	74	95	1 13	1 31	1 47	1 64
2 1/8	.....	57	79	96	1 18	1 33	1 51	1 66
2 1/4	.....	65	82	1 01	1 19	1 38	1 56	1 73
2 3/8	.....	67	84	1 05	1 23	1 43	1 61	1 80
2 1/2	.....	68	87	1 08	1 28	1 48	1 67	1 86
2 5/8	.....	70	89	1 10	1 32	1 52	1 73	1 92
2 3/4	.....	72	92	1 14	1 36	1 58	1 78	2 00
2 7/8	.....	73	94	1 18	1 40	1 62	1 84	2 10
3	.....	75	96	1 21	1 44	1 67	1 90	2 20
	.....	77	99	1 24	1 48	1 70	1 96	2 30

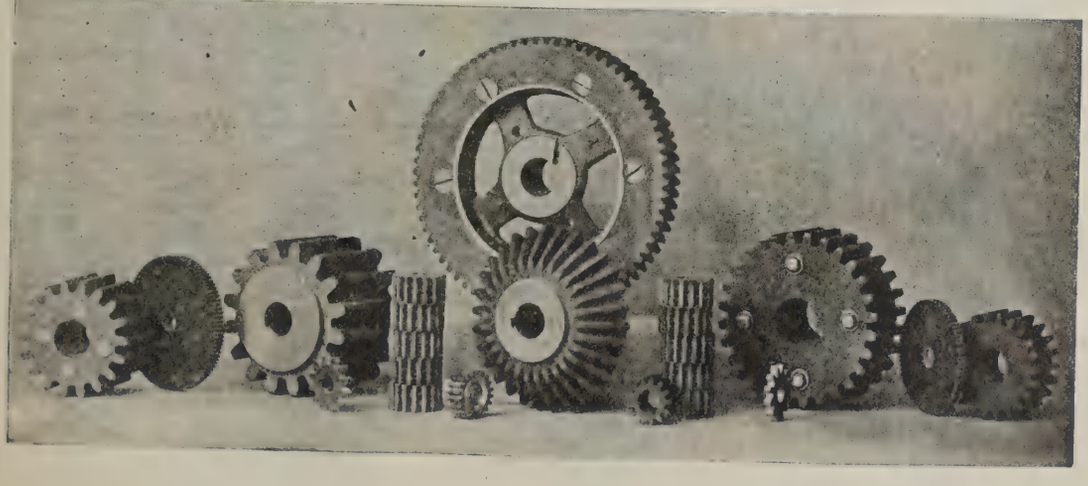
Interpolate for intermediate sizes.
Weight of tubing can be calculated as follows:
Approximate weight pounds per 100 feet = 45 (OD^2—ID^2)
OD = Outside Dia. in inches.
ID = Inside Dia. in inches.

BAKELITE MICARTA-D (21-H) GEAR AND PINION-BLANKS

Blank are cut approximately $\frac{1}{16}$-inch large to allow for finishing.

Diam. in Inches	LIST PRICE EACH — FACE WIDTH—INCHES															
	⅛	¼	⅜	½	⅝	¾	⅞	1	1¼	1½	1¾	2	2¼	2½	2¾	3
½	$ 03	$ 04	$ 05	$ 06	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
⅝	03	04	05	06	$ 07	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
¾	03	05	06	07	08	$ 09	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
⅞	04	05	07	08	10	12	$ 14	.....	.....	.....	.....	.....	.....	.....	.....	.....
1	04	07	09	11	13	15	17	$ 23	.....	.....	.....	.....	.....	.....	.....	.....
1⅛	05	07	10	12	14	16	19	23	.....	.....	.....	.....	.....	.....	.....	.....
1¼	05	08	11	14	17	20	23	27	$ 33	.....	.....	.....	.....	.....	.....	.....
1⅜	06	09	12	16	20	24	28	32	40	.....	.....	.....	.....	.....	.....	.....
1½	06	10	13	18	22	26	30	35	43	$ 50	.....	.....	.....	.....	.....	.....
1⅝	07	11	15	21	25	29	33	38	47	56	.....	.....	.....	.....	.....	.....
1¾	07	12	17	23	28	33	38	44	55	66	$ 77	.....	.....	.....	.....	.....
1⅞	08	13	19	25	31	36	42	48	60	72	84	.....	.....	.....	.....	.....
2	09	15	21	28	33	41	46	52	65	78	91	$ 1 04	.....	.....	.....	.....
2¼	10	17	23	31	38	46	53	60	73	87	1 01	1 15	$ 1 29	.....	.....	.....
2½	12	19	27	35	44	52	60	70	87	1 03	1 20	1 37	1 54	$ 1 71	.....	.....
2¾	14	21	30	40	50	60	70	81	1 00	1 20	1 40	1 60	1 80	2 00	$ 2 20	$ 2 40
3	16	23	34	45	56	68	79	90	1 13	1 35	1 58	1 80	2 03	2 25	2 48	2 70
3¼	18	27	40	53	67	80	93	1 06	1 33	1 59	1 86	2 12	2 39	2 65	2 92	3 18
3½	20	31	47	62	77	93	1 08	1 23	1 54	1 85	2 16	2 46	2 77	3 08	3 39	3 69
3¾	22	35	53	70	88	1 05	1 23	1 40	1 75	2 10	2 45	2 80	3 15	3 50	3 85	4 20
4	25	40	60	80	1 00	1 20	1 40	1 60	2 00	2 40	2 80	3 20	3 60	4 00	4 40	4 80
4¼	.....	46	68	91	1 14	1 37	1 60	1 82	2 28	2 73	3 19	3 64	4 10	4 55	5 01	5 46
4½	.....	51	77	1 02	1 28	1 53	1 79	2 04	2 55	3 06	3 57	4 08	4 59	5 10	5 61	6 12
4¾	.....	56	84	1 12	1 40	1 68	1 96	2 24	2 80	3 36	3 92	4 48	5 04	5 60	6 16	6 72
5	.....	63	95	1 26	1 58	1 89	2 21	2 52	3 15	3 78	4 41	5 04	5 67	6 30	6 93	7 56
5¼	.....	69	1 04	1 38	1 73	2 07	2 42	2 76	3 45	4 14	4 83	5 52	6 21	6 90	7 59	8 28
5½	.....	76	1 14	1 52	1 90	2 28	2 66	3 04	3 80	4 56	5 32	6 08	6 84	7 60	8 36	9 12
5¾	.....	83	1 25	1 66	2 08	2 49	2 91	3 32	4 15	4 98	5 81	6 64	7 47	8 30	9 13	9 96
6	.....	91	1 36	1 82	2 27	2 73	3 19	3 64	4 55	5 46	6 37	7 28	8 19	9 10	10 00	10 92
6¼	.....	98	1 81	1 93	2 45	2 94	3 43	3 92	4 90	5 88	6 86	7 84	8 82	9 80	10 78	11 76
6½	.....	1 06	1 59	2 12	2 65	3 18	3 71	4 24	5 30	6 36	7 42	8 48	9 54	10 60	11 66	12 72
6¾	.....	1 14	1 71	2 28	2 85	3 42	3 99	4 56	5 70	6 84	7 98	9 12	10 26	11 40	12 54	13 68
7	.....	1 23	1 85	2 46	3 08	3 69	4 31	4 92	6 15	7 38	8 61	9 84	11 07	12 30	13 53	14 76
7¼	.....	1 32	1 98	2 64	3 30	3 96	4 62	5 28	6 60	7 92	9 24	10 56	11 88	13 20	14 52	15 84
7½	.....	1 41	2 12	2 82	3 53	4 23	4 94	5 64	7 05	8 46	9 87	11 28	12 69	14 10	15 51	16 92
7¾	.....	1 50	2 25	3 00	3 75	4 50	5 25	6 00	7 50	9 00	10 50	12 00	13 50	15 00	16 50	18 00
8	.....	1 60	2 40	3 20	4 00	4 80	5 60	6 40	8 00	9 60	11 20	12 80	14 40	16 00	17 60	19 20
8¼	.....	1 70	2 55	3 40	4 25	5 10	5 95	6 80	8 50	10 20	11 90	13 60	15 30	17 00	18 70	20 40
8½	.....	1 81	2 72	3 62	4 53	5 43	6 34	7 24	9 05	10 86	12 67	14 48	16 29	18 10	19 91	21 72
8¾	.....	1 93	2 90	3 86	4 83	5 79	6 76	7 72	9 65	11 58	13 51	15 44	17 37	19 30	21 23	23 16
9	.....	2 03	3 05	4 06	6 08	6 09	7 11	8 12	10 15	12 18	14 21	16 24	18 27	20 30	22 33	24 36
9¼	.....	2 14	3 21	4 28	5 35	6 42	7 49	8 56	10 70	12 84	14 98	17 12	19 26	21 40	23 54	25 68
9½	.....	2 26	3 39	4 52	5 65	6 78	7 91	9 04	11 30	13 56	15 82	18 08	20 34	22 60	24 86	27 12
9¾	.....	2 38	3 57	4 76	5 95	7 14	8 33	9 52	11 90	14 28	16 66	19 04	21 42	23 80	26 18	28 56
10	.....	2 54	3 81	5 08	6 35	7 62	8 89	10 16	12 70	15 24	17 78	20 32	22 86	25 40	27 96	30 48
10¼	.....	2 63	3 95	5 26	6 58	7 89	9 21	10 52	13 15	15 78	18 41	21 04	23 67	26 30	28 93	31 56
10½	.....	2 76	4 14	5 52	6 90	8 28	9 66	11 04	13 80	16 56	19 32	22 08	24 84	27 60	30 36	33 12
10¾	.....	2 89	4 34	5 78	7 23	8 67	10 12	11 56	14 45	17 34	20 23	23 12	26 01	28 90	31 79	34 68
11	.....	3 03	4 55	6 06	7 58	9 09	10 61	12 12	15 15	18 18	21 21	24 24	27 27	30 30	33 33	36 36
11¼	.....	3 17	4 76	6 34	7 93	9 51	11 10	12 68	15 85	19 02	22 19	25 36	28 53	31 70	34 87	38 04
11½	.....	3 31	4 97	6 62	8 24	9 93	11 59	13 24	16 55	19 86	23 17	26 48	29 79	33 10	36 41	39 72
11¾	.....	3 46	5 19	6 92	8 65	10 38	12 11	13 84	17 30	20 76	24 22	27 68	31 14	34 60	38 06	41 52
12	.....	3 60	5 40	7 20	9 00	10 80	12 60	14 40	18 00	21 60	25 20	28 80	32 40	36 00	39 60	43 20
12¼	.....	3 76	5 64	7 52	9 40	11 28	13 16	15 04	18 80	22 56	26 32	30 08	33 84	37 60	41 36	45 12
12½	.....	3 91	5 87	7 82	9 78	11 73	13 69	15 64	19 55	23 46	27 37	31 24	35 19	39 10	43 01	46 92
12¾	.....	4 07	6 11	8 14	10 18	12 21	14 25	16 28	20 35	24 42	28 49	32 56	36 63	40 70	44 77	48 84
13	.....	4 23	6 35	8 46	10 58	12 69	14 81	16 92	21 15	25 38	29 61	33 84	38 07	42 30	46 53	50 76
13¼	.....	4 46	6 69	8 92	11 15	13 38	15 61	17 84	22 30	26 76	31 22	35 68	40 14	44 60	49 06	53 52
13½	.....	4 56	6 84	9 12	11 40	13 68	15 96	18 24	22 80	27 36	31 92	36 48	41 04	45 60	50 16	54 72
13¾	.....	4 73	7 10	9 46	11 83	14 19	16 56	18 92	23 65	28 35	33 11	37 84	42 57	47 30	52 03	56 76
14	.....	4 91	7 37	9 82	12 28	14 73	17 19	19 64	24 55	29 46	34 37	39 29	44 19	49 10	54 01	58 92

Interpolate for intermediate diameters and thicknesses.
Prices on other sizes of blanks from $\frac{1}{16}$ inch to 3 inches thick up to 35 inches diameter quoted on application.
For gear and pinion data and application information see Circular 1579A.



TREATED CLOTH AND PAPERS

Westinghouse Treated Cloths have as a base a cotton cambric woven in accordance with a specification which calls for a fabric of close uniform weave and high tensile strength. Since the insulating value of a treated cloth is mainly dependent on the quality of the varnish and its proper application, Westinghouse Treated Cloths are prepared with varnishes which have been proved by actual extended application to be especially adapted for this purpose. The use of specially designed and accurately adjusted treating machinery makes it possible to obtain a varnish coating of remarkable uniformity. Hence the dielectric strength of these treated cloths is far more uniform than that of most insulating materials. They are entirely unaffected by insulating and lubricating oils.

Tan Treated Cloth is very flexible, has high dielectric strength and will retain these properties for long periods. It is used for coil wrappers, cells in armatures, insulating washers, etc.

Black Treated Cloth differs from the tan cloth in being black in color and possessing extreme flexibility. It has an oily surface which renders it more moisture repellent and also acts as a lubricant. This lubrication permits of drawing the surfaces into closer contact, thus forming a more solid insulation when built up of numerous layers. Black Treated Cloth has longer life than the tan variety under adverse conditions of operating temperature. It is used for coil wrappers, but is especially useful in tape form.

Treated Cloth Tape, both tan and black varieties, are cut from the corresponding treated cloths. The tan tapes have a tacky finish.

Oiled Duck No. 30 is 12½ ounce duck treated with an oil which makes it waterproof. The material has good insulating properties without being liable to cracking, as is the case where varnish is applied to duck or canvas. It is used as a hood on railway motor armatures and for insulating where a strong tough material is demanded by the mechanical conditions such as for washers under field coils.

Oiled Duck No. 20 is the same as No. 30 except made from a duck of lighter weight.

Tan Treated Cloth Nos. 7-10-12-15 differ only in thickness and have just the proper amount of surface grip to make them most convenient in application.

Tan Treated Cloths No. 701 and 101 are similar to the No. 7 and No. 10, but are cut bias and have a tacky finish. The joints are lapped sufficiently to cling together when applying in a continuous tape.

Black Treated Cloth No. 1000 is a straight cloth.

Black Treated Cloth No. 1007 is a straight cloth.

Black Treated Cloth No. 1010 is the same material as the No. 1000 but is cut bias. The joints are butted and sewed before treating.

Black Treated Cloth No. 1017 is the same material as the No. 1007 but is cut bias. The joints are butted and sewed before treating.

Tan Treated Cloth Tape, straight cut, tacky finish, is cut from cloth similar to No. 7 and No. 10 but has a tacky finish.

Tan Treated Cloth Tape, bias cut, tacky finish, is cut from the No. 701 and No. 101 cloth and has the same characteristics as these cloths.

Black Treated Cloth Tape is made straight cut and bias cut from No. 1000, No. 1010, No. 1007 and No. 1017 cloths.

PRICES

In ordering specify the material wanted by number and name, also the size and number of rolls or sheets wanted. Standard rolls and sheets are carried in stock for immediate shipment. Rolls of any length, and sheets cut to any size, will be furnished when specified.

Tan Treated Cloths

Standard rolls 25 and 50 yards.

No.	Thickness	Width Inches	Average Breakdown Voltage	Approx. Wt. Per Sq. Yd.	List Price Per Sq. Yd.
7	.007	36	7,000	.47	$0 45
701	.007	36	7,000	.47	47
10	.010	36	10,000	.60	52
101	.010	36	10,000	.60	54
12	.012	36	12,000	.74	62
15	.015	36	15,000	.92	78

Black Treated Cloths

Standard rolls 25 and 50 yards

No.	Thickness	Width Inches	Average Breakdown Voltage	Approx. Wt. Per Sq. Yd.	List Price Per Sq. Yd.
1007	.007	36	7,000	.47	$0 50
1017	.007	34 to 36	7,000	.47	56
1000	.010	36	10,000	.60	56
1010	.010	34 to 36	10,000	.60	64

Oiled Duck

20	.020	36	.....	1.	1 00
30	.030	36	.....	1.19	1 20

Treated Cloth Tapes

Standard packages 20, 40 and 80 rolls.

Width	Tan Cloth Tapes: .007 Thick Approx. Weight Oz. Per Roll	Tan Cloth Tapes: .010 Thick Approx. Weight Oz. Per Roll	Tan Cloth Tapes: List Price Per 36 Yd. Roll: .007 Straight	.007 Bias	.010 Straight	.010 Bias	Black Cloth Tapes: List Price Per 36 Yd. Roll: .007 and .010 Straight	.007 and .010 Bias
½	3.5	4.3	$0 34	$0 36	$0 36	$0 39	$0 34	$0 40
⅝	4.4	5.4	40	44	42	46	42	50
¾	5.25	6.5	46	51	49	54	50	60
⅞	6.5	7.1	52	59	56	61	59	68
1	7	8.6	59	65	62	69	67	80
1¼	8.75	10.75	74	81	79	86	81	1 04
1½	10.5	13	89	97	95	1 04	99	1 22
1¾	12.25	15	1 03	1 14	1 08	1 21	1 19	1 42
2	14	17.2	1 18	1 30	1 24	1 38	1 33	1 60

612-1A

Treated Papers

In many instances the application does not require an insulator of extreme flexibility and where the clearance limitations are not severe treated papers can be economically used. The line of Westinghouse Treated Papers includes such materials as have been found especially adapted for insulation purposes. These papers are treated in much the same way as Westinghouse Treated Cloths and are produced under the same careful supervision and subject to the same rigorous test and inspection. They are taken from the stock used in the manufacture of Westinghouse apparatus.

Treated Cement Paper is made by a special process from rope cement paper and is remarkably strong and tough. The treatment is similar to the process for treated cloth and gives the paper a firm smooth surface and actually increases its flexibility. It is used for armature coil insulation, washers, spacing pieces, etc.

Paraffined Fishpaper consists of fishpaper thoroughly impregnated with paraffine to exclude moisture and to make it more convenient to handle. Fishpaper is the strongest and toughest of the insulating papers and is especially adapted for service where ability to resist mechanical injury must be combined with good insulating qualities. Used for slot cells, coil wrappers, washers, etc.

Treated Fullerboard is prepared by removing the moisture in a vacuum oven and then coating with an oil-proof moisture-repellant baking varnish. The product has good dielectric properties and is useful where good insulating qualities must be combined with mechanical rigidity. When exposed to the air all cut edges require a protecting coat of varnish or shellac. When immersed in good insulating oil and thoroughly saturated its dielectric strength is approximately trebled. This property renders it especially valuable for service where it will be continually immersed in insulating oil. It is used for angles and channels as well as in sheet form.

PRICES

Treated Cement Paper

No.	Thickness	Width of Std. Roll Inches	Average Breakdown Voltage	Approx. Wt. Lbs. Per 100 Sq. Yd.	List Price Per Sq. Yd.
8	.008	40	6400	45½	$0 39
13	.013	40	8100	70	57
18	.018	40	6500	85	67

Paraffined Fish Paper

No.	Thickness	Width of Std. Roll Inches	Average Breakdown Voltage	Approx. Wt. Lbs. Per 100 Sq. Yd.	List Price Per Sq. Yd.
4	.004	40	2000	22	$0 27
7	.007	40	3600	36½	39
10	.010	40	5500	52	55
15	.015	40	6200	89	90

Paraffined Express Paper

No.	Thickness	Width of Std. Roll Inches	Average Breakdown Voltage	Approx. Wt. Lbs. Per 100 Sq. Yd.	List Price Per Sq. Yd.
7	.007	40	1500	44	$0 16

Treated Fullerboard

No.	Thickness	Std. Sheet Inches		Wt. Per Sheet	
35	.035	36x56	14300	3 lbs.	$1 00
60	.060	40x42	18100	3¼ lbs.	1 65
130	.130	40x42	21200	7¾ lbs.	2.85

UNTREATED CLOTHS AND PAPERS

FOR INSULATING PURPOSES

All insulating materials here listed are of specially selected stock and of the kind used in the manufacture of Westinghouse electrical machinery and apparatus. Purchasers, therefore, receive the benefit of our long experience and can feel assured that the material purchased is the best of its kind obtainable.

The uses to which these untreated materials are put are so numerous that no attempt is made in these pages to enumerate them. A short description of the principal characteristics of each material follows:

Untreated Papers

Fishpaper is a very tough, strong, specially prepared paper, somewhat resembling hard fibre but considerably more flexible. Color, dark gray.

It resists mechanical injury and heat better than any other insulating paper known, and therefore has no equal as a wrapping for coils, or for cells for armature slots. Although it will stand baking for a short time, it should not be used in apparatus that is to be impregnated unless special precautions are taken.

Fishpaper is not affected by lubricating or transformer oil but will absorb moisture like all other papers unless paraffined or otherwise treated. It is used with mica, as fishpaper and mica, in making wrappers. The thinner paper may be folded and creased without destroying the fibre or the dielectric strength.

In general, fishpaper is adapted for use where a tough material affording mechanical protection as well as insulation is required. It should be creased across and not with the grain.

Express paper is a high grade wood fibre paper used as a protection for coils where moderate mechanical strength and a thin material is required: for instance, on bars of squirrel-cage rotors of induction motors. Treated with paraffine it is sometimes used in alternating-current motors. The stock selected is very strong, and care is taken to have it free from pin-holes. Color, mottled tan.

Cement papers, also called rope cement papers or rope papers, are made from good grade of hemp rope stock, and are, consequently, long fibred and strong. They are sometimes used as spacing and as a protection to the cotton insulation in winding coils. Treated with varnish they are often used as insulation between windings and around coils in transformers. The papers carried in stock are specially selected to assure freedom from pin-holes and foreign materials. Color, buff.

Fullerboard is a dense material like cardboard; less hard and stiff than hard fibre, and more easily worked. It is not affected by transformer or lubricating oil, but will absorb moisture like other papers unless treated. It is used between turns or as a filler in transformer and armature coils and sometimes for washers on magnet coils, but only where the temperature is low. Colors, mottled black or gray.

Hard fibre is a very dense, hard material used for many purposes where a tough insulator is required, such as wedges for armature slots, braces for armature coils, and washers and bushings in all kinds of electrical apparatus.

Sleeving

Cotton sleeving is of good grade, closely braided, intended to slip over the leads of armature coils, etc., for additional insulation. It is designated by nominal inside diameter. By stretching or shortening the sleeving the diameter is changed, making each diameter adaptable to several sizes of wire.

Untreated Tapes

.020″ surgical tape is closely woven on the "herring bone" pattern. It has a tensile strength of approximately 100 pounds per inch width. Used chiefly where a tape of strength and wearing qualities is required; for example, under banding wires on armatures, for taping together and bracing large field coils.

.017″ cotton gauze tape is a strong gauze tape suitable for temporary taping on coils that are to be impregnated.

.040″ gray webbing tape is the strongest tape listed. It is suitable for binding transformer coils, etc., and has a tensile strength of approximately 190 pounds per inch width.

Cotton Tapes—These linen finished tapes, sometimes called linen tapes, are used principally for coil windings. There are three grades according to thickness; .0045-inch, having a tensile strength of approximately 35 pounds per inch width, .007-inch, most generally used, with a tensile strength of about 70 pounds per inch width, and .011-inch with a tensile strength of approximately 100 pounds per inch width.

Cord and Thread

Elm flax thread is a white cord about $\frac{8}{64}$″ diameter twisted hard; tensile strength 30 to 40 pounds.

Barbours flax twine is a soft flax thread about $\frac{1}{64}$″ diameter; tensile strength 6 to 10 pounds per strand.

Four-cord machine thread is a high grade soft flax thread about $\frac{1}{32}$″ diameter; tensile strength 25 to 30 pounds.

Torpedo twine is a hard twisted flax twine designed to resist wear. The $\frac{1}{8}$″ diameter has a tensile strength of approximately 200 pounds.

Wax end is a treated machine thread suitable for use where moisture must be excluded, and where an easy working thread is required.

WESTINGHOUSE UNTREATED CLOTHS AND PAPERS—Continued

Asbestos

Asbestos Cloth—Although more costly, this Company finds it imperative to use a tightly woven, non-porus cloth, because the cheaper, more porus cloth does not answer the purpose either as a protection or as an insulator. It is used as a protection to the armature winding on some railway motors and other machines subject to rough usage and high temperatures.

Asbestos sheet contains a small amount of binder. The paper is soft and has not much mechanical strength. Used for lining metal parts such as railway circuit-breaker covers, to prevent grounds and short-circuits from arcing. Also used between turns of strap-wound coils.

Asbestos lumber is a hard, board-like substance consisting of asbestos and cement. It is a high grade flame proof material which can be readily sawed, drilled, etc. Used for arcing boxes of switches, for barriers as protection against arcing, and in general for bases, partitions, etc., where high temperatures or arcing occur.

Asbestos tape is a strong, selvedged tape made of long-fibre asbestos.

Asbestos cord is a strong white cord of long-fibre asbestos. Used for temporary binding together of parts submitted temporarily to high temperatures; also as packing.

Asbestos sleeving is a woven sleeving of asbestos. Used as fireproof insulation on coil leads, on leads of arc lamp coils, etc.

PRICES

Untreated Papers—Standard Rolls: 25, 50 and 100 Yards

Material	Thickness Inches	Approx. Breakdown Voltage†	Width in Rolls Inches	Size of Sheets Inches	Approx. Wt. Lbs. Per 100 Sq. Yds.	Approx. Wt. Lbs. Per Ream	List Price Per Pound
Fishpaper	.004	1000	40	.....	22½	....	$0 78
Fishpaper	.007	1900	40	.....	40	....	68
Fishpaper	.010	3200	40	.....	58	....	[illegible]
Fishpaper	.015	4700	40	.....	90	....	68
Fishpaper	.023	7100	..	40 x 72	....	1500	68
Fishpaper	.034	10000	..	40 x 72	....	2400	[illegible]
Fishpaper	.056	20000	..	40 x 72	....	4200	68
Express Paper	.007	1300	40	24 x 36	40	130	16
Cement Paper, High Finish	.0055	900	40	.....	19	....	305
Cement Paper, High Finish	.010	1000	40	.....	34	....	305
Cement Paper, Machine Finish	.015	1500	60	.....	54	....	305
						Per Sheet	
Fullerboard (black)	.007	2500	36	36 x 40	43	.32	27
Fullerboard (black)	.010	3800	36	36 x 40	62	.55	27
Fullerboard (black)	.015	5300	36	36 x 40	92	.82	27
Fullerboard (yellow)	.030	12000	..	36 x 56	....	2.9	27
Fullerboard (yellow)	.056	14000	..	40 x 42	....	3.6	27
Fullerboard (yellow)	.075	15000	..	40 x 42	....	6.6	27
Fullerboard (black)	.125	17000	..	40 x 42	775	....	27

†These voltages are approximate for breakdown and are not to be considered for continuous service.

White Fibre—Standard Sheets Approx. 44″ x 66″

Thickness Inches	Approx. Wt. Per Sheet in Lbs.	List Price Per Pound	Thickness Inches	Approx. Wt. Per Sheet in Lbs.	List Price Per Pound
.030—1/32	5	$0 57	3/4	120	$0 78
.035	5¾	57	7/8	140	89
.040	6½	57	1	160	1 05
.045	7¼	57	1⅛	180	1 37
1/16	10	57	1¼	200	1 72
1/8	20	57	1⅜	220	2 16
3/16	30	60	1½	240	[illegible] 72
¼	40	60	1⅝	260	3 42
5/16	50	60	1¾	280	4 56
⅜	60	60	1⅞	300	6 84
½	80	64	2	320	9 10
⅝	100	71			

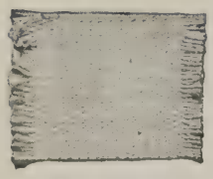
White Cotton Sleeving

WHITE COTTON SLEEVING

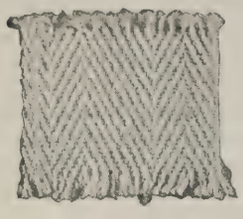
Nominal Inside Diameter Inches	Will Fit Over B. & S. Gauge Wire No.	Approx. Lbs. Per Reel	Will Increase Diameter of Wire Inches	List Price Per Pound
.045	17–18–19	5	.015	$2 20
*.0641	14–15–16	5	.015	2 20
.081	12–13	10	.020	2 20
.162	6– 7– 8	10	.020	2 20
.285	1– 2	10	.035	2 20
⅜	00	5	.035	2 20
7/16	0000	5	.035	2 20
⅝		7½	.035	2 20
¾		7½	.035	[illegible] 20
1		[illegible]	.035	2 20
1¼		7	.035	2 20
1½		5½	.035	2 20

*Will also be furnished in red and blue colors.

WESTINGHOUSE UNTREATED CLOTHS AND PAPERS—(DS614)—Continued



COTTON TAPE



SURGICAL TAPE

Tapes

Material	Thickness Inches	Width Inches	Color	Approx. Yds. Per Roll	List Price Per Gross Yds.
Cotton Tape, linen finish	.0045	½	White	36	$2 10
Cotton Tape, linen finish	.0045	¾	White	36	2 60
Cotton Tape, linen finish	.0045	¾	Red	36	3 10
Cotton Tape, linen finish	.007	½	Black	36	2 40
Cotton Tape, linen finish	.007	½	Red	36	2 40
Cotton Tape, linen finish	.007	½	White	36	2 40
Cotton Tape, linen finish	.007	¾	Red	36	3 00
Cotton Tape, linen finish	.007	¾	White	36	2 60
Cotton Tape, linen finish	.007	1	White	36	3 30
Cotton Tape, linen finish	.007	1½	White	36	5 50
Cotton Tape, linen finish	.011	1	White	36	5 70
Cotton Tape, linen finish	.011	1½	White	36	7 50
Cotton Gauze Tape	.017	1½	White	36	5 00
Surgical Tape	.020	¾	White	36	4 40
Surgical Tape	.020	1	White	36	5 60
Surgical Tape	.020	1¼	White	36	7 30
Surgical Tape	.020	1½	White	36	8 50
Surgical Tape	.020	2	White	36	12 50
Surgical Tape	.020	2¼	White	36	13 50
Surgical Tape	.020	2½	White	36	15 75
Surgical Tape	.020	2¾	White	36	18 50
Gray Webbing Tape	.040	1¼	White	12	10 30

One gross yard equals 144 lineal yards.

Cord and Thread

4-CORD MACHINE THREAD

Material	Thickness Inches	Approx. Lbs. Per Ball or Reel	List Price Per Pound
Elm Flax Thread	1/16	1	$1 50
No. 3 Barbours Flax Twine	1/64	1	5 00
Four-Cord Machine Thread	1/32	1	2 75
Torpedo Twine	1/16	25	1 30
Torpedo Twine	3/32	25	1 30
Torpedo Twine	1/8	25	1 30
Wax End	1/32	1	4 40

Asbestos

Material	Thickness Inches	How Furnished	Approx. Weight	List Price
Asbestos Cloth	.035	Sheets, 36"x36"	6¼ lbs. per sheet	$5 35 per lb.
Asbestos Lumber	1/8	Sheets, 42"x48"	.....	24 per sq. ft.
Asbestos Lumber	5/16	Sheets, 42"x48"	.....	33 per sq. ft.
Asbestos Lumber	¼	Sheets, 42"x48"	.....	43 per sq. ft.
Asbestos Lumber	7/16	Sheets, 42"x48"	.....	54 per sq. ft.
Asbestos Lumber	3/8	Sheets, 42"x48"	.....	65 per sq. ft.
Asbestos Lumber	½	Sheets, 42"x48"	.....	87 per sq. ft.
Asbestos Lumber	¾	Sheets, 42"x48"	.....	1 30 per sq. ft.
Asbestos Lumber	1	Sheets, 42"x48"	.....	1 75 per sq. ft.
Asbestos Sheet	.005	Rolls, 36" wide	110 lbs. per roll	48 per lb.
Asbestos Sheet	.007	Rolls, 36" wide	110 lbs. per roll	48 per lb.
Asbestos Sheet	.010	Rolls, 36" wide	110 lbs. per roll	44 per lb.
Asbestos Sheet	.015	Rolls, 36" wide	110 lbs. per roll	18 per lb.
Asbestos Sheet	.025	Rolls, 36" wide	110 lbs. per roll	18 per lb.
Asbestos Sheet	1/16	Sheets, 40"x40"	3½ lbs. per sheet	18 per lb.
Asbestos Sheet	1/8	Sheets, 40"x40"	6 lbs. per sheet	18 per lb.
Asbestos Sheet	5/16	Sheets, 40"x40"	10 lbs. per sheet	18 per lb.
Asbestos Sheet	¼	Sheets, 40"x40"	13½ lbs. per sheet	18 per lb.
Asbestos Sheet	3/8	Sheets, 40"x40"	18 lbs. per sheet	18 per lb.
Asbestos Sheet	½	Sheets, 40"x40"	24 lbs. per sheet	18 per lb.
Asbestos Sheet	5/8	Sheets, 40"x40"	34 lbs. per sheet	18 per lb.
Asbestos Sheet	11/16	Sheets, 40"x40"	46 lbs. per sheet	18 per lb.
Asbestos Tape	.015	½" wide, 36 yd. rolls	4 oz. per roll	10 30 per lb.
Asbestos Tape	.015	¾" wide, 36 yd. rolls	4½ oz. per roll	10 30 per lb.
Asbestos Tape	.015	1" wide, 36 yd. rolls	11 oz. per roll	10 30 per lb.
Asbestos Tape	.015	1¼" wide, 36 yd. rolls	15 oz. per roll	10 30 per lb.
Asbestos Tape	.025	¾" wide, 36 yd. rolls	20 oz. per roll	7 00 per lb.
Asbestos Tape	.025	1" wide, 36 yd. rolls	26 oz. per roll	7 00 per lb.
Asbestos Tape	.025	1⅛" wide, 36 yd. rolls	2 lbs. per roll	7 00 per lb.
Asbestos Tape	.025	1¼" wide, 36 yd. rolls	2 lbs. per roll	7 00 per lb.
Asbestos Tape	.025	1½" wide, 36 yd. rolls	2⅛ lbs. per roll	7 00 per lb.
Asbestos Cord	1/16	5 lb. rolls	.....	6 50 per lb.
Asbestos Sleeving	1/32 nominal inside dia.	5 lb. rolls	.....	6 50 per lb.

INSULATING AND SOLDERING COMPOUNDS

VARNISHES, SHELLACS, PAINTS, CEMENTS, GLUE AND SWITCH OIL

The selection of the proper insulating compounds presents one of the most complex phases of insulation application, and the user of such material who does not have the facilities for making elaborate tests, will do well to consider carefully the qualifications of the various manufacturers for producing these compounds, and their opportunities for determining the adaptability of any compound for a given service. The materials listed here are those used most extensively in the manufacture of Westinghouse electrical apparatus. By their use the customer can avail himself of the great amount of research work done in this Company's laboratories and also of the vast experience of this Company's engineers in the actual use of insulating materials.

Baking Varnishes

Westinghouse Amber Insulator is a clear amber colored baking varnish, with very high dielectric strength and very durable under operating conditions of heat and vibration.

It is acid, oil, and moisture resisting, has excellent penetration, and furnishes a hard surface with considerable flexibility, which makes it very firm in resisting mechanical injury. It is convenient in having a wide range of baking temperatures, but bakes best at 115 degrees Centigrade in eight hours. This varnish is used for general insulating purposes, such as armature, field, and transformer coils, finishing coat on armatures, and for treating wood insulators. It is applied by dipping and brushing, benzine or turpentine being used or thinning.

Westinghouse Plastic Insulator is a black baking varnish, plastic and flexible under operating conditions of heat and vibration. It is acid, alkali-fume, moisture, and oil resisting, and has high dielectric strength. Its penetration is excellent and it has a conveniently wide range of baking temperatures, but bakes best at 115 degrees Centigrade in eight hours. It is especially adapted for coils and similar applications where the conditions of heat and vibration are severe, such as for railway and mill motor service. Best results are obtained by making two applications of this insulator, dipping and brushing being the best methods of applying. Benzine or turpentine can be used for thinning.

Black Asphaltum Enamel—A high grade, glossy, black baking varnish, flexible, waterproof, oil-proof, acid and alkali-resisting and of high dielectric strength.

For good flexible coating, bake eight hours at 125 to 130 degrees Centigrade. For bone hard enamel finish, bake for 1½ hours at 180 degrees Centigrade.

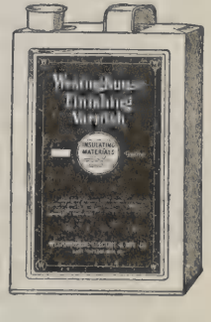
This enamel can be used by dipping, spraying or brushing and requires benzine for thinner.

This enamel is used for the finishing coat on insulators where exposed to the weather; for armature coils in applications where subject to acid or alkali fumes and similar applications. Also for finishing coat on motor frames or other parts where a glossy finish is desired.

Air-Drying Varnishes

Westinghouse Air-Drying Insulator is a glossy black, quick-drying varnish, which may also be baked. It air-dries in about one hour and bakes in twenty minutes at temperatures of approximately 90 degrees Centigrade. High dielectric strength, good penetration, and resistance to acids, alkali-fumes, and moisture are features of this varnish. It is used where a very plastic varnish is not desirable, or in place of baking varnish where baking facilities are not available. It is also used as a finishing coat on windings of air-cooled transformers and on magnet coils.

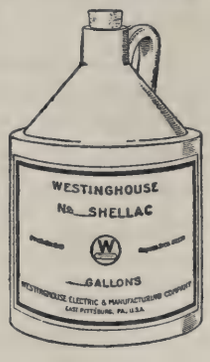
Westinghouse Finishing Varnish—A glossy air-drying, oil-proof insulating varnish which dries quickly. It is used for general finishing work on electrical apparatus, such as armatures, field coils, wooden parts, etc., and is applied by dipping, brushing, or spraying. Westinghouse No. 1 shellac or alcohol can be used for thinning.



Westinghouse No. 3 Shellac—An orange-colored heavy-bodied quick-drying shellac used for general insulating purposes, especially for building up insulation with cotton tapes and cloth; also to fill up crevices and smooth up winding work. It is applied by dipping, brushing or spraying, and can be thinned with Westinghouse No. 1 shellac or alcohol.

INSULATING AND SOLDERING COMPOUNDS—Continued

Westinghouse No. 14 Shellac—A clear, transparent, quick-drying shellac which gives a flexible coating with hard surface, is acid, acid-fume, oil, moisture, and water resisting and dries in about fifteen minutes. It has excellent penetration and high dielectric strength, and is used on marble, such as switchboards, fine woodwork, or similar applications where a colorless transparent varnish is required. It may be applied by dipping, brushing, or spraying and can be thinned with alcohol.



Westinghouse No 1 Shellac—A very thin shellac used chiefly as a thinner for heavier solutions. Being especially prepared, it is less subject to the variations found in commercial alcohol.

Insulating Paints

Westinghouse Protective Paint—A medium-glossy black, air-drying, insulating and protective paint, flexible under all conditions and acid, alkali-fume, and moisture resisting. It has no offensive odor and dries in three hours. Being intended especially for surfaces exposed to the weather, it is an excellent protection against corrosion. It is applied by dipping, brushing, or spraying, and can be thinned with benzine.

Westinghouse Flat Black Enamel—A quick-drying finishing paint containing a black pigment but free from lamp black, and drying without lustre. It will become dust-dry in 15 minutes and dry-hard in two hours. The non-conducting qualities of this enamel make it suitable for use on insulating parts as well as on castings and other metallic surfaces. For best results it should be used over a filler. It is applied by brushing and can be thinned with turpentine.

Westinghouse Switchboard Lacquer—A dead black lacquer producing a velvety finish on rough or smooth surfaces. It air-dries in 15 minutes, but gives the best finish if baked for about 2½ hours at 35 degrees Centigrade. This lacquer is used on marble and slate, and is applied by spraying.

Insulating Cements

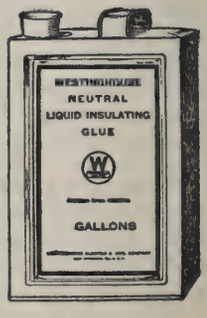
Westinghouse Commutator Cement—For filling grooves in undercut commutators, repairing pitted commutators, etc. It contains no acid, sets quickly, and produces an insulator equal to the original mica. This cement is unaffected by expansion or contraction, and will not burn, crumble, or lose its insulating qualities when heated. It consists of a powder and a liquid packed unmixed in separate containers.

Westinghouse No. 5 Cement—An armature cement used principally in railway motor armatures for filling-in purposes on the front and rear ends, and around the ends and leads of the coils to give rigidity and protection from injury due to vibration. This cement possesses excellent insulating qualities and high mechanical strength. It consists of a cement and a liquid each in a separate container boxed together.

Westinghouse No. 18 Cement—A hard oil-proof compound for filling spaces in and around transformer bushings, for sealing pot-heads and terminal bells, and for similar applications requiring an oil-proof cement. It flows readily at 160 degrees Centigrade, melts at 120 degrees Centigrade, and softens at 90 degrees Centigrade.

Westinghouse A-R-C-Cement—A-R-C (Arc Resisting Cement) will withstand temperatures up to 800 or 900 degrees Centigrade, (1500 to 1650 degrees Fahrenheit), and is a superior material for repairing arc deflectors and arc chutes, rheostats, asbestos lumber, cement, stone, porcelain, and other heat-resisting substances, as it is a better heat resistor than these substances. It is applied cold like putty, air-dries in approximately ten hours, and bakes dry in approximately three hours.

Glue



Westinghouse Insulating Glue—A non-hygroscopic liquid insulating glue. It is usually applied cold but can be baked. Being chemically neutral and very adhesive it is extremely useful for fastening tape ends, for closing cells, and for gluing insulating materials in general. It is applied cold in the ordinary way.

Soldering Paste

Westinghouse Soldering Paste is a perfect soldering compound prepared in the most economical and convenient form for rapid work. It acts as a thorough cleanser and also as a flux, containing sufficient dissolving ingredients to remove the grease and other foreign matter which may adhere to the bared surface from handling, and the oxides which may be formed by exposure, but it is not at all corrosive or destructive to insulation. For special application this paste can be varied in consistency by adding a small quantity of benzine.

INSULATING AND SOLDERING COMPOUNDS—Continued

HL Lubricating Oil

HL Oil No. 1 has been developed to meet the need of a proper and efficient oil for the lubrication of Westinghouse pneumatically operated unit switch cylinders.

This oil is sufficiently liquid so that it may be used in ordinary oil can and is used without dismantling switch group, by injecting through hole provided in the top of switch cylinder casting ⅛ oz. (one teaspoonful) every 10,000 miles (under average operating conditions). Should pistons get gummy, use more frequently, but use only minimum amount that will give free operation.

HL Oil No. 1 should also be used during heavy overhaul, i. e., when pistons are removed from cylinders. Cylinder and piston should be coated well with this oil. Approximately 1/16 oz will be required for cylinder.

LIST PRICES

Material	Per Qt. In 1 Qt. Containers	Per Gal. In 1 Gal. Containers	Per Gal. In 5-Gal. Containers	Per Gal. In 10-Gal Containers	Per Gal. In Bbl. Containers
Baking Varnishes					
Amber Insulator	.....	$ 2 90	$ 2 40	$ 2 30	$2 00
Plastic Insulator	.....	2 20	1 70	1 60	1 30
Black Asphaltum Enamel	.....	3 00	2 50	2 40	2 10
Air Drying Varnishes					
Air Drying Insulator	.....	2 20	1 70	$1 60	$1 30
Black Finishing Varnish	.....	4 15	3 70	3 60	3 30
No. 1 Shellac	.....	3 10	2 65	2 25	2 10
No. 3 Shellac	.....	4 40	3 95	3 90	3 55
No. 14 Shellac	.....	2 80	2 35	2 25	1 95
Insulating Paints					
Protective Paint	.....	1 85	$ 1 30	$1 20	$0 95
Flat Black Enamel	.....	3 30	2 80	2 70	2 40
Switchboard Lacquer*	.....	13 20	12 70	12 60	.....
Lacquer Thinner	$3 40	10 60	10 10	.....	.....

*In ordering specify about one-half as much Lacquer Thinner as Lacquer.

Insulating Glue

Westinghouse Insulating Glue	½ Pt. Cans	$0 52 each
	1 Qt. Cans	90 each
	1 Gal. Cans	2 60 each

Insulating Cements

Westinghouse Commutator Cement	½ lb. Cans	$1 10 each
	3 lb. Cans	2 70 each
Westinghouse No. 5 Cement	10 lb. Cans	35 per lb.
Westinghouse No. 18 Cement	25 lb. Cans	30 per lb.
	1-lb. Cakes, 10 lb. Cakes	26 per lb.
Westinghouse A-R-C Cement	1 pt. Cans approx. 2½ lbs.	50 each
	1 qt. Cans approx. 5 lb.	80 each
	1 gal. Cans approx. 18 lbs.	2 80 each

Soldering Paste

Westinghouse Soldering Paste	2 oz. Cans	$0 14 each
Westinghouse Soldering Paste	4 oz. Cans	22 each
Westinghouse Soldering Paste	8 oz. Cans	30 each
Westinghouse Soldering Paste	1 lb. Cans	45 each
Westinghouse Soldering Paste	5 lb. Cans	35 per lb.

HL Oil

HL Oil No. 1	1 gal. Can (7 lbs.)	$0 45 per lb.

Approximate Weights

The weight of liquids approximates 7½ pounds per gallon, with the exception of the liquid glue, which weighs 12 pounds per gallon.

Add for weight of container as follows:

1-gal. stone jug—6 lb. 1-gal. tin can—1 lb. 10-gal. tin can—10 lb.
5-gal. stone jug—17 lb. 5-gal. tin can—2½ lb.

	Lb.
Commutator cement, small size, per dozen, total weight boxed	20
Commutator cement, small size, per case (three dozen) total weight boxed	50
No. 5 Cement, in 10-lb. containers, total weight, boxed	13½
No. 5 Cement, in 25-lb. containers, total weight, boxed	30
Soldering Paste, 2-oz. tins, per gross, boxed	30

INSULATING OILS

The oils listed in this section are of the highest quality and the kind used in all Westinghouse apparatus requiring an insulating oil. A great amount of research work has been done by the Company in this line and the oils listed are the result. The purchaser can, therefore, feel assured that the material described is the best of its kind obtainable for the purpose.

LECTROSEAL TRANSFORMER OIL

General

Lectroseal oil is a special grade of oil used for insulating and cooling oil-insulated transformers and other oil-insulated and oil-cooled apparatus such as feeder regulators, rectifiers and electrolytic lightning arresters.

Lectroseal oil must not be used in Oil Circuit-Breakers.

It is a pure mineral oil free from moisture, acid, alkali or sulphur compounds and is very fluid. This oil is not affected by high temperatures reached under operating conditions. It congeals at minus 6 degrees C. (21.2 degrees F.)

Insulating Properties

Dielectric Strength—This oil has an average breakdown value of 22,000 volts when tested in the method described in the first paragraph following.

Methods of Test—The usual method of testing Lectroseal Oil is by the use of our oil testing cup Style No. 263621 (see page on Oil Testing Cups), which is a device having flat disc electrodes one inch in diameter with square edges set with surfaces in parallel planes 0.1 inch apart and with their axes in the same horizontal line.

A similar device may be used with discs 0.5 inch in diameter set 0.2 inch apart: the average breakdown value must then be not less then 38,500 volts.

A third device having electrodes consisting of spheres 0.5 inch in diameter set 0.15 inch apart in the same vertical line may be used; the average breakdown voltage with this device must not be less then 40,000 volts.

The following precautions must be followed when using all devices for making dielectric tests, to prevent obtaining results that will cause the condemnation of good oil:

When possible the gap should be adjusted and locked in place first. Then thoroughly rinse with benzine or gasoline. If wiping with cloth is necessary, it must be dry and all such cleaning must be followed by thorough rinsing until all fibers of cotton have been eliminated. Then give a final rinsing with the oil to be tested immediately before placing the test sample in the apparatus.

The temperature of both oil and testing apparatus should be as close together as possible and shall be between 20° C. and 30° C. Lower temperatures are likely to yield low break-down values and higher temperatures high values.

The oil level for apparatus with disc electrodes shall not be less than one inch above the electrodes and for apparatus with spheres arranged above one another not less than six inches above the center of the gap.

The testing transformer shall have a capacity of at least one Kv-a.

Pour the test sample into the testing device and allow it to stand until all minute air bubbles have had time to escape. This will require two or three minutes.

Apply the testing voltage, starting at a low value and increasing steadily at the rate of about 3000 volts per second without opening the circuit until breakdown takes place.

After each break, jar the testing device but do not cause the oil to be agitated sufficiently to take up air bubbles. This will tend to loosen particles of carbonized oil from between the electrodes. Do not introduce any device into the oil for stirring, as it is likely to cause low breakdown voltages on account of introducing minute particles of foreign matter or moisture. Jarring will not remove all carbon from between the electrodes, but the remainder will be driven off by the next application of voltage before the breakdown value is reached.

Repeat the application of voltage until five breakdowns have been made and use the average value as the breakdown voltage of the oil.

Sometimes a small bright spark passes across the gap but does not form an arc or cause circuit breakers or fuses to open the circuit. Such discharges should be disregarded in recording results. They are not likely to occur if sufficient time is allowed for all air to escape before applying voltage. It is better to make tests on several samples of oil if the first sample has a low breakdown value. If the tests on any one sample from the same tank, or other container, yield satisfactory results, and the tests on other samples are low, the latter may be disregarded as having been caused by contamination in taking from the container or by insufficient cleaning of the testing device.

INSULATING OILS—Continued

Moisture—It is imperative that the oil contain little or no moisture, as the dielectric strength of the oil decreases very rapidly as the percentage of moisture increases. Various grades of oil differ greatly as to their ability to separate from water with which they have been mechanically mixed. Lectroseal oil possesses this separating property to a marked degree. If mixed with a large percentage of water and the water be allowed to settle over a considerable period, the Lectroseal oil will, without other treatment, regain a large percentage of its original dielectric strength.

Chemical Reaction—The presence of traces acid or of alkali used in the purification of oil of this class is not permissible in transformer oil for two reasons: first, the presence of the acid or alkali reduces the dielectric strength of the oil; and, second, acids and alkali are corrosive or destructive in their action upon the materials of the transformer. Lectroseal oil is practically neutral.

Physical Properties

Viscosity—Since one of the main functions of the oil is to cool the apparatus it insulates, its viscosity is of great importance. The more sluggish the oil the slower will be its circulation, and consequently the transfer of heat will be correspondingly slow. Heavy oil will not circulate freely through the oil ducts of the windings with the result that a high temperature gradient exists between the oil and the transformer or other windings. The viscosity of Lectroseal oil is approximately 36 at 40 degrees Centigrade (104 degrees Fahrenheit). The viscosity is determined by the time required to flow out of a given vessel through an orifice of specified dimension. (Saybolt.)

Deposit—A transformer oil should be as free from deposit as possible. The deposit is objectionable primarily because it clings to the coil windings and fills the oil ducts. The cooling of the apparatus is thus seriously affected by oil which forms a deposit under normal conditions. The deposit also renders the oil more sluggish and thus further affects its cooling action. The deposit is an indication that a chemical decomposition is taking place and is therefore an important matter. The forming of deposit seems to be a matter of the temperature at which the oil operates and the length of time it has been used. Different grades of oil differ as the temperature at which deposit will appear. The characteristics of Lectroseal oil are particularly good as regards deposit, and no trouble will be experienced under any condition of normal operation.

Flash-Point and Fire-Point—The flash-point of oi is the temperature at which the vapor resulting from the heat ignites; and the fire-point is the temperature at which the oil actually takes fire.

The flash-and fire-point should be well above any temperatures that could be expected to obtain in the oil under operating conditions. It is not expected that the maximum temperature existing in oil-insulated transformers, regulators, etc., will much exceed 100 degrees Centigrade (212 degrees Fahrenheit). It is therefore evident that a relatively high flash-and fire-point are not necessary properties of transformer oil. This is emphasized by the fact that it is universal experience, that transformer oils do not flash or take fire under operating conditions.

The flash-point of Lectroseal oil will not be less than 126 degrees Centigrade (258.8 degrees Fahrenheit) and the fire-point must not be less than 149 degrees Centigrade (300 degrees Fahrenheit).

Evaporation—The question of the evaporation of transformer oil under service conditions is a relatively minor one. Different oils do possess somewhat different characteristics as to the degree of evaporation in open vessels. Cases of transformers, regulators and similar apparatus while not ordinarily being air tight, are sufficiently tight to prevent serious loss of oil by evaporation, even though the temperature at which evaporation is noticeable in open vessels, is reached. Service tests and general experience under service conditions have confirmed the view that with properly designed containers, trouble from oil evaporation is not to be expected with commercial grades of transformer oils. As a matter of fact, more serious sources of oil loss are liable to be leaks through cases, or syphoning of oil through transformer leads, when these features are not properly considered. Trouble from evaporation of Lectroseal oil from transformer cases will not be encountered under conditions of normal service.

Color—The color of transformer oil is of relatively small importance, but a light color is desirable, so that the transformers or other apparatus may be inspected when under oil. It is also sometimes necessary to make changes on the terminal boards submerged below the oil level, and the lighter colored oil may permit doing this without lowering the oil level.

Lectroseal oil is very light in color.

Specific Gravity—The specific gravity of Lectroseal oil is approximately 0.83.

HF SWITCH OIL

Westinghouse HF oil is recommended as the insulating medium for oil switches and circuit-breakers of all voltage classes, and oil insulated auto-starters, the general service being that wherein heat is generated by flashes caused by the "make and break" of contacts.

HF oil is a pure mineral oil, free from moisture, acid, alkali or sulphur compounds. This oil is not affected by high temperatures reached under operating conditions. It congeals at minus 11 degrees Centigrade (12.2 degrees Fahrenheit). Where oil circuit-breakers and other equipment of that type are required to operate at temperatures of minus 10 degrees Centigrade (14 degrees Fahrenheit) or lower, the type 15-F oil described below should be used.

Insulating Properties

Dielectric Strength—This oil has an average breakdown value of 18,000 volts when tested in a device having flat disc electrodes one inch in diameter with square edges set with the surface in parallel planes 0.1 inch apart and with their axes in the same horizontal line, (See oil test cup Style No. 263621). Tested in similar device using one-half inch spheres set 0.15 inch apart, the average breakdown voltage is 35,000 volts, or tested in a device using one-half inch discs set 0.2 inch apart, the average breakdown voltage is 31,500 volts.

Methods of Test—Same methods of test are used for HF oil as for Lectroseal Transformer oil.

Moisture—HF oil will separate from water quite readily, but as it is a heavier oil, will not separate as readily as Lectroseal oil.

Chemical Reaction—HF oil is similar to Lectroseal oil in being free from traces of acid or alkali.

Physical Properties

Viscosity—For switch or circuit-breaker service, low viscosity is not so important, while the high flash and fire points that can be obtained with a heavier oil, are of importance. HF oil is somewhat heavier than Lectroseal oil, the viscosity of HF oil (Saybolt test) being approximately 71 at 40 degrees Centigrade (104 degrees Fahrenheit).

Deposit—HF oil has a very low deposit under any normal operating conditions.

Flash-Point and Fire-Point—For oil switch, circuit breaker and auto-starter service, the high flash and fire-point is of importance. HF oil has a flash-point of not less than 171 degrees Centigrade (339.8 degrees Fahrenheit) and a fire-point of not less than 198 degrees Centigrade (390 degrees Fahrenheit).

Evaporation—The characteristic of evaporation is of small importance in switch service. However, HF oil under operating temperature will show only a very slight loss in evaporation.

Color—HF oil is light in color.

Specific Gravity—The specific gravity of HF oil is approximately 0.86.

15-F SPECIAL SWITCH OIL

Westinghouse 15-F oil is an oil similar to HF oil but with the remarkably low congealing point of minus 47 degrees Centigrade (minus 52.6 degrees Fahrenheit) and lower flash and fire points. It is therefore suitable for outdoor-type switches, circuit-breakers, etc., which may be subjected to extremely cold weather, and where the action of contacts might be affected by congealed oil. This is not of importance normally for outdoor-type transformers, electrolytic lightning arresters, and so-forth, as the mechanical action of contacts is not involved. Further, the heat due to loss of energy in transformers connected to the line will usually prevent Lectroseal oil from reaching a temperature where it would congeal.

The general characteristics of 15-F oil are similar to those of Lectroseal oil with regard to the flash and fire point, the main difference being in the low congealing point of 15-F oil.

As the oil in oil switches and circuit-breakers should preferably be changed and the contacts cleaned twice a year, it is recommended that where such apparatus is likely to be subjected to excessively low temperature, 15-F oil be substituted for HF oil in the fall and this again replaced by HF oil in the spring.

OIL BARRELS

Barrels will usually contain 50 gallons of oil but may contain from 49 to 53. The 25-gallon half-barrels will also vary at times from 25 to 27 gallons.

Billing—When oil is furnished in containers the purchaser will be invoiced the value of such containers, as given below, in addition to the billing price of the oil shipped.

Credit for Barrels—Full credit will be allowed for 25-gallon half-barrels and 50-gallon barrels when returned in first-class condition, f.o.b. cars, Rochester, N. Y., or Point Richmond, Cal., provided, however, that invoice or memorandum and necessary shipping papers are promptly forwarded to the Company and return shipment is made within three months from the date of original shipment.

Shipping Tags are forwarded with each invoice to facilitate the return of empty barrels.

INSULATING OILS—Continued

WEIGHTS OF CONTAINERS

Approximate Shipping Weights of Cans and Barrels Containing Oil

	Lb.
1-gallon container	10
1½-gallon container	15
2-gallon container	18
2½-gallon container	23
3-gallon container	27
4-gallon container	35
5-gallon container	45

	Lb.
25-gallon barrel	240
50-gallon barrel	460

Approximate Weight of Empty Barrels

25-gallon barrel	43
50-gallon barrel	85

RETURN OF EMPTY BARRELS

When returning empty barrels the serial numbers should be itemized on the bill-of-lading and on shipping notices.

Empty barrels that were originally forwarded **from Point Richmond, Cal., or Pacific Coast Points** should be returned to:

The Westinghouse Electric & Mfg. Co.
Care of Standard Oil Co.,
Point Richmond, Cal.

freight prepaid. Shipping papers should be made out in duplicate, sending original copy to Westinghouse Electric & Manufacturing Company, San Francisco, Cal., and duplicate copy to The Standard Oil Company, Point Richmond, Cal.

Empty barrels that were originally forwarded **from points other than** Point Richmond, Cal., or Pacific Coast points should be returned to:

The Westinghouse Electric & Mfg. Co.,
Care of The Vacuum Oil Co.,
Rochester, N. Y.

freight prepaid. Shipping papers should be made out in duplicate, sending original copy to the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., and the duplicate copy to the Vacuum Oil Company, Rochester, New York.

NOTE—To obtain the minimum freight under all classifications, containers must be consigned as "Empty Oil Barrels Returned" and not "Oil Drums," the use of the term "Drums" resulting in higher classification and freight rates.

WESTINGHOUSE TAPES

Superior and uniform results are guaranteed by using Westinghouse Tapes

FRICTION TAPE

The two important uses of friction tape are to furnish mechanical protection and to furnish electrical protection to electric wires. On circuits of very low voltage, friction tape alone is used; on wires of higher voltage the friction tape serves not so much to insulate the wire as to protect the inner wrappings of treated cloth or splicing compound.

The principal requirements of friction tape are **Durability,** or the ability to retain fixed qualities under conditions of climate, heat or moisture in which it must be used, **Adhesiveness,** or the ability to adhere firmly where applied, and **Yardage.** Covering power is purchased rather than weight, therefore other characteristics being fairly equal, the tape of higher yardage is the most economical to use.

Westinghouse Friction Tapes have all of these characteristics in the highest degree.

SPLICING COMPOUND

Splicing compound is a tape made from pure rubber, so treated that it has permanent dielectric and mechanical strength and adhesiveness.

It is used for high voltage insulation and when wound on a joint or splice should form a solid tube, allowing for the greatest possible dielectric strength at the joint and making a positive seal against water.

Perfect results are obtained with Westinghouse Splicing Compounds.

CABLE TAPE

Cable Tape is recommended for the most severe service where perfect and permanent protection is required.

This is a perfect insulator and is water-proof and acid-proof. It will not dry out or harden but always remains flexible.

A grade for each requirement

Westinghouse Friction Tape, Straight and Bias—For all service where highest quality is required.

I. X. L. Friction Tape—For motor or generator work and interior wiring. Has extremely high yardage.

Adhere Friction Tape—For general requirements where a low-priced tape is desired.

Westinghouse Special Splicing Compound—For severe service where best rubber tape is required.

Pittsburgh Splicing Compound—For general use where service conditions are not severe or where a low-priced rubber tape is desired.

Westinghouse Cable Tape—For high voltage line work, in mines and subways or where conditions of moisture are very severe.

TYPES OF OVERHEAD CONSTRUCTION

The cost per mile of overhead trolley line construction is a variable quantity depending on the type of construction used. In specifying material for overhead construction it is necessary to know the conditions under which this material is to be used, as there may be considerable variation in cost depending on these conditions. For instance, material which would be very satisfactory for a low-speed line might be a complete failure when used for high-speed operation.

One of the first factors to be considered is the **size of trolley wire to be installed.** This depends in a great degree on the maximum allowable drop in voltage from the beginning of the line to the point of maximum drop, which is not necessarily at the end of the line, but may be at some heavy intermediate grade. In an extensive city system where feeders are used in parallel with the trolley wire the size of the trolley is determined by the minimum size wire that will conduct the current without excessive heating and at the same time possess sufficient mechanical strength to withstand the strains.

As city systems in many cases are of **cross span construction** it is essential that the trolley wire be kept as small as practicable in order that the strain on the poles may be reduced to a minimum. It is often impossible to back guy the poles, and the size of the poles when not back-guyed for **cross span construction** depends largely upon the weight of the trolley wire for the same sag and length of span cable.

For city service, it appears that 2/0 round wire meets the requirements to the best advantage.

For interurban service, where the trolley wire carries a heavy current, frequently without feeder, a 4/0 trolley wire is required and where high speeds require a very rugged line construction with smooth underrun a 4/0 trolley wire of standard grooved section is best adapted.

In coal mines and mines of other character it is also necessary that the overhead construction be strong mechanically and carry heavy currents without excessive drop in voltage. For this purpose also 4/0 groove wire is well adapted as the section is such as can be securely held by means of trolley ears, and adapts itself very easily to approved forms of overhead frogs, crossings and splicers.

Before a grooved wire section had been adopted the only wire which allowed the use of screw clamps and various kinds of mechanical ears was of a figure 8 section, with a small upper lobe and large lower lobe. This form of wire has a large amount of copper in the lower lobe where contact and wear take place, but the upper lobe is so small that the wire cannot be as firmly clamped as a grooved section. The shape is also poorly adapted for splicers, frogs and crossings. There is a large amount of figure 8 wire in use, but almost exclusively in old installations. **Practically none of the recent developments use figure 8 wire and the practice is discouraged by most engineers.**

While in general it may be desirable to keep down the initial cost of overhead construction, and while there are installations where permanency is not required, it has also been found that line construction which insures low maintenance cost and freedom from interrupted service due to line repairs **pays a handsome dividend on an increased first cost.**

At present overhead line construction is of two distinct types, **direct suspension** and **catenary suspension,** each of which two types of construction have their respective fields of application. **Direct suspension type** may be further divided into single bracket arms, double bracket arms, and cross span construction. **Catenary construction** may be sub-divided into bracket arm and bridge, the latter of which varies between greater limits, in regard to both

design and cost, than any other form of construction.

Where a new line is projected it is sometimes hard to decide which type should be used inasmuch as there are no set rules for guidance. However, the following will generally hold good:

For city construction with a large number of curves of short radii, switches and crossings, the direct suspension type has advantages.

For use in mines where the space is limited to a few inches between the trolley wire and roof, and where there are also many curves of short radii, the direct suspension type has the advantage.

For industrial railways, operating at low speed, and with a great number of short radius curves, switches and crossings, direct suspension type has the advantages. In an **industrial railway** used for transporting material between plants, there might be a long stretch of tangent track where a saving might be effected due to the longer pole spacing which can be used with catenary construction.

For interurban lines, and **trunk line electrification,** the catenary type of construction has many points of superiority and should be used in the majority of cases. The slight additional cost of messenger cable and hangers is offset by longer pole spacing which may be used. A 150 foot pole spacing with bracket arm support can be used as safely in catenary construction as 100 foot spacing in direct suspension construction. Where necessary, porcelain insulation can be used exclusively or porcelain can be used at important points and wood or composition insulation at points of secondary importance. In cases where a feeder cable is required in parallel with the trolley wire it is very often used as the messenger cable, thereby eliminating an additional set of insulators and supports.

For voltages in excess of 1200 the **catenary form of construction** has been adopted as standard. Where high voltage trolley is used it also becomes desirable to use a pantagraph trolley which is suitable for operation when running in either direction, and can be raised or lowered by air. **Where pantagraph trolley, either with sliding shoe or roller contact is used,** all trolley supports must be kept well above the plane of the trolley wire. At a distance of two feet from the trolley wire and at a distance of six inches above the plane of the trolley wire, the space must be kept clear to prevent interference from the pantagraph contacts due to side sway of car or tilting of the shoe due to the elevation of the outer rail on curves. Direct suspension is not adapted for pantagraph trolley operation unless modifications are made which allow the trolley to hang some distance below the structure both on tangent track and on curves.

The bracket arm type of construction consists of a bracket arm which projects from the pole and from which the trolley wire is suspended. In this type of construction the arm must be of sufficient length so that for interurban service the distance from center of track to the track side of the pole will not be less than 7 feet 6 inches. With a standard bracket arm 9 feet long this will allow the trolley to be moved about one foot each way from the normal position due to rake of poles on curves or other causes. Where freight cars are used it is necessary that at least a ten foot arm be used. This applies to either direct suspension or catenary construction.

The overhead trolley system in mines is dependent on the conditions existing in the mine. The spacing varies with the height of the roof; however, a twenty-five foot spacing of hangers is a fair average. The kind of hanger used is also more or less dependent on the height of roof. If the roof is low, hangers are close together so that the pressure of the trolley cannot press the trolley wire against the roof. If the roof is timbered the lag screw and ordinary mine suspension is the proper type to use. If the roof is about two feet above the trolley wire and of rock, a hole is drilled in the rock about 6 inches deep and a piece of 1¼-inch pipe is forced in and a pipe

hanger placed on the bottom. If the roof is very high a hole is frequently drilled on each side, eye bolts put in, and span wire construction used. If the roof is low and of rock, a hole is drilled and an expansion bolt and mine suspension is used. In some cases a horizontal hole is drilled in the rock at the proper height, and a piece of 1¼-inch pipe and horizontal pipe hanger are used. With but few exceptions a mechanical clamp of the RE type and 4/0 wire is used in the mine. Owing to the fact that nearly every mining company has a scheme of their own, it is practically impossible to compile an accurate list of material necessary for the overhead construction in a mine. However, we will include in the following pages an approximate list of the materials necessary to construct **one thousand feet of overhead in a mine,** and **one mile of the different types of construction used by Street and Interurban Railway Companies.**

CROSS SPAN CONSTRUCTION

The material necessary for one mile of tangent track, 600 volts, 100 foot pole spacing direct suspension is as follows:

106 Poles, either steel or wood.
48 Cross-span cables ⅜-inch Siemens Martin double galvanized strand.
5 Feed-in-spans as per Fig. 1.
106 Eye bolts ⅝ x 12 inches for wood poles.
106 Pole bands for steel poles.
106 Wood strain insulators for steel poles.
48 Straight line suspensions.
5 Feeder suspensions.
51 Straight line ears.
2 Strain ears.
2 Strain plates.
24 Wood strain insulators.

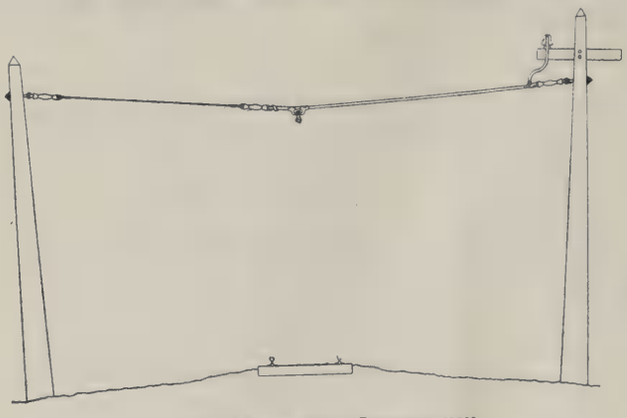


FIG. 1 CROSS SPAN CONSTRUCTION

8 Guy Anchors.
8 Strain insulators.
24 Three-bolt guy clamps.
16 Pole shims.
16 One bolt guy hooks.
16 ½ x 4 inch lag screws.
5300 Feet trolley wire.
700 Feet ⅜-inch Siemens Martin double galvanized cable for anchors and guys.
5 Lightning arresters.
2 Trolley wire splicers.
352 12-inch flexible rail bonds.
5 6-Foot solid cross bonds.

BRACKET ARM CONSTRUCTION

The material necessary for one mile of tangent track, 600 volts, 100 foot pole spacing, direct suspension bracket arm construction is as follows:

53 Poles either steel or wood.
106 Wood strain insulators for iron poles.
53 Bracket arms.
53 Straight line suspensions.
46 Straight line ears.
5 Feeder ears.
2 Strain ears.
4 Guy anchors.
8 Strain insulators.
12 Three bolt guy clamps.
8 One bolt guy hooks.
8 Pole shims.
130 ½ x 3 inches lag screws.
5300 Feet trolley wire.
540 Feet Siemens Martin double galvanized cable for anchors and guys.
5 Lightning arresters.
2 Trolley wire splicers.
352 12-Inch flexible rail bonds.
5 6-Foot solid cross bonds.

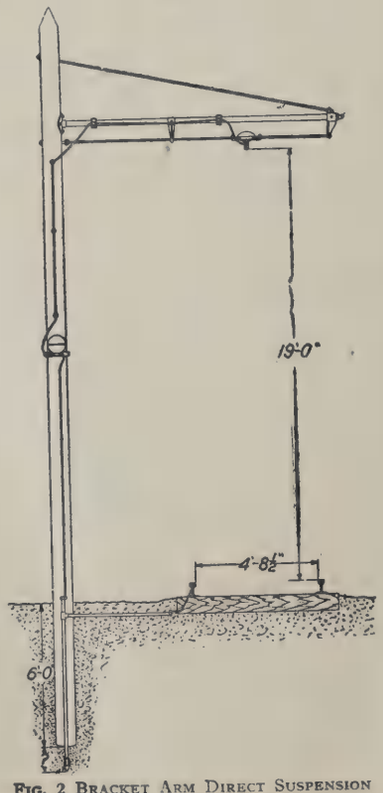


FIG. 2 BRACKET ARM DIRECT SUSPENSION

BRACKET ARM CONSTRUCTION—Continued

1. Bracket Arm.
2. Trolley Ear.
3. Straight Line Suspension.
4. Strain Ear.
5. Strain Plate.
6. Strain Insulator.
7. Strain Insulator.
8. Strain Guy.
9. Trolley Wire.
10. Eye Bolt.

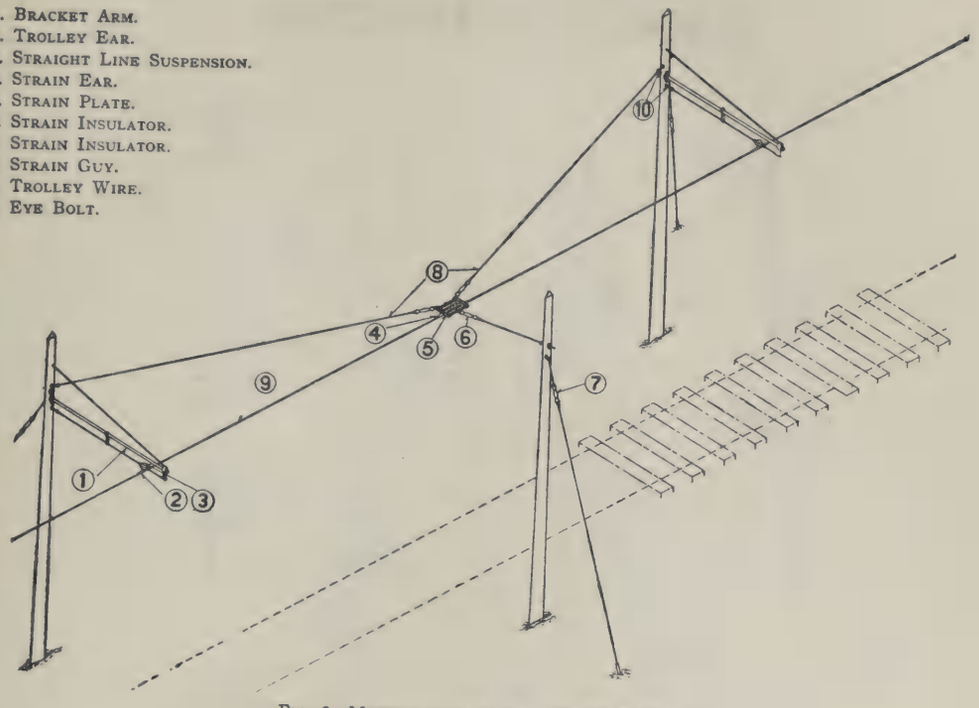


Fig. 3—Method of Anchoring Trolley Wire

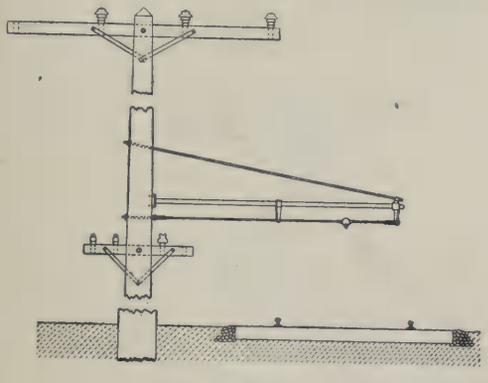


Fig. 4

Figure 4 shows the combined trolley and transmission system which includes both the telephone and the single feeder. Another system which is quite frequently used for 33,000 volt transmission and 600 volt trolley and in which the Bo-arrow form of construction is employed is shown in Figure 5. This form is very similar to the wish-bone type and is used for transmitting voltages up to and including 66,000 volts.

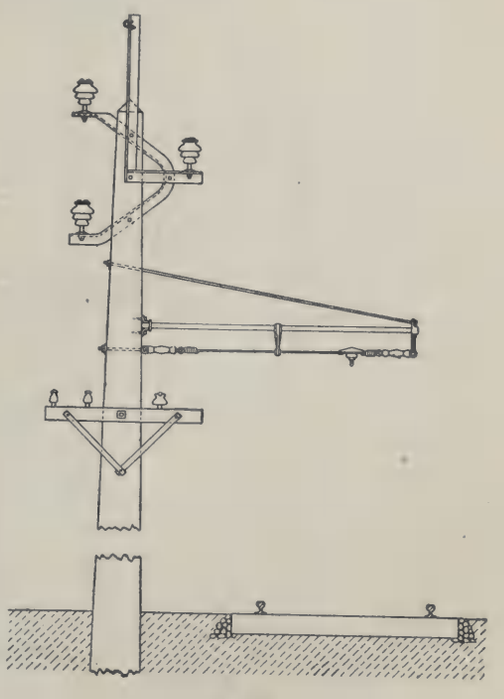


Fig. 5

CURVE CONSTRUCTION

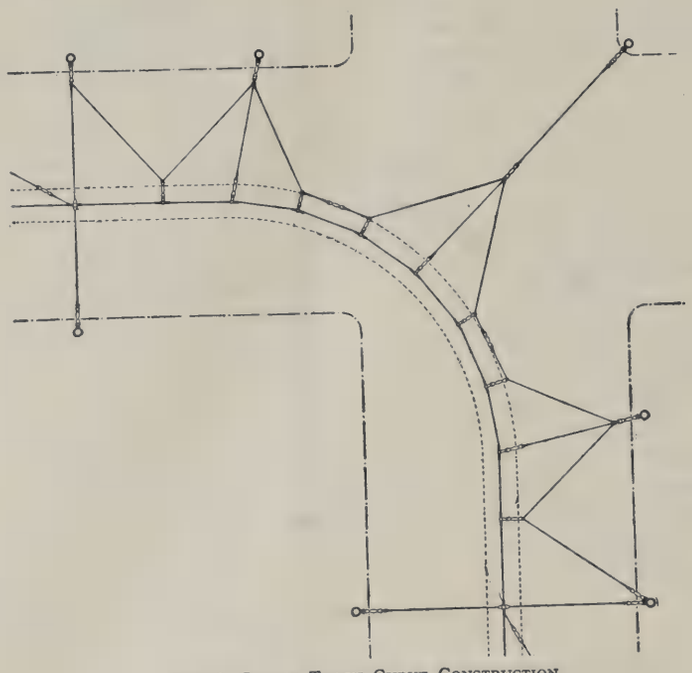


FIG. 6—SINGLE TRACK CURVE CONSTRUCTION

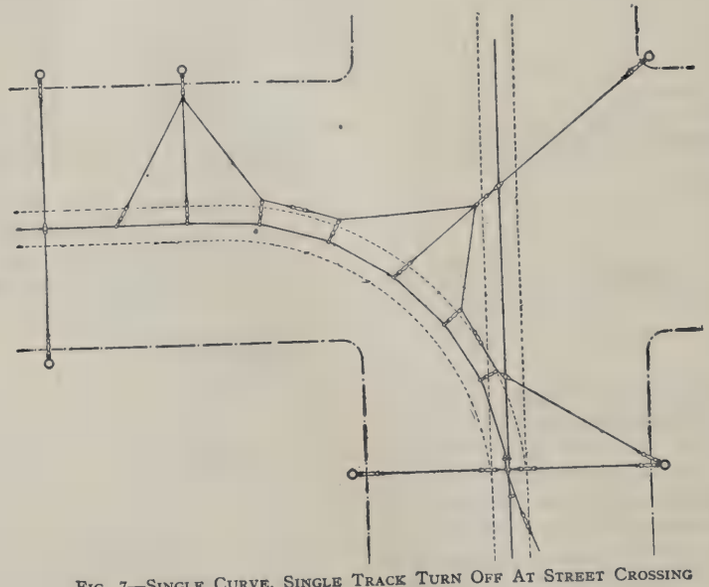


FIG. 7—SINGLE CURVE, SINGLE TRACK TURN OFF AT STREET CROSSING

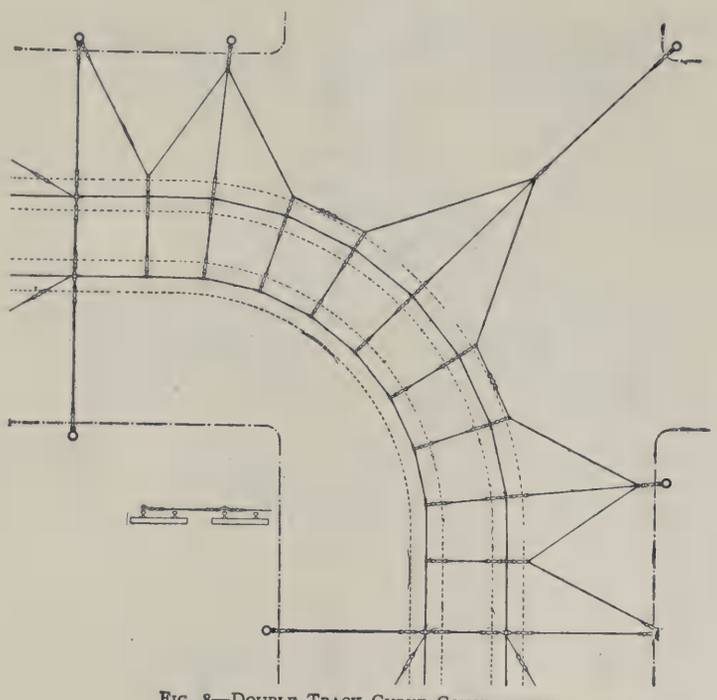


FIG. 8—DOUBLE TRACK CURVE CONSTRUCTION

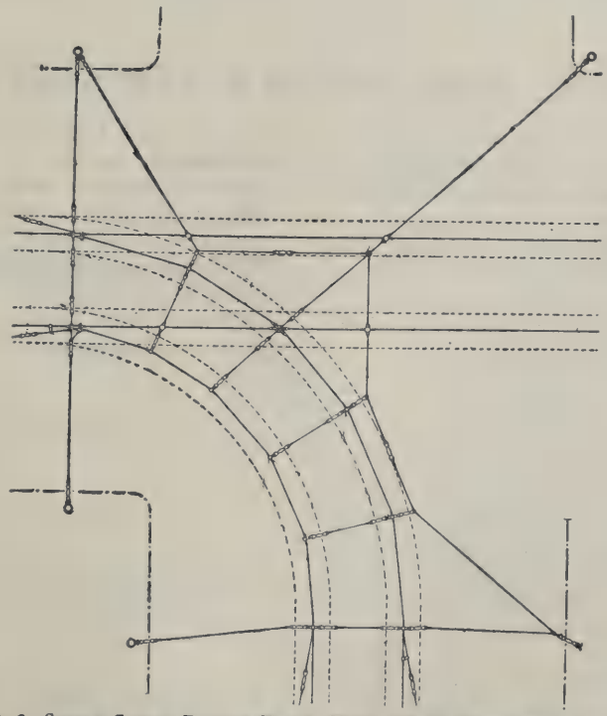


FIG. 9—SINGLE CURVE, DOUBLE TRACK, TURN OFF AT STREET CROSSING

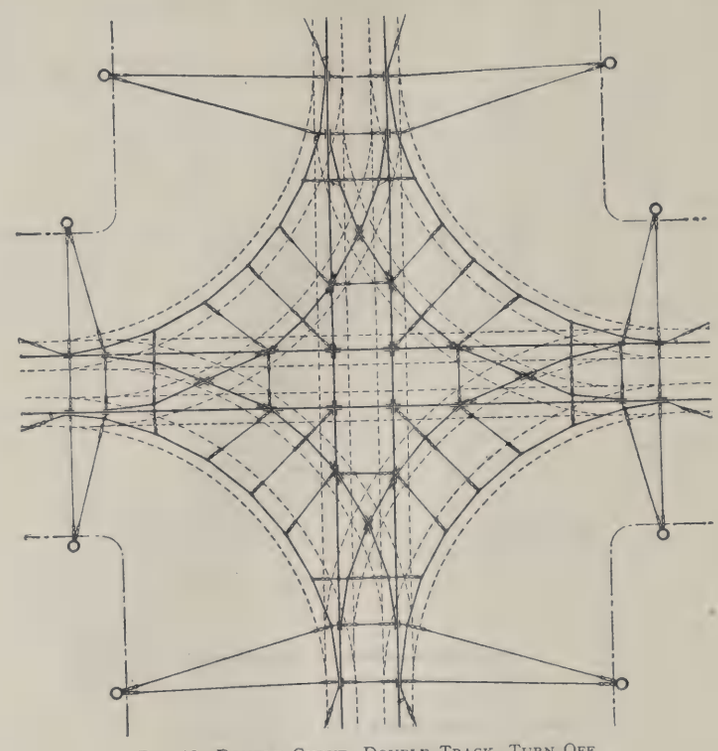


FIG. 10—DOUBLE CURVE, DOUBLE TRACK, TURN OFF AT STREET CROSSING

TELEPHONE AND FEEDER CONSTRUCTION

In railway work the feeders are, as a rule, placed on the same pole line as the trolley and quite frequently the transmission wires are supported on the same poles.

The material necessary per mile for one 600-volt single feeder and two telephone wires is as follows:

53 Cross arms, 4-foot, 4-pin, 3¼x4¼.
106 Galvanized cross arm braces, ¼x1¼x24 inches.
53 Feeder insulators 1-inch pin hole.
159 Locust pins, 1½x9x1-inch top.
106 Telephone insulators.
106 ⅜x4-inch galvanized carriage bolts.
53 ½x4-inch galvanized lag screws.
53 ⅝x12-inch galvanized through bolts.
106 ⅝-inch galvanized washers.
106 Feeder tap supports.
5300 Feet of feeder cable.
10,600 Feet of telephone wire.

MINE CONSTRUCTION

The material necessary for 1000 feet of tangent track is as follows:

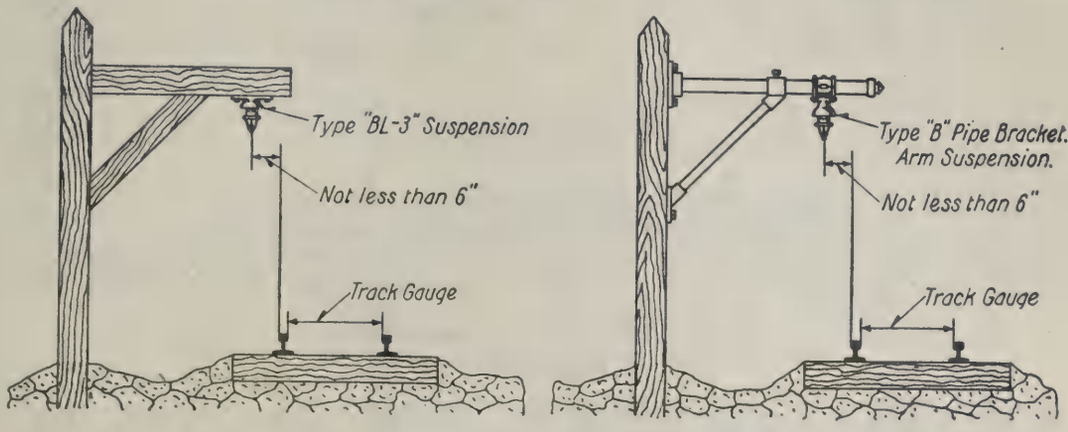
1000 Feet trolley wire (4/0 grooved preferable).
50 Mine suspensions.
50 Expansion bolts.
50 Mechanical clamps.
1 Trolley splicer
67 Rail bonds.
1 Cross bond 6 feet long.

Spacing of mine suspensions on curves:

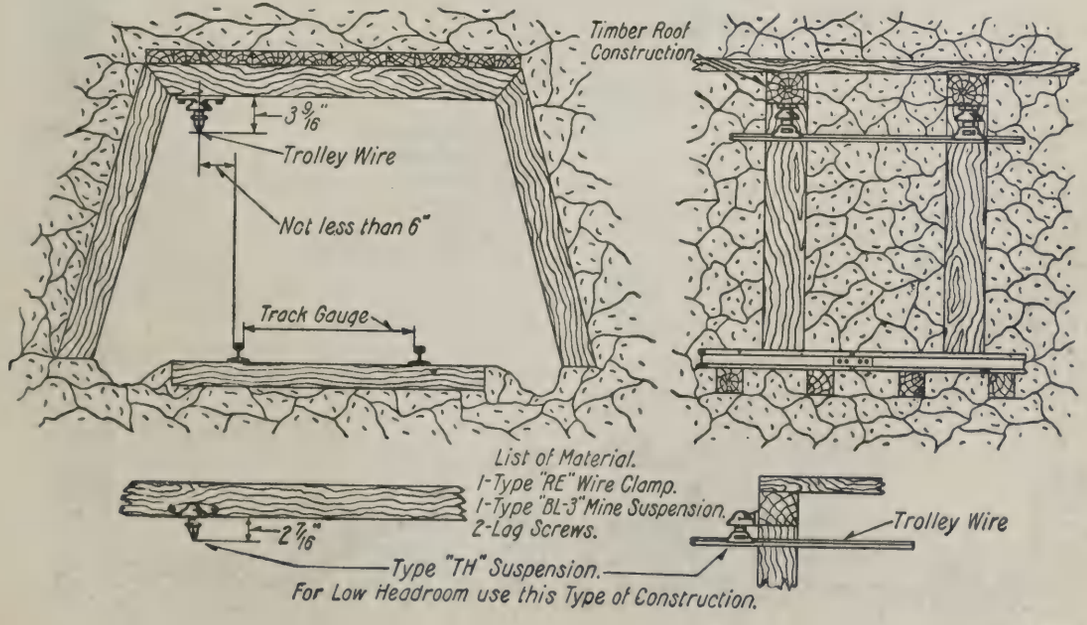
Tangent to 120 feet radius.....20 feet.
120-Foot radius to 90-foot radius.....15 feet.
90-Foot radius to 60-foot radius.....10 feet.
60-Foot radius to 40-foot radius.....6½ feet.
40-Foot radius to 20-foot radius..... 5 feet.

In new mines 30-foot rails are used, but in old ones a 20-foot rail is common and 100 bonds per 1000 feet are required.

Outside Construction



Timber Roof Construction



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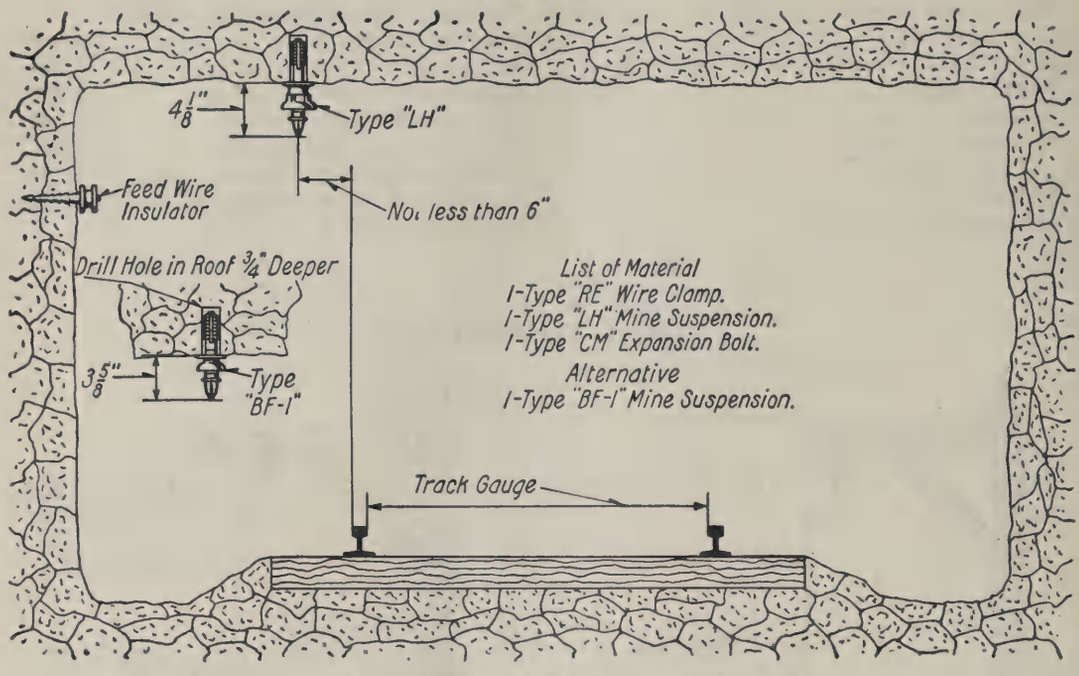
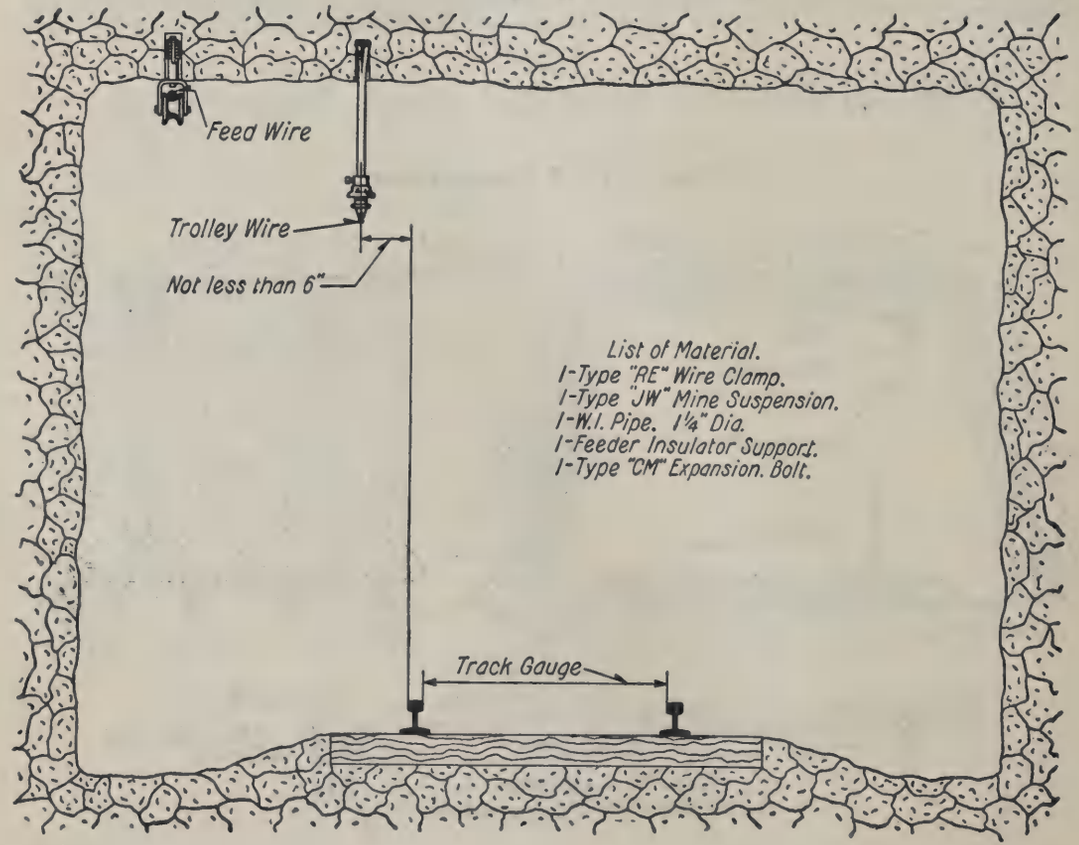
MINE CONSTRUCTION—Continued

Rock or Slate Roof Construction
Low Roof



Rock or Slate Roof Construction
High Roof



WESTINGHOUSE STANDARD BRACKET ARMS

The standard bracket arms listed on the following pages, comprise a variety of types, the choice of which depends upon the conditions of service.

These bracket arms are made of standard type C structural steel tubing.

Nominal Diameter Inches	Actual Inside Diameter Inches
2	$2\frac{1}{16}$ (2.067)
$1\frac{1}{2}$	$1\frac{5}{8}$ (1.610)
$1\frac{1}{4}$	$1\frac{3}{8}$ (1.380)

All castings are malleable iron and are heavier than those usually found on the market.

All parts of bracket arms are given one coat of black paint immediately before shipment.

The cable for the flexible bracket arm is $\frac{5}{16}$-inch Bessemer strand, galvanized. The distance from center of arm to center of cable is 7 inches.

All of these bracket arms extend at least 9 feet beyond the pole and the tension rod enters the pole 1 foot 10 inches above the arm. Shorter bracket arms will be furnished on order. The 2-inch tubing bracket arms are fitted with ½-inch tension rods. The 1½-inch tubing bracket arms are fitted with ⅜-inch tension rods.

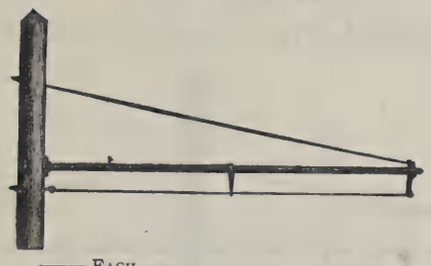
The tubing is made of sheet steel rolled into a tube but not welded. This permits the use of a high grade of steel, and tests have proven that these tubes are stiffer, stronger and more elastic than wrought iron pipe of the same thickness of wall. Dimensions are as follows:

Actual Outside Diameter Inches	Weight in Pounds Per Foot
$2\frac{3}{8}$ (2.375)	3.58
$1\frac{29}{32}$ (1.900)	2.67
$1\frac{21}{32}$ (1.660)	2.23

The sockets for wood poles do not permit the bracket arm proper to come in direct contact with the pole; they are made to take two ½-inch lag screws.

The prices for all complete bracket arms include the castings, tension rods, steel strand and eye bolts. Lag screws for attaching the bracket arm to the pole are not included unless specified.

TYPE LC—FLEXIBLE
For Wood Pole



Style No.	Description	Each: Approx. Wt., Lbs.	Each: List Price
	9-Foot Flexible Arm, 2-inch Type C Tubing		
81599	Complete bracket arm	52	$9 00
100416	Arm only, 9 feet of 2 inch type C tubing	32½	
87664	Tension rod ½″ x 10′ 2″	7	1 70
81607	End casting (outer span holder)	3	1 30
100420	Socket only	2	80
263383	Middle support only	2½	70
101954	Eye bolt only, ½″ x 12″	3	*
.....	10′ 6″ of $\frac{5}{16}$″ Bessemer strand	2	.....
	10-Foot Flexible Arm, 2-Inch Type C Tubing		
139100	Complete bracket arm	57½	10 00
142021	Arm only, 10′ of 2″ type C tubing	36½	
139104	Tension rod only, ½″ x 11′ 3½″	8	1 90
81607	End casting only (outer span holder)	3	1 30
100420	Socket only	2	80
263383	Middle support only	2½	70
101954	Eye bolt only, ½″ x 12″	3	*
.....	11′ 6″ of $\frac{5}{16}$″ Bessemer strand	2½	.....
	12-Foot Flexible Arm, 2-Inch Type C Tubing		
139101	Complete bracket arm	68	12 00
142022	Arm only, 12′ of 2″ type C tubing	45	
139105	Tension rod only, ½″ x 13′ 6″	9½	2 30
81607	End casting only (outer span holder)	3	1 30
100420	Socket only	2	80
263383	Middle support only	2½	70
101954	Eye bolt only, ½″ x 12″	3	*
.....	13′ 6″ of $\frac{5}{16}$″ Bessemer strand	3	.....

Style No.	Description	Each: Approx. Wt., Lbs.	Each: List Price
	9-Foot Flexible Arm, 1½-Inch Type C Tubing		
81600	Complete bracket arm	40	$7 30
100417	Arm only, 9′ of 1½″ type C tubing	24	
87665	Tension rod only, ⅜″ x 10′ 2″	4	1 20
81608	End casting only (outer span holder)	3	1 10
100421	Socket only	2	60
263384	Middle support only	2	60
101954	Eye bolt only, ½″ x 12″	3	*
.....	10′ 6″ of $\frac{5}{16}$″ Bessemer strand	2	.....
	10-Foot Flexible Arm, 1½-Inch Type C Tubing		
139102	Complete bracket arm	44	8 00
142023	Arm only, 10′ of 1½″ type C tubing	26½	
139106	Tension rod only, ⅜″ x 11′ 3½″	4½	1 50
81608	End casting only (outer span holder)	3	1 10
100421	Socket only	2	60
263384	Middle support only	2	60
101954	Eye bolt only ,½″ x 12″	3	*
.....	11′ 6″ of $\frac{5}{16}$″ Bessemer strand	3	.....
	12-Foot Flexible Arm, 1½-Inch Type C Tubing		
139103	Complete bracket arm	48½	9 40
142024	Arm only, 12′ of 1½″ type C tubing	30½	
139107	Tension rod only, ⅜″ x 13′ 6″	5	1 70
81608	End casting only (outer span holder)	3	1 10
100421	Socket only	2	60
263384	Middle support only	2	60
101954	Eye bolt only, ½″ x 12″	3	*
.....	13′ 6″ of $\frac{5}{16}$″ Bessemer strand	3	.....

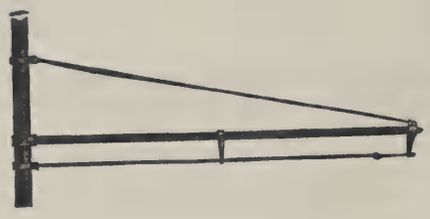
Regularly furnished painted black, but can be galvanized on special order.

*See Eye Bolts

WESTINGHOUSE STANDARD BRACKET ARMS—Continued

TYPE LC—FLEXIBLE

Single Track Arm—For Steel Pole



FOR 5-INCH POLES

Style No.	Description	Each Approx. Wt., Lbs.	Each List Price
	9-Foot Flexible Arm, 2-Inch Type C Tubing		
118987	Complete bracket arm	56½	$13 80
100416	Arm only, 9′ of 2″ type C tubing	32½	
81798	Tension rod only, ½″ x 9′ 6½″	6½	1 70
83355	End casting only (outer span holder)	3	1 30
118984	Band only for 5″ pole (two required)	2	
120076	Socket only for 5″ pole	5	3 15
263383	Middle support only	2½	70
83393	Eye bolt only, ½″ x 5″	3	*
.....	10′ 6″ of $\frac{5}{16}$″ Bessemer strand	2	.....
	9-Foot Flexible Arm, 1½-Inch Type C Tubing		
118990	Complete bracket arm	44	$10 90
100417	Arm only, 9′ of 1½″ type C tubing	24	
87666	Tension rod only, ⅜″ x 9′ 7″	3½	1 20
83356	End casting only (outer span holder)	2	1 10
118984	Band only for 5″ pole (two required)	2	
120079	Socket only for 5″ pole	5	3 15
263384	Middle support only	2	60
83393	Eye bolt, ½″ x 5″	3	*
.....	10′ 6″ of $\frac{5}{16}$″ Bessemer strand	2	.....

Double Track Arm—For Steel Pole

Style No.	Description	Each Approx. Wt., Lbs.	Each List Price
	9-Foot, Flexible Double-Track Arm, 2-Inch Type C Tubing, For 5-Inch Poles		
118996	Complete double-track bracket arm	109	$22 20
100416	Arm only, 9′ of 2″ type C tubing (two required)	32½	
81798	Tension rod only, ½″ x 9′ 3″ (two required)	6	1 70
83355	End castings only (outer span holders) (two required)	3	1 30
119014	Band only, for 5″ pole (two required)	2½	
120082	Socket only, for 5″ pole (one required)	6	3 50
263383	Middle support only, (two required)	2½	70
83393	Eye bolt, only ½″ x 5″ (two required)	3	*
.....	21′ of $\frac{5}{16}$″ Bessemer strand	4	.....

Style No.	Description	Each Approx. Wt., Lbs.	Each List Price
	9-Foot, Flexible Double-Track Arm, 1½-Inch Type C Tubing, For 5-Inch Poles		
118999	Complete double-track bracket arm	85	$17 10
100417	Arm only, 9′ of 1½″ type C tubing (two required)	24	
87666	Tension rod only, ⅜″ x 9′ 3″ (two required)	3½	1 20
83356	End casting only (outer span holder) (two required)	2½	1 10
119014	Band only, for 5″ pole (two required)	2½	
120085	Pole socket only, for 5″ pole (one required)	6	3 50
263384	Middle support only (two required)	2	60
83393	Eye bolt only, ½″ x 5″ (two required)	3	*
.....	21′ of $\frac{5}{16}$″ Bessemer strand	4	.....

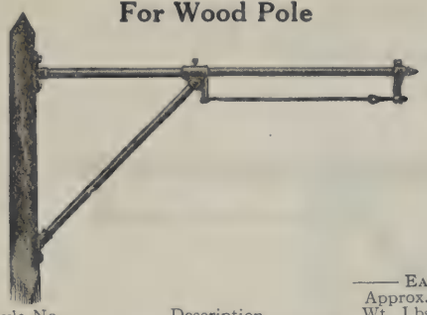
Regularly furnished painted black, but can be galvanized on special order.

*See Eye Bolts.

WESTINGHOUSE STANDARD BRACKET ARMS—Continued

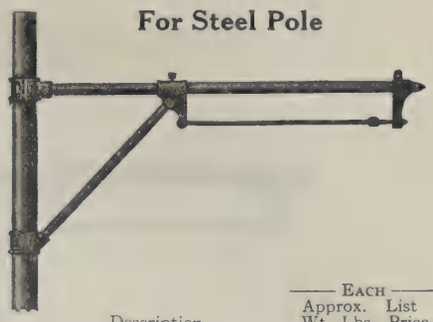
TYPE MC FLEXIBLE

For Wood Pole



Style No.	Description	Approx. Wt., Lbs. (Each)	List Price (Each)
	9-Foot Flexible Arm, 2-Inch Type C Tubing		
97474	Complete bracket arm	63½	$11 50
100416	Arm only, 9 feet of 2″ type C tubing	32½	.....
100418	Brace only, 6 feet of 1½″ type C tubing	16	.....
83355	End casting only (outer span holder)	3	1 30
100420	Upper pole socket only	2	80
100422	Lower pole socket only	2½	1 10
100426	Middle casting only	3½	2 20
83393	Eye bolt only, ½″ x 5″	3	*
.....	5′ 9″ of $\frac{5}{16}$″ Bessemer strand	1	.....
	9-Foot Arm, 1½-Inch Type C Tubing		
97475	Complete bracket arm	51	9 50
100417	Arm only, 9 feet of 1½″ type C tubing	24	.....
100419	Brace only, 6 feet of 1¼″ type C tubing	12	.....
83356	End casting only (outer span holder)	2½	1 10
100421	Upper pole socket only	2	60
100423	Lower pole socket only	2½	1 10
100427	Middle casting only	4	1 80
83393	Eye bolt only, ½″ x 5″	3	*
.....	5′ 9″ of $\frac{5}{16}$″ Bessemer strand	1	.....

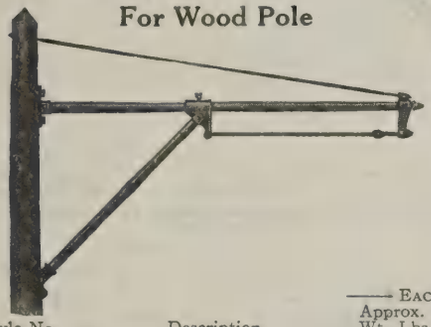
For Steel Pole



Style No.	Description	Approx. Wt., Lbs. (Each)	List Price (Each)
	9-Foot Flexible Arm, 2-Inch Type C Tubing, For 5-Inch Poles		
118948	Complete bracket arm	72½	$15 50
100416	Arm only, 9 feet of 2″ type C tubing	32½	.....
100418	Brace only, 6 feet of 1½″ type C tubing	16	.....
83355	End casting only	3	1 30
120076	Upper socket only for 5″ pole	5	3 15
119043	Lower socket only for 5″ pole	8½	3 50
100426	Middle casting only	3½	2 20
83393	Eye bolt only, ½″ x 5″	3	*
.....	5′ 9″ of $\frac{5}{16}$″ Bessemer strand	1	.....
	9-Foot Arm, 1½-Inch Type C Tubing		
118951	Complete bracket arm	59	13 50
100417	Arm only, 9 feet of 1½″ type C tubing	24	.....
100419	Brace only, 6 feet of 1¼″ type C tubing	12	.....
83356	End casting (outer span holder)	2½	1 10
120079	Upper socket only for 5″ pole	5	3 15
119046	Lower socket only for 5″ pole	7½	3 50
100427	Middle casting only	4	1 80
83393	Eye bolt, ½″ x 5″	3	*
.....	5′ 9″ of $\frac{5}{16}$″ Bessemer strand	1	.....

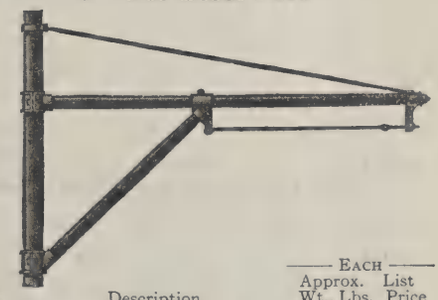
TYPE LMC FLEXIBLE

For Wood Pole



Style No.	Description	Approx. Wt., Lbs. (Each)	List Price (Each)
	9-Foot Flexible Arm, 2-Inch Type C Tubing		
92133	Complete bracket arm	70½	$13 00
100416	Arm only, 9 feet of 2″ type C tubing	32½	.....
100418	Brace only, 6 feet of 1½″ type C tubing	16	.....
87664	Tension rod only, ½″ x 10′ 2″	7	1 70
83355	End casting only (outer span holder)	3	1 30
100420	Upper pole socket only	2	80
100422	Lower pole socket only	2½	1 10
100426	Middle casting only	3½	2 20
83393	Eye bolt only, ½″ x 5″	3	*
.....	5′ 9″ of $\frac{5}{16}$″ Bessemer strand	1	.....
	9-Foot Flexible Arm, 1½-Inch Type C Tubing		
92132	Complete bracket arm	55	11 00
100417	Arm only, 9 feet of 1½″ type C tubing	24	.....
100419	Brace only, 6 feet of 1¼″ type C tubing	12	.....
87665	Tension rod only, ⅜″ x 10′ 2″	4	1 20
83356	End casting (outer span holder)	2½	1 10
100421	Upper pole socket only	2	60
100423	Lower pole socket only	2½	1 10
100427	Middle casting only	4	1 80
83393	Eye bolt only, ½″ x 5″	3	*
.....	5′ 9″ of $\frac{5}{16}$″ Bessemer strand	1	.....

For Steel Pole



Style No.	Description	Approx. Wt., Lbs. (Each)	List Price (Each)
	9-Foot Flexible Arm, 2-Inch Type C Tubing, For 5-Inch Poles		
119020	Complete bracket arm	80½	$17 00
100416	Arm only, 9 feet of 2″ type C tubing	32½	.....
100418	Brace only, 6 feet of 1½″ type C tubing	16	.....
81798	Tension rod only, ½″ x 9′ 6½″	6	1 70
83355	End casting only (outer span holder)	3	1 30
118984	Band only for 5″ pole	2	.....
120076	Upper socket only for 5″ pole	5	3 15
119043	Lower socket only for 5″ pole	8½	3 50
100426	Middle casting only	3½	2 20
83393	Eye bolt only, ½″ x 5″	3	*
.....	5′ 9″ of $\frac{5}{16}$″ Bessemer strand	1	.....
	9-Foot Flexible Arm, 1½-Inch Type C Tubing		
119017	Complete bracket arm	65	15 00
100417	Arm only, 9 feet of 1½″ type C tubing	24	.....
100419	Brace only, 6 feet of 1¼″ type C tubing	12	.....
87666	Tension rod only, ⅜″ x 9′ 7″	4	1 20
83356	End casting (outer span holder)	2½	1 10
118984	Band only for 5″ pole	2	.....
120079	Upper socket only for 5″ pole	5	3 15
119046	Lower socket only for 5″ pole	7½	3 50
100427	Middle casting only	4	1 80
83393	Eye bolt only, ½″ x 5″	3	*
.....	5′ 9″ of $\frac{5}{16}$″ Bessemer strand	1	.....

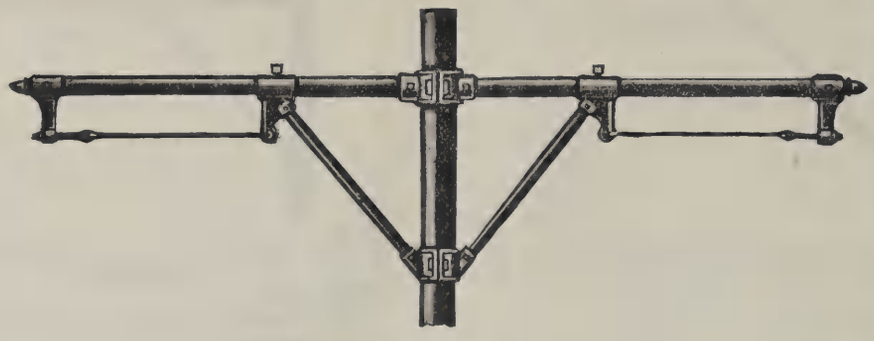
Regularly furnished painted black, but can be galvanized on special order.

*See Eye bolts.

WESTINGHOUSE STANDARD BRACKET ARMS—Continued

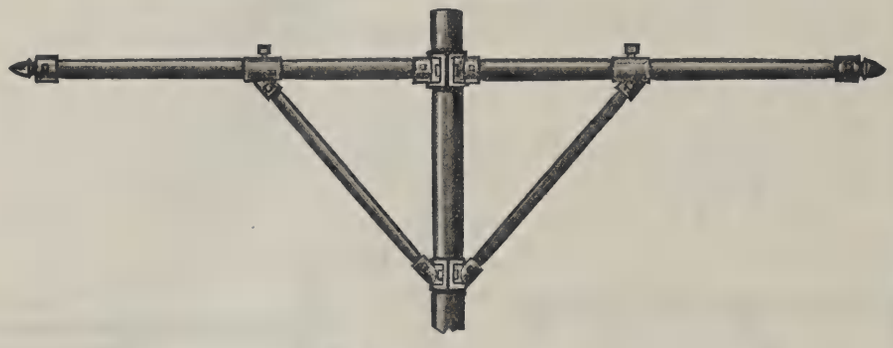
TYPE M-C—FLEXIBLE

For Steel Pole—Double Track



TYPE M-C—NON-FLEXIBLE

For Steel Pole—Double Track



Style No.	Description	Each Approx. Wt., Lbs.	Each List Price
9-Foot Flexible Arm, 2-Inch Type C Tubing, For 5-Inch Poles			
118960	Complete double-track bracket arm	134½	$27 50
100416	Arm only, 9 feet of 2″ type C tubing (two required)	32½	.....
100418	Brace only, 6 feet of 1½″ type C tubing (two required)	16	.....
83355	End casting only (outer span holder (two required)	3	1 30
120082	Upper socket only, for 5″ pole (one required)	5½	3 50
119049	Lower socket only for 5″ pole, (one required)	10	4 00
100426	Middle support only (two required)	3½	2 20
83393	Eye bolt only, ½″ x 5″	3	*
.....	11′ 6″ of $\frac{5}{16}$″ Bessemer strand (two required)	2½	.....
9-Foot Flexible Double-Track Arm, 1½-Inch Type C Tubing			
118963	Complete double-track bracket arm	106½	25 00
100417	Arm only, 9 feet of 1½″ type C tubing (two required)	24	.....
100419	Brace only, 6 feet of 1¼″ type C tubing (two required)	12	.....
83356	End casting only (outer span holder (two required)	2½	1 10
120085	Upper socket only, for 5″ pole (one required)	6	3 50
119052	Lower socket only, for 5″ pole (one required)	10	4 00
100427	Middle support only (two required)	3½	1 80
83393	Eye bolt only, ½″ x 5″ (two required)	3	*
.....	11′ 6″ of $\frac{5}{16}$″ Bessemer strand	2½	.....

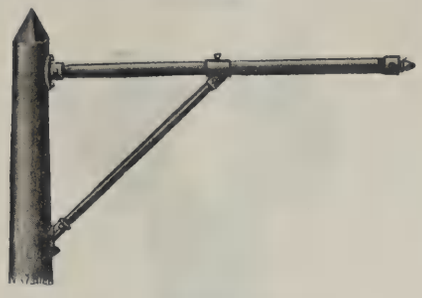
Style No.	Description	Each Approx. Wt., Lbs.	Each List Price
9-Foot Non-Flexible Arm, 2-Inch Type C Tubing, For 5-Inch Poles			
118954	Complete double-track bracket arm	123½	$24 40
100416	Arm only, 9 feet of 2″ type C tubing (two required)	32½	.....
100418	Brace only, 6 feet of 1½″ type C tubing (two required)	16	.....
83347	End casting only (two required)	2	70
120082	Upper socket only, for 5″ pole (one required)	5½	3 50
119049	Lower socket only, for 5″ pole (one required)	10	4 00
100424	Middle casting only (two required)	3½	1 75
9-Foot Non-Flexible Double-Track Arm, 1½-Inch Type C Tubing			
118957	Complete double track bracket arm	95	$21 60
100417	Arm only, 9 feet of 1½″ type C tubing (two required)	24	.....
100419	Brace only, 6 feet of 1¼″ type C tubing (two required)	12	.....
83348	End casting only (two required)	1½	60
120085	Upper socket only, for 5″ pole (one required)	6	3 50
119052	Lower socket only, for 5″ pole (one required)	10	4 00
100425	Middle casting only (two required)	3	1 50

Regularly furnished painted black, but can be galvanized on special order.

*See Eye bolts.

STANDARD BRACKET ARMS

Type M-C—Non-Flexible For Wood Pole



Made in types A and C tubing—The 2-inch arm has a 1½-inch brace and the 1½-inch arm a 1¼-inch brace.

Style No.	Description	Approx. Wt., Each Pounds	List Price Each
97466	9′ Bracket Arm 2 ″ C tubing	60	$8 50
268340	9′ Bracket Arm 2 ″ A tubing	47	8 20
97467	9′ Bracket Arm 1½″ C tubing	47	7 15
268341	9′ Bracket Arm 1½″ A tubing	38	6 85
268342	6′ Bracket Arm 1½″ C tubing	30	5 00
268343	6′ Bracket Arm 1½″ A tubing	22	4 70
268344	4′ Bracket Arm 1½″ C tubing	25	4 50
268345	4′ Bracket Arm 1½″ A tubing	18	4 30

Parts for type M. C. non-flexible Bracket Arms.

Style No.	Description	Wt., Each	List Price Each
83347	End Casting only, 2″	2	$ 70
83348	End Casting only, 1½″	2	60
100420	Upper pole socket only, 2″	2	80
100421	Upper pole socket only, 1½″	2	60
100422	Lower pole socket only, 2″	2½	1 10
100423	Lower pole socket only, 1½″	2½	1 10
100424	Middle Casting only, 2″	3½	1 75
100425	Middle Casting only, 1½″	3½	1 50

Order by Style Number

INSULATED MIDDLE SUPPORTS

SHERARDIZED

750 Volts

Distance from center of tubing to center of porcelain spool is 7 inches. It is considered good construction to use a "hot" span wire at feed in points on bracket arm construction. This can be accomplished by substituting this insulated middle support for the middle casting. This will insulate the span wire from the bracket arm, when the span wire is insulated at the end casting and the pole. With this construction it is necessary to use a feed in hanger and a composition straight line ear. The hole in the insulating bushing is one inch in diameter.

Style No.	Description	Per 100 Approx. Wt., Lbs.	Per 100 List Price
136104	Support for 1½-inch tube complete with spool	350	$125 00
136105	Support for 2 -inch tube complete with spool	360	160 00
119081	Split porcelain spool	28	6 00

FEEDER TAP INSULATORS

SHERARDIZED

750 Volts

Distance from center of tubing to center of porcelain spool is 3 inches. These insulators are used to support the feeder tap from the trolley pole where the bracket type of construction is employed. Hole in insulating bushing is 1 inch in diameter.

Style No.	Description	Per 100 Approx. Wt., Lbs.	Per 100 List Price
119079	Complete for 1½-inch tube	170	$80 00
119080	Complete for 2-inch tube	180	90 00
119081	Split porcelain spool	28	6 00

WESTINGHOUSE MOULDED INSULATION

"Westinghouse" insulation is the result of years of investigation to determine the proper ingredients and method of manufacture. Insulation of this nature can be made hard or soft, tough or brittle, of high or low dielectric strength, more or less heat-resisting, etc., at will; but the attainment of one of these qualities to an unnecessary degree means a corresponding loss in some other perhaps important characteristic. One may have very great heat-resisting capacity but poor mechanical strength; another may be very hard and strong, but have poor dielectric strength, and so on. Our insulation is so made that we have a product whose characteristics represent the best balance obtainable for actual service conditions between the different possible variations in qualities outlined above. It is of high dielectric strength, moisture-proof, hard and tough, heat-resistant, and of very high-mechanical strength, but no one quality has been attained to an extreme degree at a sacrifice of other qualities less noticeable on surface inspection or rough tests which do not parallel service conditions. Very great pressures are used in moulding this material into shape, making it exceedingly dense, and as a result the material is capable of resisting very heavy strains even when heated to a temperature far above that reached in service, without any flow of the insulation between the metal parts under strain, which would result in distortion and consequent breakdown of the piece.

WESTINGHOUSE SHERARDIZING

In January, 1910, we installed at our East Pittsburgh Works a complete equipment for rust-proofing malleable iron and steel parts by the sherardizing process—named for the inventor, Sherard.

Briefly, this process may be described as follows:

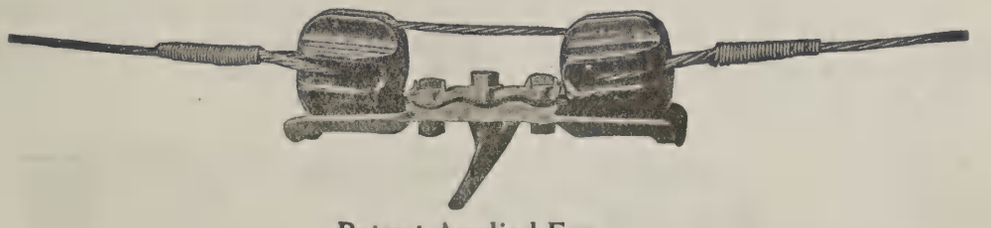
After the articles are thoroughly pickled and cleaned, they are placed in air-tight drums packed with zinc dust. The drums are 6 feet long, which limits the length of articles that may be sherardized. The drums are placed in an oven, revolved at the rate of one revolution every three minutes, and the temperature raised to 500 or 600 degrees Fahrenheit, which is considerable below the melting point of zinc (788 degrees Fahrenheit.) After 8 hours, the drums are removed from the furnace, allowed to cool for 24 hours and the contents removed. The zinc forms an alloy at the surface of the article and on top of this a layer of pure zinc is deposited. Practically nothing is added to the size or weight of the metal.

Sherardizing gives a protective surface that renders iron or steel incapable of oxidation, makes a pleasing appearance and does not, in the slightest degree, obliterate the sharp lines of the casting or machined piece. This process does not affect the strength of malleable iron, as does galvanizing by hot dipping.

We guarantee all of our sherardizing to meet the standard copper sulphate test.

HIGH-VOLTAGE STRAIGHT-LINE SUSPENSIONS

FOR VOLTAGES UP TO 3300



Patent Applied For

The porcelains are in compression and are protected against blows from dislodged trolley poles by the lower half of the sherardized clamp, which forms an apron around the insulators.

One wire is threaded through the insulators and stopped in the clamp, being held by the ridged surfaces of the clamp, and the two bolts.

This suspension is designed for use with the small and medium size type PG porcelain strain insulators. Similar construction of this apron can be adapted to the large size type PG and to the PS insulators.

This suspension does not include the trolley ear, but it will interchange with any type of ear.

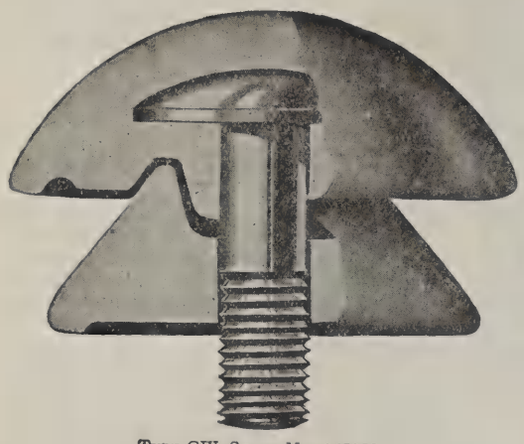
Furnished assembled with $\frac{5}{8}$-inch stud.

Style No.	Line Voltage	Insulators Style No.	Approx. Wt. lbs. per 100	List Price per 100
246593	1200	181856	950	$450 00
246594	3300	171897	1133	500 00

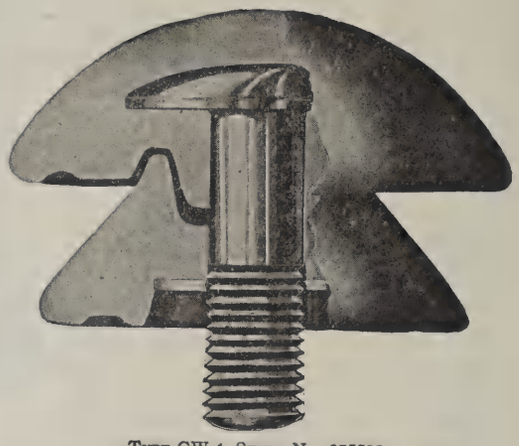
CAP AND CONE INSULATORS

FOR USE WITH TYPE A SUSPENSIONS

For Voltages up to 750—Test Voltage 10,000



TYPE CW, STYLE NO. 265958



TYPE CW-1, STYLE NO. 275529

TYPE CW—STANDARD

The molded material used in this cap and cone will not soften under intense heat and will withstand any weather conditions. The mechanical strength is far in excess of any service conditions. The studs are sherardized.

Style No.	Description	Diameter Stud, Inches	Per 100 Wt. Lb.	Per 100 List Price
265958	Standard cap and cone insulator	5/8	100	$84 00
265956	Standard cap, only	5/8	70	56 00
265957	Standard cone, only	5/8	30	28 00

A standard package of Style No. 265958 is 100.

TYPE CW-1 SPECIAL—FOR USE WITH LOCK WASHERS

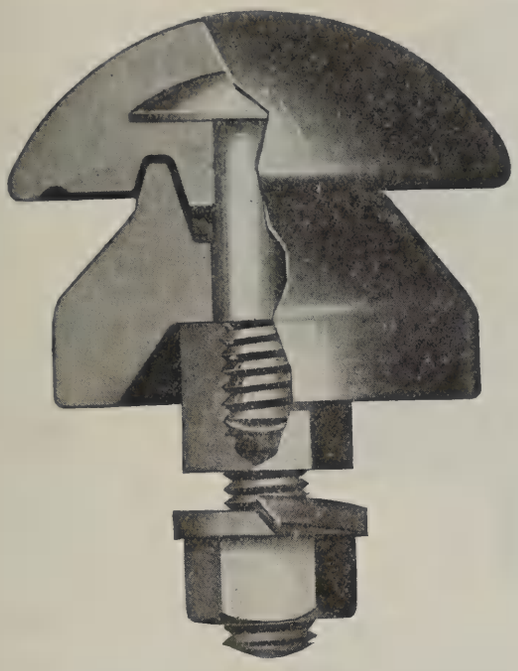
The type CW-1 cap and cone insulator is similar to the type CW except that the cone is special, allowing sufficient projection of the stud that a standard lock washer may be used between the boss of the trolley ear and the cone. The cone is provided with a metal washer for the lock washer to bear against; the washer and stud are sherardized.

Style No.	Description	Diameter Stud, Inches	Per 100 Wt. Lb.	Per 100 List Price
275529	Special cap and cone insulator	5/8	95	$84 00
265956	Standard cap, only	5/8	70	56 00
275177	Special cone, only	5/8	25	28 00

A standard package of Style No. 275529 is 100.

CAP AND CONE INSULATORS—Continued

COKE OVEN TYPE



COKE OVEN TYPE
STYLE NO. 268527

APPLICATION OF COKE OVEN
TYPE INSULATOR CEILING SUSPENSION
STYLE NO. 52571

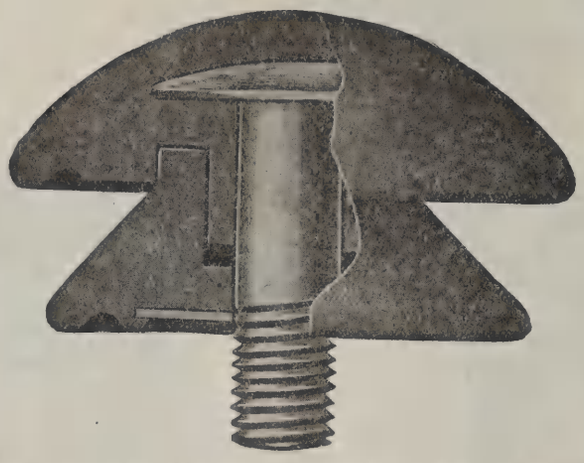
This suspension consists of a ceiling body with special heat resisting Cap and Cone with extra creepage distance and an extension nut for holding angle irons, etc. It is especially applicable about coke ovens and industrial plants. Style No. 268527 can be used with any standard type A suspension body.

Style No.	Description	Per 100 Wt., Lbs.	Per 100 List Price
68527	Complete cap and cone with extension nut	140	$130 00
290719	Cap and cone only	108	84 00
265956	Standard cap only	70	56 00
285631	Special cone only	38	28 00
252571	Malleable iron body only—Sherardized	270	100 00
278006	Extension nut only—Sherardized	32	46 00

TYPE A SUSPENSIONS
750 Volts

MALLEABLE IRON CASTINGS AND STEEL STUDS SHERARDIZED

CAP AND CONE



The type A suspension is a very durable device, consisting of a steel stud imbedded in a cap of "Westinghouse" insulating compound and passing through a cone of the same material. Between the cap and the cone is held a malleable iron body which is made in several shapes for straight line, curve, strain and ceiling suspensions. When the stud is screwed into the trolley ear, the suspension is rigid and holds the trolley ear securely.

The diameter of the head of the stud bolt is larger than the central opening of the hanger body, which prevents the dropping of the trolley wire in case the insulation fails.

Style No.	Description	Diameter Stud, Inches	Per 100 Wt. Lbs.	Per 100 List Price
185775	Standard cap and cone	5/8	100	$84 00
185772	Standard cap only	5/8	70	56 00
185773	Standard cone	5/8	30	28 00

A standard package of Style No. 185775 is 100.

SPECIAL CAP AND CONE

When it is desired to use cap and cones with lock washers the bolt projection must be longer than in the standard cap and cone. The following have a bolt projection of 15/16 inches which is sufficient to use with either a 5/8-inch or 3/4-inch lock washer.

Style No.	Description	Diameter Stud, Inches	Per 100 Wt. Lbs.	Per 100 List Price
241640	Special cap and cone	5/8	95	$84 00
185772	Standard cap only	5/8	70	56 00
241639	Special cone only	5/8	25	28 00

A standard package of Style No. 241640 is 100.

STRAIGHT LINE

Style No.	Description	Diameter Stud, Inches	Per 100 Wt., Lbs.	Per 100 List Price
52557	Complete	5/8	195	132 00
52559	Malleable iron body sherardized	5/8	102	48 00

TYPE A SUSPENSIONS—Continued

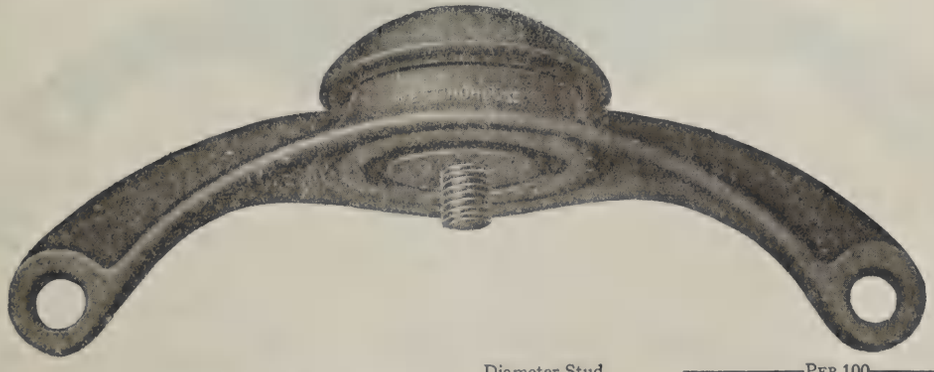
STRAIN

Style No.	Description	Diameter Stud, Inches	Per 100 Wt., Lbs.	Per 100 List Price
52566	Complete	5/8	245	$154 00
52568	Malleable iron body sherardized	..	152	70 00

SINGLE CURVE

Style No.	Description	Diameter Stud, Inches	Per 100 Wt., Lbs.	Per 100 List Price
52560	Complete	5/8	222	$140 00
52562	Malleable iron body sherardized	..	129	56 00

DOUBLE CURVE



Style No.	Description	Diameter Stud, Inches	Per 100 Wt., Lbs.	Per 100 List Price
52563	Complete	5/8	286	$168 00
52565	Malleable iron body sherardized	..	193	84 00

TYPE A SUSPENSIONS—Continued

FOR DOUBLE TROLLEY WIRE—6-INCH SPACING

STRAIGHT LINE

Style No.	Description	Diameter Stud, Inches	Per 100 Wt., Lbs.	Per 100 List Price
82645	Complete	⅝	436	$268 00
82648	Malleable iron body sherardized	..	250	100 00

SINGLE CURVE

Style No.	Description	Diameter Stud, Inches	Per 100 Wt., Lbs.	Per 100 List Price
82633	Complete	⅝	461	$293 00
82636	Malleable iron body sherardized	..	275	125 00

DOUBLE CURVE

Style No.	Description	Diameter Stud, Inches	Per 100 Wt., Lbs.	Per 100 List Price
82639	Complete	⅝	486	$308 00
82642	Malleable iron body sherardized	..	300	140 00

TYPE A SUSPENSIONS—Continued

CEILING AND MINE

CEILING—2¼ INCHES HIGH

MINE—4⅜ INCHES HIGH

Ceiling

Style No.	Description	Diameter Stud, Inches	Per 100 Wt., Lbs.	Per 100 List Price
52569	Complete	⅝	360	$184 00
52571	Malleable iron body sherardized	..	270	100 00

½-inch by 2-inch lag screws or ½-inch bolts are suitable for the ceiling suspensions.

Mine

Style No.	Description	Diameter Stud, Inches	Per 100 Wt., Lbs.	Per 100 List Price
52572	Complete	⅝	425	$209 00
52574	Malleable iron body sherardized	..	330	125 00

BRACKET

FORM 1

FORM 2

FORM 3

FORM 4

Style No.	Description	Size Pipe, Inches	Diameter Stud, Inches	Per 100 Wt., Lbs.	Per 100 List Price
	Pipe Bracket—Form 1—Rigid With Sleeve Clamp				
182006	Complete	1½	⅝	433	$234 00
144047	Body sherardized	1½	..	340	150 00
182007	Complete	2	⅝	473	250 00
144048	Body sherardized	2	..	380	166 00
	Pipe Bracket—Form 2—Hinged With Sleeve Clamp				
52576	Complete	1½	⅝	488	250 00
52582	Body sherardized	1½	..	395	166 00
52578	Complete	2	⅝	527	262 00
52583	Body sherardized	2	..	434	178 00
	Pipe Bracket—Form 3—Rigid With Split Clamp				
182005	Complete	1½	⅝	393	234 00
167507	Body sherardized	1½	..	300	150 00
	Pipe Bracket—Form 4—Hinged With Split Clamp				
171086	Complete	1½	⅝	317	250 00
186368	Body sherardized	1½	..	224	166 00
171088	Complete	2	⅝	353	262 00
186367	Body sherardized	2	..	260	178 00

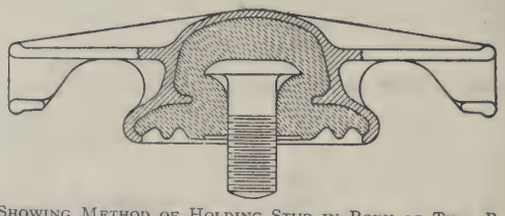
TYPE B SUSPENSIONS

750 Volts—Round Top

MALLEABLE IRON CASTINGS AND STEEL STUDS SHERARDIZED

APPLICATION OF TYPE BC-1 HANGER WITH WOOD STRAIN INSULATORS

STYLE NOS. 227032 AND 227037



SHOWING METHOD OF HOLDING STUD IN BODY OF TYPE B-SUSPENSION WITH SPECIAL INSULATING COMPOUND

STYLE NO. 227144

STYLE NO. 227146

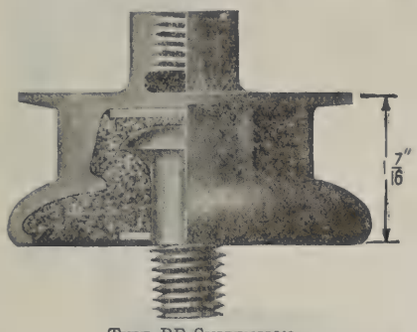
The forged steel stud is held in the malleable iron body of the suspension by means of special Westinghouse insulating compound. For 750 volt service the suspensions are used without secondary insulation. For higher voltages a strain insulator in series with the suspension insulator is recommended. The clevis suspensions are furnished with ½-inch x 1⅝-inch button-head pins with cotter keys.

Style No.	Description	Diam. Body, Inches	Diam. Stud, Inches	Per 100 Wt., Lbs.	Per 100 List Price
227032	Straight line, medium size	3¼	⅝	175	$105 00
227037	Straight line, large size	3½	⅝	200	120 00
227140	Straight line, without arms	3¼	⅝	185	115 00
227142	Single curve without arm	3¼	⅝	160	110 00
227144	Single curve with arm	3¼	⅝	230	140 00
227146	Double curve with arms	3¼	⅝	325	175 00
227148	Arm only	...	..	55	30 00

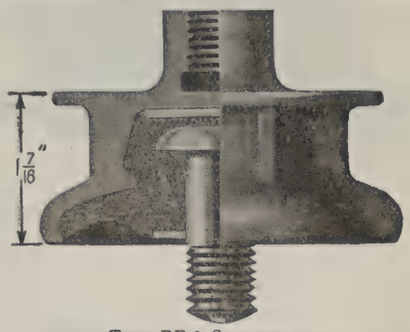
TYPE B MINE SUSPENSIONS

STEEL STUDS SHERARDIZED

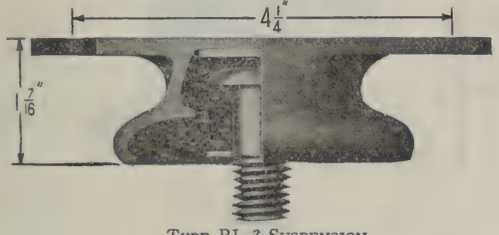
Test Voltage 10,000 Volts. Tapped for 5/8-inch Expansion Bolt



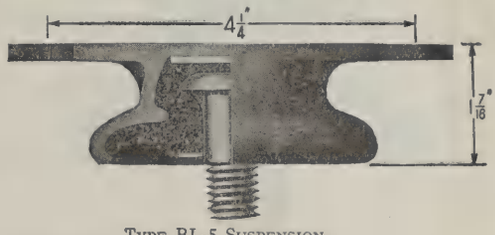
TYPE BF SUSPENSION
STYLE NO. 207352



TYPE BF-2 SUSPENSION
STYLE NO. 246700



TYPE BL-3 SUSPENSION
STYLE NOS. 207353 AND 227139



TYPE BL-5 SUSPENSION
STYLE NO. 282115

The suspensions shown on this page are made from the same high grade material as used in all of our mine suspensions. The types BF-2 and BL-5 suspensions are similar to the types BF and BL-3 suspensions except without corrugations. They are all 1 7/16 inches high with 5/8-inch stud. The type BL has two slotted holes 9/16" in diameter:

Style No.	Description	Type	Diameter Body	Per 100 Wt., Lbs.	Per 100 List Price
207352	Sherardized Body and Bolt	BF	3 1/4	150	$90 00
207353	Sherardized Body and Bolt	BL-3	3 1/4	140	90 00
227139	Sherardized Body and Bolt	BL-3	3 1/2	165	95 00
246700	Japanned Body Sherardized Bolt	BF-2	3 1/4	150	90 00
282115	Japanned Body Sherardized Bolt	BL-5	3 1/4	140	90 00

Showing application of washer Style No. 225318 in connection with the types BF and BF-2 suspensions.

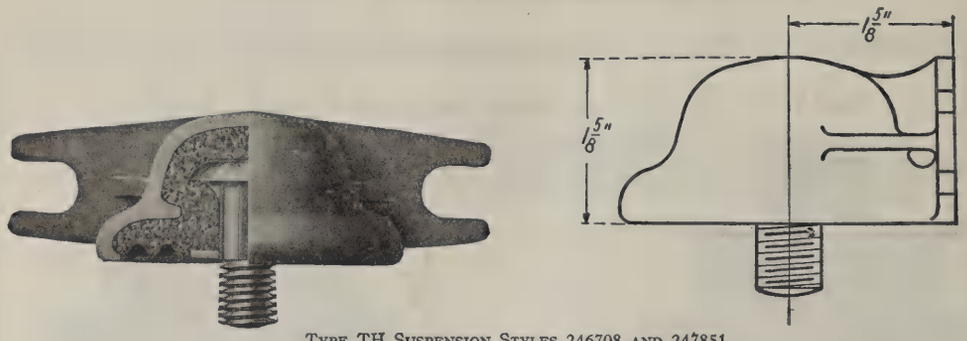
Style No.	Description	Per 100 Wt., Lbs.	Per 100 List Price
225318	Sherardized	50	$28 00

Type BF Wrenches for installing the type BF suspensions are listed in part VII of this section.

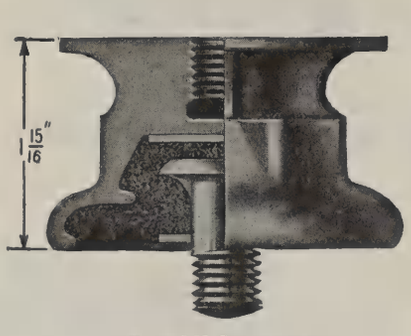
Order by Style Number

MINE SUSPENSIONS—Continued

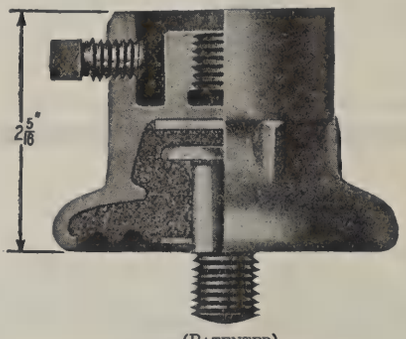
STEEL STUDS SHERARDIZED



TYPE TH SUSPENSION STYLES 246708 AND 247851
HOLES ✠" DIAMETER 4¼" C TO C



TYPE LH SUSPENSION
STYLES 246701 AND 246702



(PATENTED)
TYPE JW SUSPENSION
STYLES 246703 AND 246704

The type "LH" suspension is similar to the type BF suspensions, except it has a flat top which makes it very desirable for curve work. The type "JW" combination suspension can be supported from either expansion bolts or 1¼-inch pipe. It has two ⅜" x ½" set screws for attachment to pipe, spaced 90° apart. The bodies are all 3¼ inches in diameter with ⅝-inch sherardized studs.

Style No.	Description	Per 100 Wt., Lbs.	Per 100 List Price
246708	Sherardized	155	$115 00
247851	Japanned	155	115 00
246701	Japanned	160	95 00
246702	Sherardized	160	95 00
246703	Japanned	170	100 00
246704	Sherardized	170	107 70

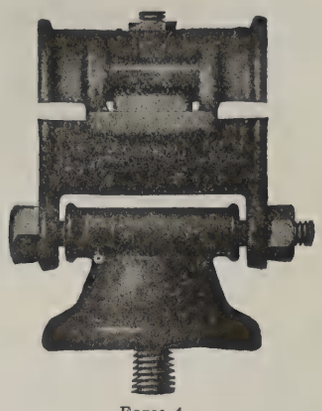
The types JW and LH suspensions can be furnished without corrugated insulation when specified.
Type BF wrenches for installing types JW and LH suspensions are listed in part VII of this section.

Order by Style Number

TYPE B MINE SUSPENSIONS—Continued

TYPE B PIPE BRACKET SUSPENSIONS
Outside Diameter of Insulated Bell is 3¼ Inches

FORM 2



FORM 4

	Description	Size Pipe, Inches	Diam. Stud Inches	Wt., Lbs. (Per 100)	List Price (Per 100)
		Form 2 —Hinged With Sleeve Clamp			
52596	Sherardized	1½	⅝	360	$225 00
52598	Sherardized	2	⅝	400	250 00
		Form 4—Hinged With Split Clamp			
182360	Sherardized	1½	⅝	355	225 00
182354	Sherardized	2	⅝	395	250 00
		Insulated Bell for Pipe Bracket Suspensions			
227138	Sherardized		⅝	150	115 00

TYPE B PIPE SUSPENSIONS

VERTICAL PIPE
STYLE No. 146067

HORIZONTAL PIPE
STYLE No. 146068

VERTICAL PIPE SUSPENSION
Pipe Receptacle Takes 1¼-Inch Pipe and is 2⅛ Inches Deep; Sherardized

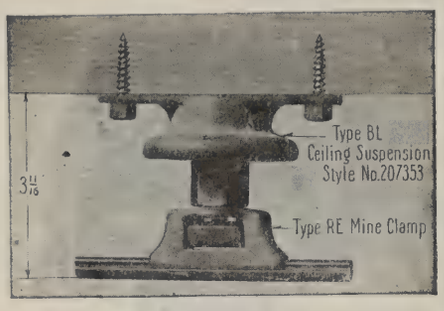
Style No.	Description	Diameter Body, Inches	Diameter Stud, Inches	Wt., Lbs. (Per 100)	List Price (Per 100)
146067	Complete as illustrated	3¼	⅝	337	$190 00
146065	Pipe attachment only	...	⅝	137	72 00

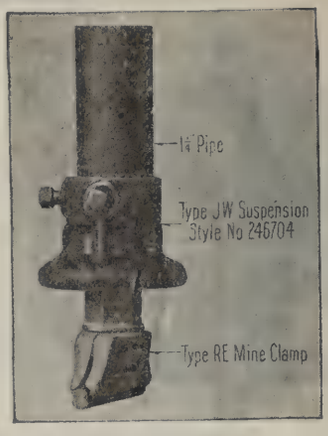
HORIZONTAL PIPE SUSPENSION
Pipe Receptable Takes 1½-Inch Pipe and is 3 Inches Long; Sherardized

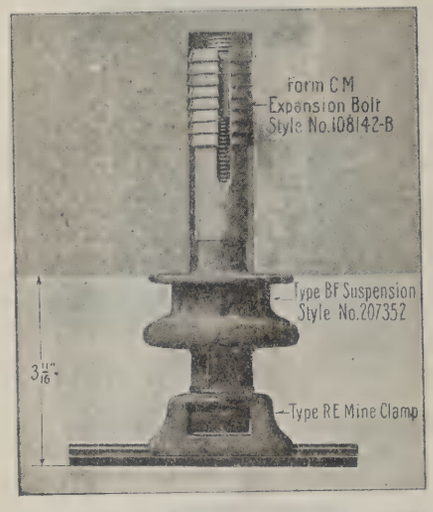
Style No.	Description	Diameter Body, Inches	Diameter Stud, Inches	Wt., Lbs. (Per 100)	List Price (Per 100)
146068	Complete as illustrated	3¼	⅝	380	$190 00
146066	Pipe attachment only	...	⅝	180	75 00

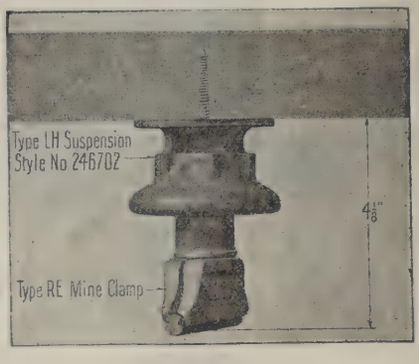
Order by Style Number

Methods of Applying Westinghouse Suspensions in Mines

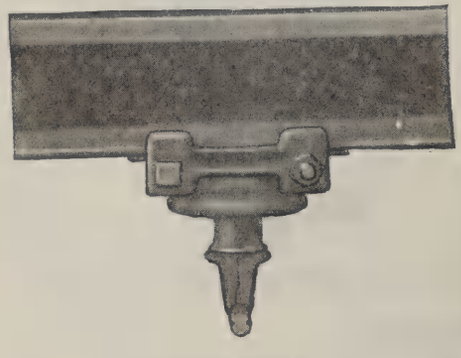


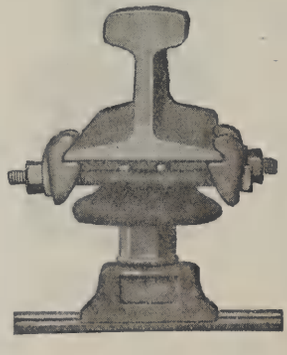






"I" BEAM CLAMP





Used for attaching suspensions to I beams in mines, industrial plants or other places where they may be desirable. Style No. 287555 is made to take I beams with 3-inch base or less. It consists of 2 clamps, Style No. 287554 and 2 ⅜x5-inch machine bolts. If it is desired to apply this clamp to a larger I beam, use 2 of Style No. 287554 and 2 ⅜-inch machine bolts 2 inches longer than the base of the I beam.

Style	Description	Per 100 Wt. Lbs.	Per 100 List Price
287555	Clamp complete—Sherardized	121	$50 00
287554	Clamp only—Sherardized	40	21 50

TYPE C SUSPENSIONS

750 Volts—West End

MALLEABLE IRON CASTINGS AND STEEL STUDS SHERARDIZED—INSULATED BOLTS

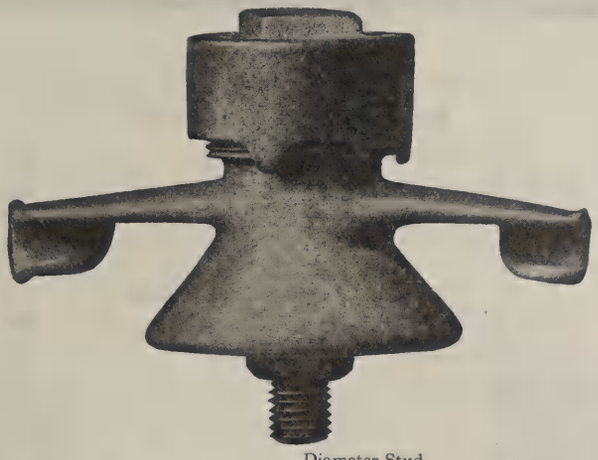
These suspensions consist of a steel bolt insulated by Westinghouse moulded insulation, placed in a recessed metal body and held by a cap screwed tightly over it. The bolt has a hexagon shoulder at its lower end just above the thread, to which a wrench can be applied for screwing the suspension into the trolley ear.

The "Special" bolts are $\frac{5}{8}$-inch shorter than "Standard" and are recommended for 250-volt service only.

The above "Standard" and "Special" insulated bolts have heads $1\frac{21}{32}$-inch diameter and $\frac{3}{4}$-inch high; the body of bolt is $1\frac{3}{16}$-inch diameter. The steel bolts are sherardized.

Style No.	Description	Diameter, Stud Inches	Per 100 Wt., Lbs.	Per 100 List Price
229814	Standard insulated bolt	$\frac{5}{8}$	70	$56 00
88703	Special insulated bolt	$\frac{5}{8}$	55	60 00

STRAIGHT LINE



Style No.	Description	Diameter Stud, Inches	Per 100 Wt., Lbs.	Per 100 List Price
52602	Complete	$\frac{5}{8}$	264	$148 00
52604	Malleable iron body and cap sherardized	..	196	92 00

SINGLE CURVE

Style No.	Description	Diameter Stud, Inches	Per 100 Wt., Lbs.	Per 100 List Price
54966	Complete	$\frac{5}{8}$	262	$156 00
54924	Malleable iron body and cap sherardized	..	194	100 00

WESTINGHOUSE CLEVELAND TROLLEY WIRE SPLICERS

Made of Composition

This is an improved form of mechanical splicer capable of easy and quick connection, having a secure hold on the wire, and possessing great strength and long life under severe conditions. It is perfectly straight and smooth under running. No solder is required. It is equally well adapted for emergency and permanent work.

All styles of this splicer are made of composition metal having great strength and low contact resistance. Made in 21-inch length for general use, and in 30-inch length for special cases where the distance between the ends of the wire to be spliced is greater than 6 inches.

The trolley wire is passed through the opening and a high-carbon steel split chuck is placed over the end of the wire and then hammered into the sleeve. The chuck is threaded internally to secure its hold on the wire. Obviously, the greater the pull the more secure is the hold. It cannot possibly lose its grip when the wire is under tension, but it can readily be removed if it is desired to take up slack.

Special attention is called to our latest design of split chuck which has sufficient length and flexibility to engage a new wire of the size for which it is rated or the same wire worn to one size smaller.

Style No.	Size Wire	Length	Per 100 Wt., Lbs.	Per 100 List Price
	Regular Length Without Boss			
179981	No. 0 round	21	250	$360 00
179982	No. 00 round	21	250	400 00
179983	No. 000 round	21	275	440 00
179984	No. 0000 round	21	300	490 00
179985	No. 00 grooved	21	250	400 00
179986	No. 000 grooved	21	275	440 00
179987	No. 0000 grooved	21	300	490 00
	Special Length Without Boss			
226048	No. 00 grooved	30	400	600 00
175932	No. 000 grooved	30	430	640 00
169771	No. 0000 grooved	30	462	700 00
226044	No. 00 round	30	400	600 00
226049	No. 000 round	30	430	640 00
169769	No. 0000 round	30	462	700 00

Style No.	Size Wire	Diam. Tap, Inches	Length	Per 100 Wt., Lbs.	Per 100 List Price
	Regular Length With Boss				
179988	No. 0 round	5/8	21	275	$400 00
179989	No. 00 round	5/8	21	275	440 00
179990	No. 000 round	5/8	21	300	480 00
179992	No. 0000 round	5/8	21	325	530 00
179994	No. 00 grooved	5/8	21	275	440 00
179995	No. 000 grooved	5/8	21	300	480 00
179997	No. 0000 grooved	5/8	21	325	530 00
	Special Length With Boss				
169873	No. 00 round	5/8	30	425	640 00
226050	No. 000 round	5/8	30	455	680 00
169768	No. 0000 round	5/8	30	487	740 00
226046	No. 00 grooved	5/8	30	425	640 00
226052	No. 000 grooved	5/8	30	455	680 00
169770	No. 0000 grooved	5/8	30	487	740 00

TYPE C SUSPENSIONS—Continued

DOUBLE CURVE—DOUBLE TROLLEY—6-INCH CENTERS

Style No.	Description	Diam. Stud, Inches	Per 100 Wt., Lbs.	Per 100 List Price
82667	Complete	5/8	610	$512 00
82779	Malleable iron body and cap sherardized	..	474	400 00

CEILING SUSPENSIONS

Form 1

The height of Form 1 from the top of flange to the shoulder of the bolt is 3 3/8 inches.

The height of Form 2 from the top of flange to the shoulder of the bolt is 3 3/4 inches.

Form 2

54934	Ceiling form 1 complete	5/8	216	$ 98 00
54936	Ceiling Form 1 body sherardized	..	148	42 00
82742	Ceiling Form 2 complete	5/8	258	166 00
82747	Ceiling Form 2 body sherardized	..	190	110 00

PIPE BRACKET SUSPENSIONS

Form 2

Form 4

The distance from the bottom of the bracket tubing to the shoulder of the bolt is 5 inches.

Style No.	Description	Size Pipe, Inches	Diam. Stud, Inches	Per 100 Wt., Lbs.	Per 100 List Price
	Form 2—Hinged With Sleeve Clamp				
54937	Complete	1 1/2	5/8	458	$276 00
54943	Malleable iron body sherardized	1 1/2	..	390	220 00
54939	Complete	2	5/8	488	301 00
54944	Malleable iron body sherardized	2	..	420	245 00
	Form 4—Hinged With Split Clamp				
182041	Complete	1 1/2	5/8	458	276 00
182039	Malleable iron body sherardized	1 1/2	..	390	220 00
182045	Complete	2	5/8	488	301 00
182037	Malleable iron body sherardized	2	..	420	245 00

TYPE D SUSPENSIONS

Sherardized

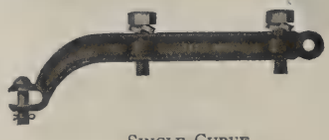
Any of our standard wood or composition strain insulators are adapted for use with these suspensions but no strain insulators are included with any of the following styles; if wanted, they must be ordered extra. Voltage depends on the insulation used.

STRAIGHT LINE—STRAIN INSULATORS NOT INCLUDED
STYLE NO. 127059

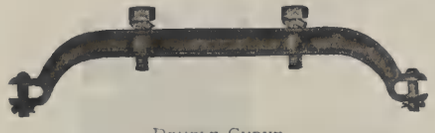
DOUBLE CURVE
STYLE NO. 54956

SINGLE CURVE—STRAIN INSULATORS NOT INCLUDED
STYLE NO. 54950

STRAIGHT LINE
STYLE NO. 82701



SINGLE CURVE
STYLE NO. 82629



DOUBLE CURVE
STYLE NO. 82617

DOUBLE TROLLEY YOKE
STYLE NO. 82689

Style No.	Description	Diam. Stud. Inches	Per 100 Wt., Lbs.	Per 100 List Price
	Suspensions for Single Trolley			
127059	Straight line suspension	5/8	225	$110 00
54950	Single curve suspension	5/8	169	90 00
54956	Double curve suspension	5/8	245	145 00
	Suspensions for Double Trolley			
	Six-inch spacing between stud centers			
82701	Straight line suspension	5/8	410	215 00
82629	Single curve suspension	5/8	360	185 00
82617	Double curve suspension	5/8	420	270 00
	Straight Line Yoke for Double Trolley			
	Six-inch spacing between stud centers			
82689	Complete, 5/8-inch bolt	5/8	262	140 00

EXPANSION BOLTS
PLAIN AND SHERARDIZED

FORM A-M

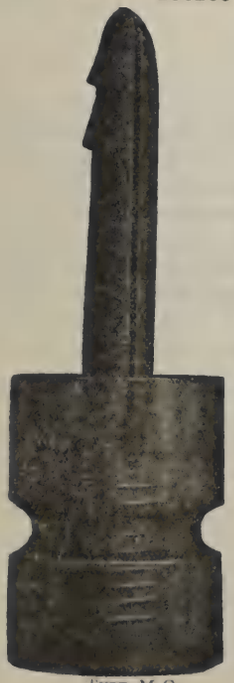
FORM B-M

FORM C-M

FORM W-S

Form AM has a ⅝-inch bolt with hexagon head; for use with type A mine suspension.

Style No. Plain	Style No. Sherardized	Description	Per 100 Wt., Lbs.	Per 100 List Price, plain or sherardized
226729	125763	Complete with 4-inch shell	113	$48 00
226731	141620	Complete with 6-inch shell	159	61 00
Form BM has a ⅝-inch stud with fixed hexagon shoulder.				
226728	127267	Complete with 4-inch shell	120	62 50
226732	141621	Complete with 6-inch shell	170	75 00
Form CM has a ⅝-inch stud threaded both ends.				
226727	108142	Complete with 4-inch shell	120	42 00
226733	141622	Complete with 6-inch shell	170	55 00
Form WS consists of wood plug 1½-inch by 4-inch and stud lag ⅝-inch by 5-inches.				
.....	256265	Complete with sherardized stud-lag	45	26 00
.....	83121	Complete with plain stud-lag	45	26 00
.....	83123	Wood plug only	16	8 00
.....	83125	Stud-lag, plain	27	15 00
.....	256266	Stud-lag, sherardized	27	15 00



TYPE M-G

FEED WIRE INSULATORS FOR MINES

These feed wire insulators are of simple and effective design. The Type MG has a porcelain spool 3½ inches high, 2¾ inches diameter and is threaded for a 1-inch pin. The type MF has a special porcelain spool 2-inches high, 2½ inches diameter, the pin is 8 inches long, mechanically attached to the porcelain spool.

Style No.	Description	Per 100 Weight, Lbs.	Per 100 List Price
	Type MF		
246707	Complete with sherardized pin	106	$26 00
251643	Complete with plain pin	106	26 00
246705	Porcelain spool	60	9 00
246706	Malleable iron pin, plain	46	17 00
256261	Malleable iron pin, sherardized	46	17 00
	Type MG		
182018	Complete with sherardized pin	200	44 00
256262	Complete with plain pin	200	44 00
146632	Porcelain spool	120	16 00
137729	Malleable iron pin, sherardized	80	28 00
256306	Malleable iron pin, plain	80	28 00

TYPE M-F

FEED WIRE INSULATORS FOR MINES—Continued

For Heavy Cable, Metal Parts Sherardized

This insulator is used for carrying large Feeder Cables and insulating them from the roof of the mine.

It is used in connection with expansion bolts, especially the Form AM.

For cables up to 400,000 c. m.

The diameter of the groove in the porcelain spool is 1⅜ inches. The bolt is ⅜ inch x 3½ inches.

Style No. does not include the expansion bolt.

Style No.	Description	Per 100 Wt., Lbs.	Per 100 List Price
251712	Insulator complete except expansion bolt	125	$36 50
263528	Insulator complete with 4″ expansion bolt	228	84 50
268529	Insulator complete with 6″ expansion bolt	284	97 50

ARMORED FEEDER INSULATORS

Sherardized

Furnished with One-inch Pin Hole

STRAIGHT LINE FEEDER INSULATOR

750 Volts

STYLE NO. 216151

This insulator consists of a moulded insulation body and a malleable iron cap having a saddle top with a long bearing surface and easy radius allowing an insulated cable to be supported with the least possible danger of injuring its insulation. Side projections are provided of sufficient height so that it is impossible for the cable to leave the groove. The fact that the lower half of the insulator is composed entirely of insulating material excludes the possibility of a ground where this insulator is used.

Style No.	Description	Per 100 Wt., Lbs.	Per 100 List Price
216151	For 500,000 c.m. Wire	170	$120 00
268588	For 1,000,000 c.m. Wire	200	130 00

ARMORED CORNER FEEDER INSULATORS

PITTSBURGH-TYPE—SHERARDIZED—WITH ONE-INCH PIN HOLE

For Voltages up to 750—Test Voltage 10,000

WITH COLLAR

WITHOUT COLLAR

This insulator is composed of molded insulation, surrounded by a malleable iron cap. Its purpose is to hold feeder cables on curves; it is provided with a deep side groove.

With the collar, or retaining ring, it prevents the cable from leaving the groove whatever may be the angularity. This design is especially well adapted to slight curves as the cable will be retained in the grove without tie wires. The collar is free to turn on the cap, so that after the insulator is firmly screwed on to the pin, the collar may be turned until the cable seat is in the proper position to best support the cable. The use of tie wires is entirely eliminated.

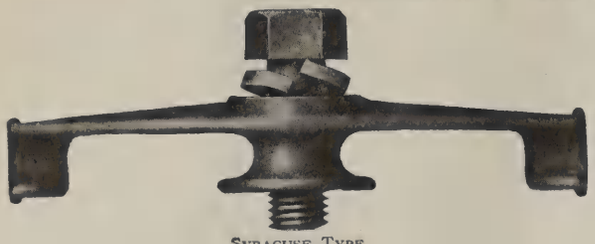
Without the collar, it is quite similar to standard designs that are suitable for holding cables where the corner or the side is a sharp angle.

Style No.	For Feeders, C.M.	Per 100 Wt. Lb.	Per 100 List Price
	With Collar		
226332	500,000	235	$160 00
256162	1,000,000	335	195 00
	Without Collar		
275607	500,000	195	140 00
275608	1,000,000	285	170 00
	Collar Only		
275609	500,000	40	20 00
275610	1,000,000	50	25 00

Order by Style Number

FEEDER SUSPENSIONS

Yokes of High Grade Composition Metal; Steel Bolts and Lock Washers Sherardized



SYRACUSE TYPE

CONNECTICUT TYPE

GROVER TYPE

PITTSBURGH TYPE

Style No.	Description	Diameter Stud Inches	Per 100 Wt., Lbs.	Per 100 List Price
†121602	Syracuse	5/8	85	90 00
47893	Connecticut	5/8	150	144 00
82720	Grover	5/8	150	170 00
216193	Pittsburgh	5/8	100	90 00
*245985	Utica	5/8	90	90 00

†The Syracuse type is also made with malleable iron yoke for use as a non-insulated suspension.
*The Utica type is similar to the Syracuse type except heavier in design.

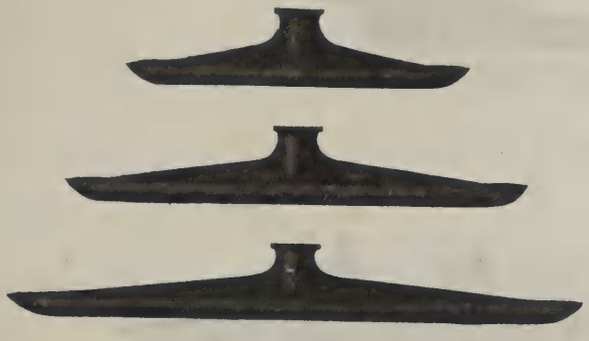
WESTINGHOUSE COMPOSITION TROLLEY EARS

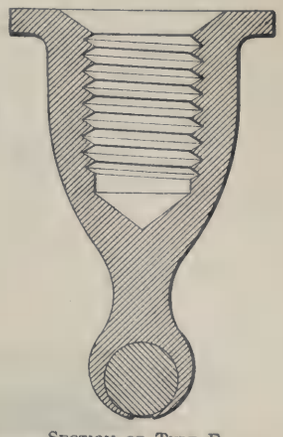
One of the most important items in line construction is a composition clinch ear for round trolley wire. It should be extremely ductile and yet possess great stiffness and permanence of form, so that when the lips are peened around the trolley wire they will successfully withstand the shocks of service and remain in place. The groove should be accurately shaped to the size of wire which it is intended to fit. The lips should be long enough to support the wire without soldering and thin enough so as not to unduly obstruct the passage of the trolley wheel.

Westinghouse ears, listed on the following pages, meet all of the above requirements.

TYPE E FOR ROUND WIRE

9-Inch, 12-Inch, and 15-Inch Lengths





SECTION OF TYPE E
HEIGHT OF EAR AT BOSS 2 1/16 INCHES

The following styles are regularly furnished not tinned; if wanted tinned, they must be so ordered.

Style No.	Size Wire	Diam. Tap, Inches	Per 100 Wt., Lbs.	Per 100 List Price
		Length, 9 inches		
140689	No. 0 round	5/8	65	$ 76 00
140690	No. 00 round	5/8	65	82 00
		Length, 12 inches		
140691	No. 0 round	5/8	85	88 00
140692	No. 00 round	5/8	85	96 00
140693	No. 000 round	5/8	110	104 00
140695	No. 0000 round	5/8	110	112 00
		Length, 15 inches		
140697	No. 0 round	5/8	100	102 00
140698	No. 00 round	5/8	105	110 00
140699	No. 000 round	5/8	130	120 00
140701	No. 0000 round	5/8	135	130 00

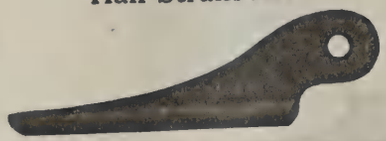
WESTINGHOUSE COMPOSITION TROLLEY EARS—Continued

TYPE E FOR ROUND WIRE

Strain Ear

LENGTH 15 AND 19 INCHES TINNED FOR SOLDERING

Half Strain Ear



LENGTH 6 INCHES TINNED FOR SOLDERING—8 INCHES OVERALL

Feeder Ear

LENGTH 15 INCHES TINNED FOR SOLDERING

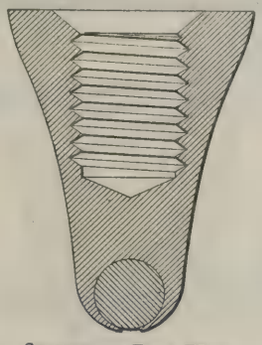
Style No.	Description	Size Wire	Diam. Top, Inches	Per 100 Wt., Lbs.	Per 100 List Price
		Length, 15 Inches			
85329	Strain	0 round	5/8	115	$165 00
85330	Strain	00 round	5/8	125	175 00
85332	Strain	000 round	5/8	140	200 00
85334	Strain	0000 round	5/8	145	210 00
		Length, 19 inches			
49362	Strain	0 round	5/8	160	170 00
49363	Strain	00 round	5/8	165	180 00
82797	Strain	000 round	5/8	165	220 00
82798	Strain	0000 round	5/8	170	230 00
		Length, 8 inches			
48645	Half Strain	0 round	..	55	96 00
48646	Half Strain	00 round	..	60	100 00
48647	Half Strain	000 round	..	65	104 00
48648	Half Strain	0000 round	..	70	108 00
		Length, 15 inches			
48649	Feeder ear	0 round	5/8	105	156 00
48650	Feeder ear	00 round	5/8	110	164 00
82873	Feeder ear	000 round	5/8	120	180 00
82874	Feeder ear	0000 round	5/8	125	190 00

WESTINGHOUSE COMPOSITION TROLLEY EARS—Continued

TYPE EL-1 LOW CENTER EAR FOR ROUND WIRE

Made Only In 12-Inch And 15-Inch Lengths

The type EL-1 is intended to supplant the type EL as it has greater holding power and longer life. It is made without machining the groove and is furnished with the inside smooth enough for all purposes and with the proper grip to keep it from sliding on the straight line or on a curve where the side pull has a component tending to slide the ear along the trolley wire. Solder is unnecessary to hold the type EL-1 at any point on the line.



SECTION OF TYPE EL-1
HEIGHT OF EAR AT BOSS 1¾ INCHES

The following styles are regularly furnished not tinned; if wanted tinned, they must be so ordered.

Length, 12 Inches

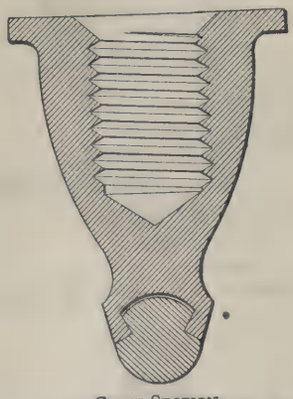
Style No.	Size Trolley Wire	Diam. Tap, Inches	Per 100 Wt., Lbs.	Per 100 List Price
249225	No. 0 round	⅝	85	[illegible] 00
249226	No. 00 round	⅝	90	[illegible] 00
249227	No. 000 round	⅝	110	104 00
249229	No. 0000 round	⅝	115	112 00

Length, 15 inches

249219	No. 0 round	⅝	95	102 00
249220	No. 00 round	⅝	100	110 00
249221	No. 000 round	⅝	125	120 00
249223	No. 0000 round	⅝	130	130 00

WESTINGHOUSE COMPOSITION TROLLEY EARS—Continued

TYPE G FOR GROOVE AND FIG. 8 WIRE
Made Only In 12-Inch and 15-Inch Lengths



CROSS-SECTION
HEIGHT OF EARS AT BOSS 1¾ INCHES

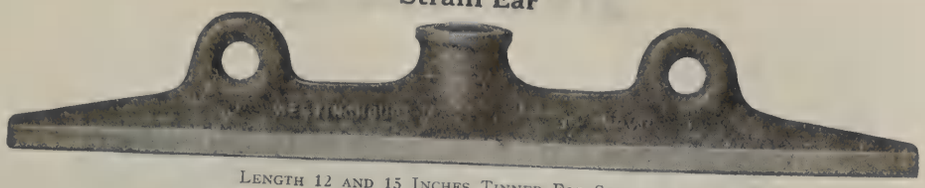
The following styles are regularly furnished not tinned; if wanted tinned they must be so ordered.

Style No.	Size Wire	Diam. Tap, Inches	Per 100 Wt., Lbs.	Per 100 List Price
		Length, 12 inches		
122611	No. 0 grooved	⅝	80	$105 00
82799	No. 00 grooved	⅝	85	115 00
122609	No. 000 grooved	⅝	95	125 00
82801	No. 0000 grooved	⅝	100	135 00
		Length, 15 inches		
124760	No. 0 grooved	⅝	100	122 00
82803	No. 00 grooved	⅝	105	132 00
124762	No. 000 grooved	⅝	115	144 00
82805	No. 0000 grooved	⅝	125	156 00
		Length, 12 inches		
126976	No. 0 Fig. 8	⅝	85	105 00
126977	No. 00 Fig. 8	⅝	90	115 00
126978	No. 000 Fig. 8	⅝	100	125 00
126980	No. 0000 Fig. 8	⅝	105	135 00
		Length, 15 inches		
139742	No. 0 Fig. 8	⅝	105	122 00
139743	No. 00 Fig. 8	⅝	110	132 00
139745	No. 000 Fig. 8	⅝	120	144 00
139747	No. 0000 Fig. 8	⅝	125	156 00

WESTINGHOUSE COMPOSITION TROLLEY EARS—Continued

TYPE G FOR GROOVE AND FIG. 8 WIRE

Strain Ear



LENGTH 12 AND 15 INCHES TINNED FOR SOLDERING

Half Strain Ears

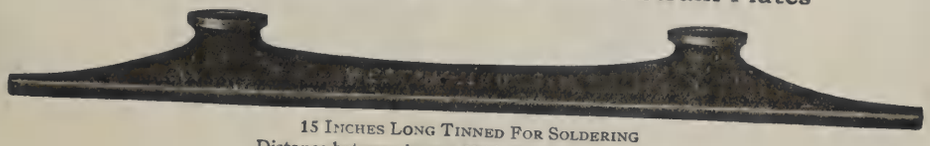
LENGTH 6 INCHES TINNED FOR SOLDERING—8 INCHES OVERALL

Feeder Ear

LENGTH 15 INCHES TINNED FOR SOLDERING

Style No.	Description	Size Wire	Length Inches	Diam. Top Inches	Per 100 Wt., Lbs.	Per 100 List Price
125781	Strain	0 groove	12	5/8	90	$170 00
82787	Strain	00 groove	12	5/8	105	182 00
125783	Strain	000 groove	12	5/8	115	212 00
82789	Strain	0000 groove	12	5/8	120	224 00
125782	Strain	0 groove	15	5/8	125	198 00
82791	Strain	00 groove	15	5/8	120	210 00
125785	Strain	000 groove	15	5/8	130	240 00
82793	Strain	0000 groove	15	5/8	135	252 00
119917	Half strain	0 groove	8	..	70	115 00
125552	Half strain	00 groove	8	..	70	120 00
119916	Half strain	000 groove	8	..	75	125 00
125553	Half strain	0000 groove	8	..	75	130 00
119915	Half strain	0 Fig. 8	8	..	60	115 00
125554	Half strain	00 Fig. 8	8	..	60	130 00
119914	Half strain	000 Fig. 8	8	..	65	125 00
125555	Half strain	0000 Fig. 8	8	..	65	130 00
125788	Feeder	0 groove	15	5/8	105	187 00
99404	Feeder	00 groove	15	5/8	110	197 00
125789	Feeder	000 groove	15	5/8	120	216 00
99402	Feeder	0000 groove	15	5/8	125	228 00

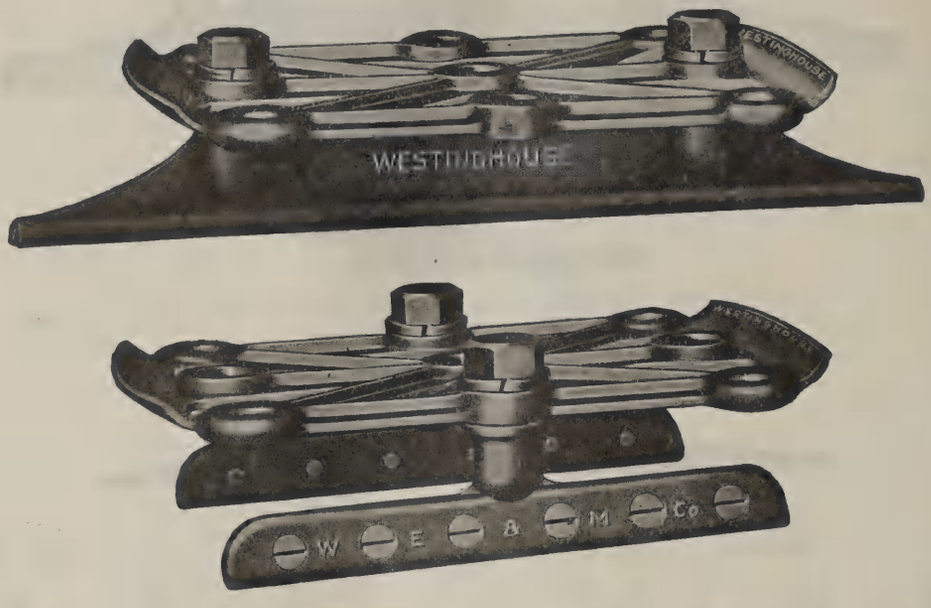
DOUBLE CENTER COMPOSITION STRAIN EAR
For Use With Metropolitan or Combination Strain Plates



15 INCHES LONG TINNED FOR SOLDERING
Distance between bosses 7¾ inches center to center

Style No.	Size Wire	Diam. Tap, Inches	Per 100 Wt., Lbs.	Per 100 List Price
85416	No. 0 round	5/8	110	$165 00
85417	No. 00 round	5/8	110	175 00
85418	No. 000 round	5/8	125	200 00
85419	No. 0000 round	5/8	125	210 00
125778	No. 0 grooved	5/8	115	198 00
85421	No. 00 grooved	5/8	115	210 00
125779	No. 000 grooved	5/8	130	240 00
85422	No. 0000 grooved	5/8	130	252 00

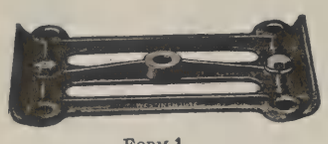
WESTINGHOUSE MALLEABLE IRON STRAIN PLATES



The Form 1 is for single trolley wire. The holes for stud bolts are 3¾ inches center to center.

The Form 2 can be used with either single or double trolley wire. The holes for stud bolts are 7¾ inches center to center.

The Form 3 is the A. E. R. A. standard. The holes for studs are made to engage strain ears with holes 7¾ inches to 8 inches center to center. The holes for the guy wires are 8 inches center to center. Can be used with single or double trolley wire.



FORM 1

FORM 2

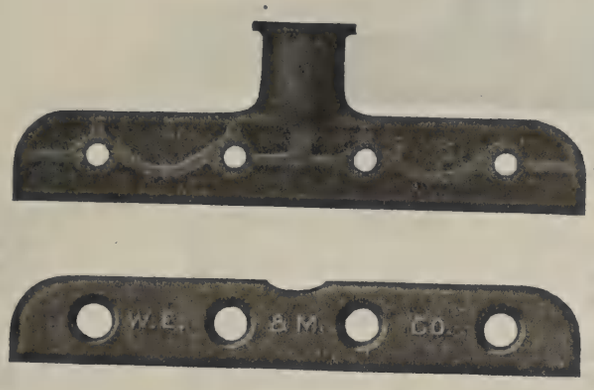
FORM 3

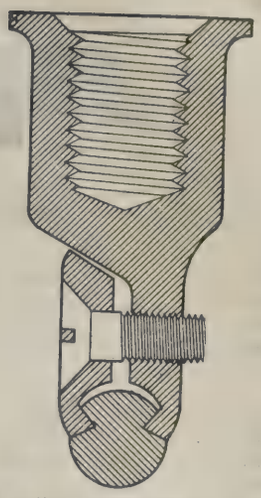
Complete with stud bolts and lock washers, all sherardized.

Style No.	Form	Diam. Bolts for Trolley Ear, Inches	Diam. Tap for Hanger Stud, Inches	Wt., Lbs. per 100	List Price per 100
82738	1	⅝	⅝	350	$180 00
125724	2	⅝	⅝	450	180 00
181863	3	⅝	⅝	500	180 00

TYPE F EARS

TYPE F CLAMPING EARS

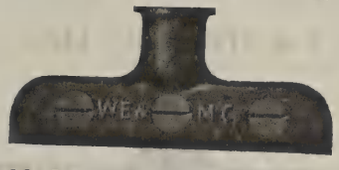




The type F ear is a screw clamp for round, grooved or Fig. 8 wire. The design has been very carefully determined, resulting in excellent strength and staying qualities. The straight line ears in 5-inch and 7-inch lengths are satisfactory for curves of long radius. Sherardized steel screws are regularly furnished with these ears.

All screws for Type F clamping ears are No. 18 (.294 inches diameter) with 18 threads per inch.

TYPE F-3 STRAIGHT LINE EAR



Malleable Iron—Sherardized—Length, 5 Inches

Style No.	Size Trolley Wire	Diam. Tap, Inches	Per 100 Wt., Lbs.	Per 100 List Price
47931	No. 00–0000 grooved	⅝	70	50 00
120483	No. 0–00 Fig. 8	⅝	70	50 00
109340	No. 000–0000 Fig. 8	⅝	70	50 00

Bronze—Length, 5 inches

125739	No. 0 round	⅝	85	100 00
125740	No. 00 round	⅝	85	100 00
125741	No. 000 round	⅝	85	100 00
125743	No. 0000 round	⅝	85	100 00
50885	No. 00–00000 grooved	⅝	80	100 00
125745	No. 0–00 Fig. 8	⅝	80	100 00
125746	No. 000–0000 Fig. 8	⅝	80	100 00

TYPE FP EARS

Malleable Iron—Sherardized—Length 4½ Inches

Style No.	Size Trolley Wire	Diam. Tap Inches	Per 100 Wt., Lbs.	Per 100 List Price
250467 steel screws	00–0000 grooved	⅝	45	46 00
250468 brass screws	00–0000 grooved	⅝	45	52 90
264093 steel screws	00–0000 Fig. 8	⅝	45	46 00
264094 brass screws	00–0000 Fig. 8	⅝	45	52 90

TYPE F EARS—Continued

TYPE F-4 STRAIGHT LINE EAR

Malleable Iron—Sherardized—Length, 7 Inches

Style No.	Size Trolley Wire	Diam. Tap, Inches	Per 100 Wt. Lbs.	Per 100 List Price
82672	No. 00–0000 grooved	5/8	80	$ 58 00
120563	No. 0–00 Fig. 8	5/8	80	58 00
116800	No. 000–0000 Fig. 8	5/8	80	58 00
	Bronze—Length, 7 Inches			
121610	No. 0 round	5/8	90	120 00
125747	No. 00 round	5/8	90	120 00
125748	No. 000 round	5/8	90	120 00
125750	No. 0000 round	5/8	90	120 00
82671	No. 00–0000 grooved	5/8	85	120 00
125752	No. 0–00 Fig. 8	5/8	85	120 00
125753	No. 000–0000 Fig. 8	5/8	85	120 00

TYPE F-6 STRAIGHT LINE EAR

Malleable Iron—Sherardized—Length, 9 Inches

Style No.	Size Trolley Wire	Diam. Tap, Inches	Per 100 Wt., Lbs.	Per 100 List Price
125754	No. 00–0000 grooved	5/8	115	70 00
	Bronze—Length, 9 Inches			
125755	No. 00–0000 grooved	5/8	125	160 00

TYPE F EARS—Continued

TYPE F CURVE EARS

Malleable Iron—Sherardized—Length, 10 Inches

Style No.	Size Trolley Wire	Diam. Tap, Inches	Per 100 Wt., Lbs.	Per 100 List Price
49372	No. 00–0000 grooved	⅝	100	84 00
120484	No. 0–00 Fig. X	⅝	100	84 00
120485	No. 000–0000 Fig. 8	⅝	100	84 00

Composition—Length, 10 Inches

49373	No. 00–0000 grooved	⅝	110	170 00

Malleable Iron—Sherardized—Length, 14 Inches

Style No.	Size Trolley Wire	Diam. Tap, Inches	Per 100 Wt., Lbs.	Per 100 List Price
152937	No. 00–0000 grooved	⅝	185	110 00
152938	No. 00–0000 Fig. 8	⅝	185	110 00

TYPE FP FEEDER EAR

Composition—Length, 4 Inches

Lug will engage a feed wire up to ½ inch diameter.

Style No.	Size Trolley Wire	Per 100 Wt., Lbs.	Per 100 List Price
251711	00–0000 grooved	50	$100 00

TYPE F EARS—Continued

TYPE F FEEDER EARS
Tinned For Soldering

Composition—Length, 4 Inches

Style No.	Size Trolley Wire		Diam. Tap, Inches	Per 100 Wt., Lbs	Per 100 List Price
125725	No. 0	round	5/8	80	$120 00
125726	No. 00	round	5/8	80	120 00
125727	No. 000	round	5/8	80	120 00
125729	No. 0000	round	5/8	80	120 00
125247	No. 00–0000	grooved	5/8	80	120 00
125731	No. 0–00	Fig. 8	5/8	80	120 00
125732	No. 000–0000	Fig. 8	5/8	80	120 00

Composition—Length, 7 Inches

Style No.	Size Trolley Wire		Diam. Tap, Inches	Per 100 Wt., Lbs.	Per 100 List Price
125733	No. 0	round	5/8	115	140 00
125734	No. 00	round	5/8	115	140 00
125735	No. 000	round	5/8	115	140 00
125737	No. 0000	round	5/8	115	140 00
48653	No. 00–0000	grooved	5/8	105	140 00
125547	No. 0–00	Fig. 8	5/8	105	140 00
109341	No. 000–0000	Fig. 8	5/8	105	140 00

Composition—Length, 7 Inches

Style No.	Size Trolley Wire		Diam. Tap, Inches	Per 100 Wt., Lbs.	Per 100 List Price
160905	No. 00–0000	grooved	..	90	120 00

TYPE F EARS—Continued

TYPE F STRAIN EAR
Tinned For Soldering
Double Strain

Malleable Iron—Sherardized—Length, 12 Inches

Style No.	Size Trolley Wire	Diam. Tap, Inches	Per 100 Wt., Lbs.	Per 100 List Price
82735	No. 00–0000 grooved	5/8	145	$140 00
125756	No. 0–00 Fig. 8	5/8	145	140 00
125757	No. 000–0000 Fig. 8	5/8	145	140 00
	Composition—Length, 12 Inches			
47933	No. 00–0000 grooved	5/8	160	225 00
125758	No. 0–00 Fig. 8	5/8	160	225 00
125759	No. 000–0000 Fig. 8	5/8	160	225 00

TYPE F-4 HALF STRAIN EAR

Composition—Length, 8 Inches

Style No.	Size Trolley Wire	Per 100 Wt., Lbs.	Per 100 List Price
126269	No. 00–0000 grooved	100	$100 00
126270	No. 0–00 Fig. 8	90	100 00
126271	No. 000–0000 Fig. 8	95	100 00

TYPE F-6 HALF STRAIN

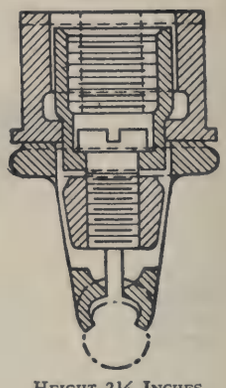
Malleable Iron—Sherardized—Length, 12 Inches

Style No.	Size Trolley Wire	Per 100 Wt., Lbs.	Per 100 List Price
171653	No. 00–0000 groove	150	$140 00

WESTINGHOUSE MINE CLAMPS

TYPE RE MINE CLAMP
For Round, Groove, and Figure 8 Wire

MALLEABLE IRON SHERARDIZED—LENGTH 3 INCHES



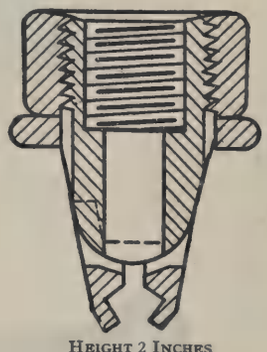
HEIGHT 2¼ INCHES

This clamp embodies in its make-up all of the desirable features of a mine clamp, perfect wheel clearance, little head room, ease of installation, minimum weight, and is fool proof. It can be tightened on the suspension to a locked joint between the shoulder and the boss of the clamp regardless of the alignment of the trolley wire.

Style No.	Size Wire	Diam. Tap, Inches	Per 100 Wt., Lbs.	Per 100 List Price
180417	No. 00–0000 groove	⅝	65	66 00
180418	No. 00–0000 Fig. 8	⅝	65	66 00
220287	No. 00 round	⅝	65	66 00
221308	No. 000–0000 round	⅝	65	66 00
239225	No. 0 round—bronze jaws	⅝	65	110 00

TYPE RE-1 MINE CLAMP

MALLEABLE IRON SHERARDIZED—LENGTH 3 INCHES



HEIGHT 2 INCHES

This clamp is similar to the type RE except that it does not have the aligning feature. It is usually used where suspensions are attached to the mine roof with expansion bolts. It has exceptionally good wheel clearance, is very low and is mechanically strong.

Style No.	Size Wire	Diam. Tap. Inches	Per 100 Wt., Lbs.	Per 100 List Price
279361	No. 00–0000 grooved	⅝	65	$51 00
280229	No. 00–0000 Fig. 8	⅝	65	51 00

Type BF wrenches for installing types RE and RE-1 mine clamps are listed in part VII of this section.

Order by Style Number

WEDGE TYPE CLAMP

MALLEABLE IRON SHERARDIZED—LENGTH 4 INCHES

END VIEW SHOWING WHEEL CLEARANCE

This wedge clamp consists of four parts, 2 clamps, a housing and a pin. It can be very easily installed by driving the wedge home by means of a hammer or any tool at hand. When the wedge is driven tight, it will not loosen. The lips fit the wire for which they are made perfectly, and give a maximum of wheel clearance. The clamp can be supplied for grooved and Figure 8 wire.

Style No.	Description	Diam. Tap Inches	Per 100 Wt., Lbs.	Per 100 List Price
289070	00–0000 Grooved wire	⅝	100	$62 50
291611	00–0000 Figure Eight wire	⅝	100	62 50

MECHANICAL FEEDER CLAMP

TYPE RE-1

COMPOSITION LENGTH—3 INCHES

This clamp is the same as the Type RE-1 except that it is made of Bronze and with a lug as part of one lip to take a 4/0 Feed Wire.

Style No.	Description	Diam. Tap Inches	Per 100 Wt., Lbs.	Per 100 List Price
285471	2/0 to 4/0 Grooved wire	⅝	81	$125 00
285472	2/0 to 4/0 Figure Eight wire	⅝	81	125 00

TYPE C SUSPENSIONS—Continued

DOUBLE CURVE

Style No.	Description	Diameter Stud, Inches	Per 100 Wt., Lbs.	Per 100 List Price
54928	Complete	5/8	345	$172 00
54930	Malleable iron body and cap sherardized	..	277	116 00

STRAIGHT LINE—DOUBLE TROLLEY—6-INCH CENTERS

Style No.	Description	Diameter Stud Inches	Per 100 Wt., Lbs.	Per 100 List Price
82655	Complete	5/8	572	$397 00
82773	Malleable iron body and cap sherardized	..	436	285 00

SINGLE CURVE—DOUBLE TROLLEY—6-INCH CENTERS

Style No.	Description	Diameter Stud, Inches	Per 100 Wt., Lbs.	Per 100 List Price
82661	Complete	5/8	600	$472 00
82776	Malleable iron body and cap sherardized	..	464	360 00

STANDARD SPLICING SLEEVES

These splicing sleeves have a safe mechanical strength and are at the same time slender enough not to interfere with the smooth running of the trolley wheel. Machines of extreme precision are employed in the manufacture of these splicers. High grade drawn brass rod is used.

Style No.	Size Trolley Wire	Length and Greatest Diameter, Inches	Wt., Lbs.	Per 100 List Price
87514	No. 0 round	10 x 5/8	48	$132 00
87513	No. 0 round	15 x 5/8	75	180 00
87516	No. 00 round or 0 grooved	10 x 11/16	45	132 00
87515	No. 00 round or 0 grooved	16 x 11/16	76	200 00
141145	No. 00 round or 0 grooved	18 x 11/16	84	270 00
92232	No. 000 round or 00 grooved	11 x 3/4	70	200 00
87517	No. 000 round or 00 grooved	18 x 3/4	115	300 00
92233	No. 0000 round or 000 grooved	12 x 7/8	104	270 00
87518	No. 0000 round or 000 grooved	20 x 7/8	174	420 00
92234	No. 0000 grooved	12 x 7/8	104	270 00
87519	No. 0000 grooved	20 x 7/8	164	420 00

EMERGENCY SPLICING SLEEVES

This is a mechanical splicer in which the trolley wire is held by means of tempered steel wedges as shown in cut. Two of these wedges are furnished with each splicer. Each size of splicer has a mechanical strength greater than the wire which it is intended to hold. No soldering is necessary.

Made of Extra Strong Composition

Style No.	Size Trolley Wire	Length, Inches	Greatest Diam., Inches	Per 100 Wt., Lbs.	Per 100 List Price
247941	No. 0 round	10	11/16	69	$130 00
247942	No. 00 round or 0 grooved	10	3/4	70	140 00
247943	No. 000 round or 00 grooved	10	13/16	83	160 00
247944	No. 0000 round or 000 grooved	15	7/8	120	200 00
247945	No. 0000 grooved	15	11/16	137	220 00
247946	No. 0 round in one end and 00 grooved in other end	10	11/16	85	160 00
		10	..	63	140 00
247947	No. 00 Fig. 8	15	..	100	200 00
247948	No. 000 Fig. 8	15	..	159	220 00
247949	No. 0000 Fig. 8	..	..	...	6 00
140183	Extra steel wedges for above				

CLARK SPLICING EARS

WITHOUT BOSS

FORM 1
COMPOSITION—LENGTH, 12 INCHES

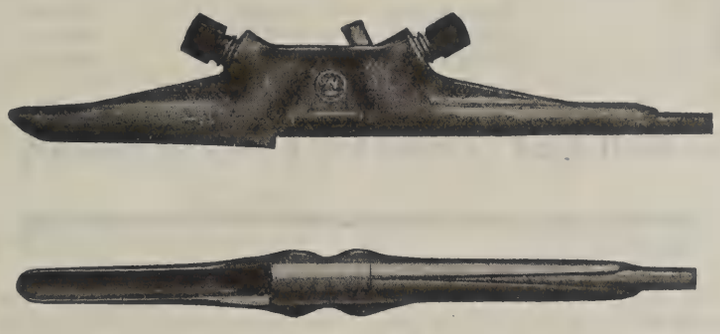
WITH BOSS

FORM 3
COMPOSITION—LENGTH, 15 INCHES

Style No.	Form	Size Wire	Diam. Top, Inches	Per 100 Wt., Lbs.	Per 100 List Price
		Length, 12 inches without Boss			
125794	1	No. 0 Fig. 8	No boss	85	$176 00
125795	1	No. 00 Fig. 8	No boss	90	194 00
119890	1	No. 000 Fig. 8	No boss	100	216 00
119891	1	No. 0000 Fig. 8	No boss	105	230 00
		Length, 15 Inches with Boss			
154794	3	No. 0 Fig. 8	5/8	150	290 00
154795	3	No. 00 Fig. 8	5/8	150	300 00
154796	3	No. 000 Fig. 8	5/8	165	320 00
154797	3	No. 0000 Fig. 8	5/8	165	340 00
		Combination Splicers with Boss			
121561	3	No. 0 round and 00 Fig. 8	5/8	115	320 00
126387	3	No. 00 round and 00 Fig. 8	5/8	115	330 00
121562	3	No. 000 round and 00 Fig. 8	5/8	125	340 00
151111	3	No. 0000 rd. and 0000 Fig. 8	5/8	160	350 00

TYPE U TROLLEY WIRE SPLICERS

This is an improved trolley wire splicer with the same type of approach as that used in the Westinghouse-Cleveland Splicer. The approach encircles the trolley wire where it bends to enter the splicer proper and tapers off to the end of the approach leaving a V-shaped exposure of the trolley wire at that point, allowing a smooth passage of the trolley wheel when passing under the splicer These splicers are made of high grade bronze composition. The wire is held by ½-inch x 1-inch sherardized cup pointed set screws.



STYLE No. 279145

WITHOUT BOSS—COMPOSITION—LENGTH 10 INCHES

Style No.	Size Wire	Per 100 Weight Lbs.	Per 100 List Price
279145	No. 0 and 00 Round and Grooved	100	$170 00
279146	No. 000 Round and Grooved	120	180 00
279147	No. 0000 Round and Grooved	130	200 00

STYLE No. 279148

WITH ⅝-INCH BOSS—COMPOSITION—LENGTH 15 INCHES

Style No.	Size Wire	Per 100 Weight Lbs.	Per 100 List Price
279148	No. 0 and 00 Round and Grooved	185	$275 00
279149	No. 000 Round and Grooved	190	285 00
279151	No. 0000 Round and Grooved	210	300 00

Order by Style Number

WESTINGHOUSE TROLLEY WIRE CHUCKS

For Round, Grooved, and Fig. 8 Wires

These chucks, or tapered split sleeves, are made of special steel and are sherardized. They are intended for use with the following devices only:

Westinghouse Cleveland splicers—for round and grooved wires only.

Westinghouse type KB section insulators—for round, grooved, and Fig. 8 wires.

Westinghouse automatic section insulators—for round, grooved, and Fig. 8 wires.

Any given size of chuck will securely hold a new wire of the size indicated or the same size wire which is worn to the equivalent of one size smaller.

Size Wire	Round Wire	Grooved Wire	Fig. 8 wire	List Price Per 100
0	167524	162416	145973	$42 00
00	162416	167525	145974	42 00
000	167526	167527	145975	42 00
0000	167528	167529	145976	42 00

TROLLEY PROTECTING ARMOR

These armors offer an excellent means of reducing the wear on the trolley wire at or near suspension points, frogs, crossings, and section insulators, thereby greatly prolonging the life of the wire, reducing maintenance cost, and minimizing trouble calls.

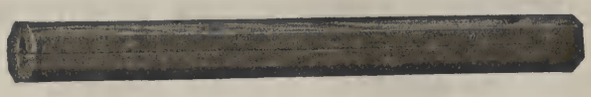
Very frequently trolley wire becomes worn to its safe limit in certain places, but it may be desired to defer making a renewal of the wire. In such cases, these armors may be employed to excellent advantage.

Made of sheet brass or cold rolled copper .04 inch thick, in four-foot lengths and bent in U shape to permit of easy attachment to wire.

Size Trolley Wire			Approx. Wt., Lbs. Per 100	Style No.		List Price Per 100
Round	Grooved	Fig. 8		Brass	Copper	
0	....	....	60	135087	135094	$240 00
00	0	0	65	135088	135095	250 00
000	00	....	75	135089	135096	260 00
....	000	00	75	135090	135097	270 00
0000	....	000	80	135091	135098	300 00
....	0000	....	85	135092	135099	315 00
	....	0000	90	135093	135100	335 00

WOODEN CONTACT INSULATORS

This form of insulator is used to prevent feeder and electric light wires from coming into contact with trees or with each other. They are made in halves, of seasoned hard wood, thoroughly impregnated to exclude moisture and to prevent deterioration, and are grooved in the center to fit the wire.



Style No.	Length, Inches	Diam. Hole, Inches	Per 100 Wt., Lbs.	Per 100 List Price
126962	12	⅝	42	$32 00
126966	12	⅞	84	34 00
126970	12	1⅛	141	40 00
126963	18	⅝	63	36 00
126967	18	⅞	126	36 00
126971	18	1⅛	211	42 00

TROLLEY FROGS

DETROIT TROLLEY FROGS

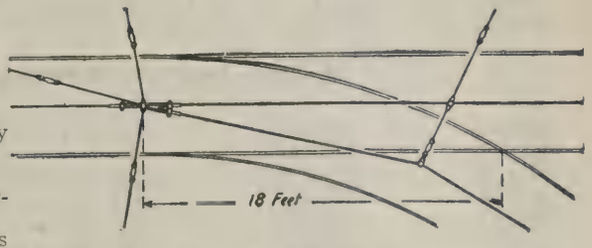
The inherent short-comings of the "old style" frog, which until recently was in such general use, are properly chargeable with a large percentage of the total overhead maintenance cost and with most of the troubles resulting from "wild" trolley wheels. With that frog it is necessary to use three different angles of divergence depending upon the degree of track turn-out. If the number of cars in one direction is greater than in the other, the resulting wear of the frog on the pan will often misguide the wheel. The "old style" trolley frog must be placed so far in advance of the switch point that the extreme angularity of the trolley wheel on the wire results in the rapid wearing away of the latter.

All of these troubles disappear with the use of the Westinghouse-Detroit frog when installation is made in accordance with the very simple directions given below.

This frog is the original Detroit pattern with only such improvements as have been approved by the original designer. It has been used by several large companies for the past 20 years.

Advantages—The advantages of this frog may be summed up as follows:

1. It is very strong and cannot buckle.
2. It is and will always remain smooth under-running.
3. The wheel travels but a short distance on its flanges; this reduces arcing and prolongs the life of frog and wheel.
4. The groove in the pan prevents wobbling of the wheel and prevents the wheel from taking the turn-out when the car is passing on the straight line with a defective trolley wheel or with inferior track conditions. At the same time this groove never prevents the wheel from following the car into the turn-out.
5. It is made only in the one angle (12 degrees) and can be used on any turn-out regardless of the degree of curvature.
6. It can be placed farther from the track frog, and thus nearer to the switch point, than is possible with the "old style" trolley frog, thereby providing a more natural path for the wheel by minimizing its angular position on the wire, prolonging the life of the wire accordingly, and preventing disengagement of the wheel.
7. The curve wire may be run through the frog and dead-ended in a strain guy, relieving the straight line of undue strains and permitting the frog to be readjusted or renewed without disturbing the line and without the use of block and tackle.
8. The frog is provided with composition approaches, the length and flexibility of which are such that the wheel takes the frog without any impact or hammer blow, thus preventing crystallization of the wire.
9. It has ample space and has a "preventer" on the double end. This prevents a wild wheel from jamming and makes unnecessary an additional preventer.
10. It will outlast five or six "old style" frogs.



Directions for Installing—On all curves up to and including an 80-foot radius and when the trolley wire is from 18 to 20 feet high, the center of the Detroit frog should always be placed over a point 18 feet from the track frog toward the switch point. On longer radius curves this distance is increased accordingly. In this position the angle of the frog (12 degrees) will be maintained to the first single curve pull-over, provided the latter is properly located.

For Any Degree of Turnout

The bodies of these frogs are made of malleable iron sherardized or composition and are complete with composition flexible approaches. These approaches are fastened to the body with stove bolts. All malleable castings and steel bolts are sherardized.

Style Nos. Malleable Iron Bodies	Style Nos. Composition Bodies	Turn-out	Size and Type of Wire	Overall Length Inches	Net Wt.	Each List Price Malleable Iron Bodies	Each List Price Composition Bodies
167514*	167510*	Right-hand	00 round or grooved	37½	14	$11 00	$16 00
146360	146356	Right-hand	000 round or grooved	37½	14	11 00	16 00
146361	146357	Right-hand	0000 round or grooved	37½	14	11 00	16 00
183148	159493	Right-hand	00 Fig. 8	37½	14	11 00	16 00
183149	159494	Right-hand	000 Fig. 8	37½	14	11 00	16 00
183150	159495	Right-hand	0000 Fig. 8	37½	14	11 00	16 00
167516*	167512*	Left-hand	00 round or grooved	37½	14	11 00	16 00
146370	146366	Left-hand	000 round or grooved	37½	14	11 00	16 00
146371	146367	Left-hand	0000 round or grooved	37½	14	11 00	16 00
183151	159497	Left-hand	00 Fig. ■	37½	14	11 00	16 00
183152	159498	Left-hand	000 Fig. ■	37½	14	11 00	16 00
183153	159499	Left-hand	0000 Fig. ■	37½	14	11 00	16 00

*Covers frogs specially adapted for use with shallow 3 and 4-inch wheels. These will work equally well with the standard interurban wheel.

V-Shaped Detroit Frogs

Style Nos. Malleable Iron Body	Style Nos. Composition Body	Size and Type of Wire	Net Wt.	Each List Price Malleable Iron Bodies	Each List Price Composition Bodies
162390	162386	00 round or grooved†	14	$11 00	$16 00
162391	162387	000 round or grooved†	14	11 00	16 00
162392	162388	0000 round or grooved†	14	11 00	16 00

†Can be furnished for Fig. ■ wire when specified.

TYPE BR TROLLEY FROGS

The Trolley Wheel Never Travels On Its Flanges

15 Degrees

The type BR frog can be installed nearer to a point directly over the track switch-point than any other type, thereby increasing the life of the trolley wire on the straight line approaching the frog by preventing the grind of the trolley wheel riding angularly at this point.

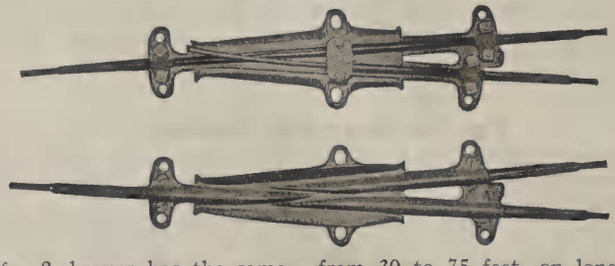
There is no bump to the wheel while passing through the type BR frog, and higher speeds can be obtained on account of practically a continuous contact of the tread of the wheel during the period of transition.

Trolley wheels last longer when operating in connection with the type BR frog, as the flange is not subjected to frictional wear at this point.

Malleable Iron Body Sherardized With Bronze Approaches

Style No.	Turnout	Size and Type of Wire	Overall Length, Inches	Each: Net Wt., Lbs.	Each: List Price
221271	Right-hand	00 round or grooved	32	13¾	$9 00
221272	Right-hand	000 round or grooved	32	13¾	9 00
221273	Right-hand	0000 round or grooved	32	13¾	9 00
221274	Right-hand	00 Fig. [illegible]	32	13¾	9 00
221275	Right-hand	000 Fig. 8	32	13¾	9 00
221276	Right-hand	0000 Fig. [illegible]	32	13¾	9 00
221277	Left-hand	00 round or grooved	32	13¾	[illegible] 00
221278	Left-hand	000 round or grooved	32	13¾	9 00
221279	Left-hand	0000 round or grooved	32	13¾	9 00
221280	Left-hand	00 Fig. [illegible]	32	13¾	9 00
221281	Left-hand	000 Fig. 8	32	13¾	9 00
221282	Left-hand	0000 Fig. [illegible]	32	13¾	9 00

8 Degrees



The type BR frog for 8 degrees has the same general characteristics as the 15-degree type BR frog. While the 15-degree frog lends itself admirably to city work on curves, having a radius of from 30 to 75 feet, on longer radius curves the 8-degree is better adapted. For high-speed interurban work where long turnouts on sidings are used, the 8-degree frog gives better results.

Malleable Iron Body Sherardized With Bronze Approaches

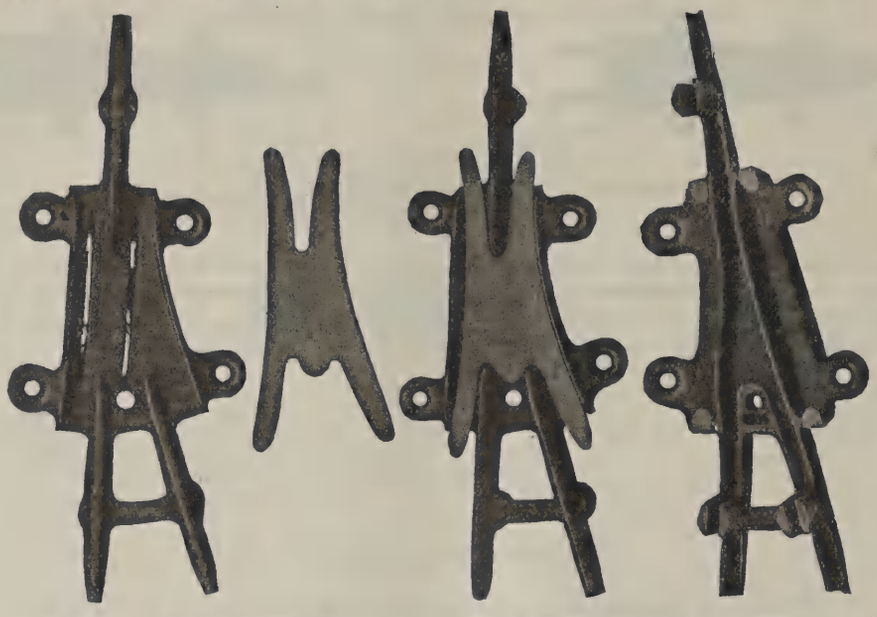
Style No.	Turnout	Size and Type of Wire	Overall Length, Inches	Each: Net Wt., Lbs.	Each: List Price
237026	Right-hand	00 round or grooved	32	13¾	$9 00
237027	Right-hand	000 round or grooved	32	13¾	9 00
237028	Right-hand	0000 round or grooved	32	13¾	[illegible] 00
237029	Right-hand	00 Fig. 8	32	13¾	[illegible] 00
237030	Right-hand	000 Fig. 8	32	13¾	[illegible] 00
237031	Right-hand	0000 Fig. 8	32	13¾	9 00
237032	Left-hand	00 round or grooved	32	13¾	[illegible] 00
237033	Left-hand	000 round or grooved	32	13¾	9 00
237034	Left-hand	0000 round or grooved	32	13¾	9 00
237035	Left-hand	00 Fig. 8	32	13¾	9 00
237036	Left-hand	000 Fig. 8	32	13¾	9 00
237037	Left-hand	0000 Fig. [illegible]	32	13¾	[illegible] 00

BRONZE TROLLEY FROGS

These frogs are made of high strength copper alloy. The wire is held by malleable iron jam nuts. The frog has four pull-off rings which insures perfect adjustment of position when making installation. Frogs are listed both with and without wearing plates. A wearing plate or half sole should be used to prolong the life of these frogs at points where the traffic is heavy.

Style No. without Wearing Plate	Style No. with Wearing Plate	Description	Net Weight	Each — List Price without Wearing Plate	Each — List Price with Wearing Plate
		Twenty Degree Angle			
124755	125909	Right hand for No. 1–0 or 2–0 round or groove wire	7	8 40	8 60
249377	159464	Right hand for No. 1–0 or 2–0 Figure 8 wire	7	8 40	8 60
82711	125910	Right hand for No. 3–0 or 4–0 round or groove wire	7½	9 00	9 20
249378	159465	Right hand for No. 3–0 or 4–0 Figure 8 wire	7½	9 00	9 20
124756	125911	Left hand for No. 1–0 or 2–0 round or groove wire	7	8 40	8 60
249379	159466	Left hand for No. 1–0 or 2–0 Figure 8 wire	7	8 40	8 60
82712	125912	Left hand for No. 3–0 or 4–0 round or groove wire	7½	9 00	9 20
249380	159467	Left hand for No. 3–0 or 4–0 Figure 8 wire	7½	9 00	9 20
124757	125913	V-shape for No. 1–0 or 2–0 round or groove wire	7	8 40	8 60
249381	159468	V-shape for No. 1-0 or 2-0 Figure 8 wire	7	8 40	8 60
82713	125914	V-shape for No. 3–0 or 4–0 round or groove wire	7½	9 00	9 20
249382	159469	V-shape for No. 3–0 or 4–0 Figure 8 wire	7½	9 00	9 20
		Fifteen Degree Angle			
82714	125916	Right hand for No. 1–0 to 4–0 round or groove wire	8	10 50	10 70
249383	159470	Right hand for No. 1–0 to 4–0 Figure 8 wire	8	10 50	10 70
82715	125918	Left hand for No. 1–0 to 4–0 round or groove wire	8	10 50	10 70
249384	159471	Left hand for No. 1–0 to 4–0 Figure 8 wire	8	10 50	10 70
82716	125920	V-shape for No. 1–0 to 4–0 round or groove wire	8	10 50	10 70
249385	159472	V-shape for No. 1–0 to 4–0 Figure 8 wire	8	10 50	10 70
		Eight Degree Angle			
82717	125922	Right hand for No. 1–0 to 4–0 round or groove wire	9	13 00	13 20
249386	159473	Right hand for No. 1–0 to 4–0 Figure 8 wire	9	13 00	13 20
82718	125924	Left hand for No. 1–0 to 4–0 round or groove wire	9	13 00	13 20
249387	159474	Left hand for No. 1–0 to 4–0 Figure 8 wire	9	13 00	13 20
82719	125926	V-shape for No. 1–0 to 4–0 round or groove wire	9	13 00	13 20
249388	159475	V-shape for No. 1–0 to 4–0 Figure 8 wire	9	13 00	13 20

WEARING PLATES FOR TROLLEY FROGS AND CROSSINGS



This device consists of die-punched shapes of special iron, 1/16-inch thick, fitting the pans of the various frogs and crossings as specified below. They prevent the trolley wheel from wearing and cutting into the pan and thus give a much longer life of the frog or crossing. They can be readily attached to old style frogs and crossings which are already on the line, by simply placing the plate in position and bending the ends over the edges of the pan. No special tools or solder are required.

Style No.	Adaptation	Per 100 Wt., Lbs.	Per 100 List Price
125927	For 20 degree right-hand or left-hand frogs	50	$20 00
125928	For 20 degree V-shape frogs	50	20 00
125929	For 15 degree right-hand or left-hand frogs	50	20 00
125930	For 15 degree V-shaped frogs	50	20 00
125931	For 8 degree right-hand, left-hand or V-shape frogs	50	20 00
127205	For 30–90 degree adjustable crossings, No. 127209 and No. 123917	50	20 00
127206	For 90 degree rigid crossings, No. 127210 and No. 49380	50	20 00
127207	For 35 degree rigid crossing, No. 126032	50	20 00
127208	For 15 degree rigid crossing, No. 49383	50	20 00

FLEXIBLE APPROACHES

These approaches are made of high-grade composition metal, six inches long, and are adapted for use in connection with Westinghouse-Detroit frogs, Westinghouse metallic crossings, Westinghouse insulated adjustable crossings, and Westinghouse section insulators. Sherardized stove bolts or carriage bolts will be included when specified. If not specified, approaches will be shipped without bolts.

For Round or Grooved Wire

For Fig. 8 Wire

Style No.	Size and Type of Wire	Per 100 Wt., Lbs.	Per 100 List Price
241022	0 round or grooved	65	$100 00
188424	00 round or grooved	70	100 00
188425	000 round or grooved	75	100 00
188426	0000 round or grooved	80	100 00
188427	0 Figure 8	65	100 00
188428	00 Figure 8	70	100 00
188429	000 Figure 8	75	100 00
188430	0000 Figure 8	80	100 00

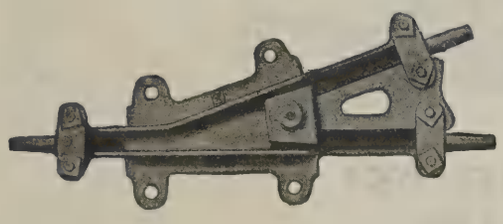
TYPE MK TROLLEY FROGS

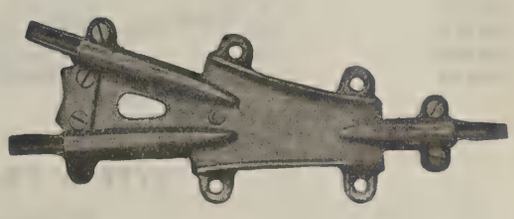
Malleable Iron Body Sherardized With Bronze Approaches

15 Degrees

Style No.	Turnout	Size and Type of Wire	Overall Length Inches	Each — Net Wt. Lbs.	Each — List Price
246732	Right-hand	00 round or grooved	21″	10	$7 60
246733	Right-hand	000 round or grooved	21″	10	7 60
246734	Right-hand	0000 round or grooved	21″	10	7 60
246735	Right-hand	00 Fig. 8	21″	10	7 60
246736	Right-hand	000 Fig. 8	21″	10	7 60
246737	Right-hand	0000 Fig. 8	21″	10	7 60
246738	Left-hand	00 round or grooved	21″	10	7 60
246739	Left-hand	000 round or grooved	21″	10	7 60
246740	Left-hand	0000 round or grooved	21″	10	7 60
246741	Left-hand	00 Fig. 8	21″	10	7 60
246742	Left-hand	000 Fig. 8	21″	10	7 60
246743	Left-hand	0000 Fig. 8	21″	10	7 60

20 Degrees





Style No.	Turnout	Size and Type of Wire	Overall Length Inches	Each — Net Wt. Lbs.	Each — List Price
246720	Right-hand	00 round or grooved	18″	9	$7 10
246721	Right-hand	000 round or grooved	18″	9	7 10
246722	Right-hand	0000 round or grooved	18″	9	7 10
246723	Left-hand	00 round or grooved	18″	9	7 10
246724	Left-hand	000 round or grooved	18″	9	7 10
246725	Left-hand	0000 round or grooved	18″	9	7 10
246726	Right-hand	00 Fig. 8	18″	9	7 10
246727	Right-hand	000 Fig. 8	18″	9	7 10
246728	Right-hand	0000 Fig. 8	18″	9	7 10
246729	Left-hand	00 Fig. 8	18″	9	7 10
246730	Left-hand	000 Fig. 8	18″	9	7 10
246731	Left-hand	0000 Fig. 8	18″	9	7 10

TROLLEY FROGS—Continued

TYPE RF TROLLEY FROGS

15 Degrees

Composition Body

All styles are complete with Westinghouse composition flexible approaches. All malleable iron fittings and steel bolts are sherardized.

This type has ample space and a "preventer" on the double end to prevent a wild wheel from jamming. It also has wedges which hold the wire in place while renewing approaches. The over-all length is 33 inches with approaches.

This frog is made only in composition.

Style No.	Turnout	Size and Type of Wire	Each Wt., Lbs.	Each List Price
188335	Right-hand	00 round or grooved	15	$14 00
188336	Right-hand	000 round or grooved	15	14 00
188337	Right-hand	0000 round or grooved	15	14 00
188341	Right-hand	00 Figure 8	15	14 00
188342	Right-hand	000 Figure 8	15	14 00
188343	Right-hand	0000 Figure 8	15	14 00
188338	Left-hand	00 round or grooved	15	14 00
188339	Left-hand	000 round or grooved	15	14 00
188340	Left-hand	0000 round or grooved	15	14 00
188344	Left-hand	00 Figure 8	15	14 00
188345	Left-hand	000 Figure 8	15	14 00
188346	Left-hand	0000 Figure 8	15	14 00

TYPE W TROLLEY FROGS

15 Degrees, 3 Way

Composition Body

All styles are complete with Westinghouse composition flexible approaches. All malleable iron castings and steel bolts are sherardized.

This type of frog has ample space and "preventers" on the three-way end, thus preventing a wild wheel from jamming. It also has wedges which hold the wire in place while renewing approaches. The over-all length is 2 feet 9½ inches with approaches.

This frog is made only in composition.

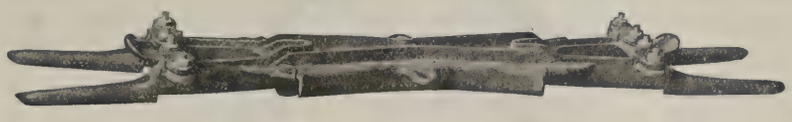
Style No.	Size and Type of Wire	Each Wt., Lbs.	Each List Price
186838	00 round or grooved	18½	$20 00
186839	000 round or grooved	18½	20 00
186840	0000 round or grooved	18½	20 00
188323	00 Figure 8	18½	20 00
188324	000 Figure 8	18½	20 00
188325	0000 Figure 8	18½	20 00

WESTINGHOUSE RIGID METALLIC CROSSINGS

The design of these crossings has been very carefully worked out so as to properly distribute the material, secure satisfactory transition of the wheel and obtain maximum life.

The bodies of these crossings are of malleable iron or composition metal and are complete with four Westinghouse composition flexible approaches. These approaches are fastened to the body of the crossing with stove bolts on the 15, 35, and 90-degree crossings and by carriage bolts on the 18 and 23-degree crossings. The carriage bolts are so placed in the end lugs that when a nut is unscrewed the bolt will not drop out. Wedges which hold the wire in place while the approaches are being renewed, are also supplied on the 18 and 23-degree crossing.

All malleable iron castings and steel bolts are sherardized.



15-Degree Crossing

18-Degree Crossing

35-Degree Crossing

Style Number — Malleable Iron Body	Style Number — Composition Body	Size and Type of Wire	Total Overall Length, Inches	Weight, Lbs.	Each — List Price — Malleable Iron Body	Each — List Price — Composition Body
		15-Degree Crossings				
181537	181534	00 round or grooved	35¾	15	$11 00	$16 00
181538	181535	000 round or grooved	35¾	15	11 00	16 00
181539	181536	0000 round or grooved	35¾	15	11 00	16 00
181543	181540	00 Figure 8	35¾	15	11 00	16 00
181544	181541	000 Figure 8	35¾	15	11 00	16 00
181545	181542	0000 Figure 8	35¾	15	11 00	16 00
		18-Degree Crossings				
181555	181552	00 round or grooved	35½	13	11 00	16 00
181556	181553	000 round or grooved	35½	13	11 00	16 00
181557	181554	0000 round or grooved	35½	13	11 00	16 00
181561	181558	00 Figure 8	35½	13	11 00	16 00
181562	181559	000 Figure 8	35½	13	11 00	16 00
181563	181560	0000 Figure 8	35½	13	11 00	16 00
		23-Degree Crossings				
181573	181570	00 round or grooved	30⅜	12	10 00	15 00
181574	181571	000 round or grooved	30⅜	12	10 00	15 00
181575	181572	0000 round or grooved	30⅜	12	10 00	15 00
181579	181576	00 Figure 8	30⅜	12	10 00	15 00
181580	181577	000 Figure 8	30⅜	12	10 00	15 00
181581	181578	0000 Figure 8	30⅜	12	10 00	15 00
		35-Degree Crossings				
181591	181588	00 round or grooved	23½	10	10 00	15 00
181592	181589	000 round or grooved	23½	10	10 00	15 00
181593	181590	0000 round or grooved	23½	10	10 00	15 00
181597	181594	00 Figure 8	23½	10	10 00	15 00
181598	181595	000 Figure 8	23½	10	10 00	15 00
181599	181596	0000 Figure 8	23½	10	10 00	15 00

RIGID METALLIC CROSSINGS—Continued

90-DEGREE CROSSING

Style Number — Malleable Iron Body	Style Number — Composition Body	Size and Type of Wire	Total Overall Length, Inches	Weight, Lbs.	Each — List Price — Malleable Iron Body	Each — List Price — Composition Body
		90-Degree Crossings				
181608	181605	00 round or grooved	23¾	11	$9 00	$12 00
181609	181606	000 round or grooved	23¾	11	9 00	12 00
181610	181607	0000 round or grooved	23¾	11	9 00	12 00
181614	181611	00 Figure 8	23¾	11	9 00	12 00
181615	181612	000 Figure 8	23¾	11	9 00	12 00
181616	181613	0000 Figure 8	23¾	11	9 00	12 00

ADJUSTABLE METALLIC CROSSINGS

For Angles of 30 to 90 Degrees

The bodies of these crossings are made of malleable iron or composition metal and are complete with four composition flexible approaches. All iron and steel parts are sherardized. Two forms are supplied.

Form 1 has approaches fastened to the body with stove bolts.

Form 2 has approaches fastened to body with carriage bolts and has deflector bars for preventing jamming due to a wild trolley wheel. Wedges are provided on Form 2 crossings for holding the wire in place while renewing approaches.

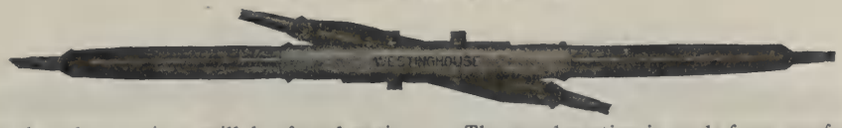
FORM 1—METALLIC

FORM 2—METALLIC

Style Number — Malleable Iron Body	Style Number — Composition Body	Size and Type of Wire	Weight, Lbs.	Each — List Price — Malleable Iron Body	Each — List Price — Composition Body
		Form 1			
181627	154072	00 round or grooved	18	$12 00	$16 00
181628	157151	000 round or grooved	18	12 00	16 00
181629	157152	0000 round or grooved	18	12 00	16 00
181633	181630	00 Figure 8	18	12 00	16 00
181634	181631	000 Figure 8	18	12 00	16 00
181635	181632	0000 Figure 8	18	12 00	16 00
		Form 2			
181645	181642	00 round or grooved	20	13 00	17 00
181646	181643	000 round or grooved	20	13 00	17 00
181647	181644	0000 round or grooved	20	13 00	17 00
181651	181648	00 Figure 8	20	13 00	17 00
181652	181649	000 Figure 8	20	13 00	17 00
181653	181650	0000 Figure 8	20	13 00	17 00

RIGID INSULATED CROSSINGS

For Voltages Up to 750



These fixed-angle crossings will be found satisfactory for any angle of crossing within three degrees over or under the rated angle. A continuous wire may rest in the groove on the top of the wood body or the wire may be terminated at the clamps. Similarly, the crossing pan wire may be attached without cutting the wire.

The wood portion is made from carefully selected straight-grained hickory, air dried and impregnated. The end castings and the crossing pan are the same high-grade composition metal which we use for all similar work. These crossings are adapted for round or grooved wires.

Style No.	Crossing Angle	Overall Length, Inches	Each Wt., Lbs.	Each List Price
119317	15-degree, right-hand	49½	18	$36 00
147946	15-degree, left-hand	49½	18	36 00
177321	20-degree, right-hand	58	22	36 00

TYPE KD ADJUSTABLE INSULATED CROSSINGS

For Voltages Up to 750

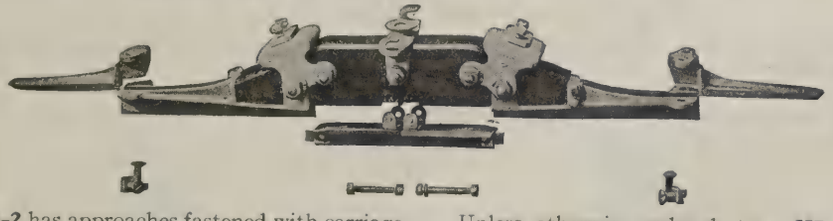
The type KD adjustable insulated crossing consists of a length of carefully selected straight-grained hickory, air dried and impregnated, and attached to which are malleable iron or composition end castings and a metallic crossing adjustable from 53 to 90 degrees. Westinghouse standard composition flexible approaches are included with all styles of this crossing. It is not necessary to cut either of the trolley wires. The over-all length, including the approaches, is 47 inches.

Style Number: Malleable Iron End Castings	Style Number: Compositon End Castings	Size and Type of Wire	Wt., Lbs.	Each List Price: Malleable Iron End Castings	Each List Price: Composition End Castings
163691	163687	00 round or grooved	19	$30 00	$35 00
163692	163688	000 round or grooved	19	30 00	35 00
163693	163689	0000 round or grooved	19	30 00	35 00

SECTION INSULATORS

TYPES HR AND HR-2 SECTION INSULATORS—750 Volts

These section insulators consist of a length of second-growth hickory, impregnated to exclude moisture, complete with malleable iron or composition end castings and Westinghouse composition flexible approaches. A feeder lug is part of each end casting. The fiber runner gives 8 inches of insulation and is made in two parts either of which is readily renewed by simply removing a bolt. The overall length is 3 feet 6⅜ inches with approaches. Two types are supplied.



Type HR-2 has approaches fastened with carriage bolts and is provided with wedges which hold the wire in place. Type HR has stove bolts, no wedges.

Unless otherwise ordered, type HR and HR-2 section insulators are furnished with the center support casting tapped for ⅝-inch stud.

Style Number: Type HR Malleable Iron End Castings	Style Number: Type HR Composition End Castings	Style Number: Type HR-2 Malleable Iron End Castings	Style Number: Type HR-2 Composition End Castings	Size of Wire	Wt., Lbs. Each	List Price Each: Type HR Malleable Iron End Castings	List Price Each: Type HR Composition End Castings	List Price Each: Type HR-2 Malleable Iron End Castings	List Price Each: Type HR-2 Composition End Castings
163667	163663	185370	185367	00 round or grooved	18	$16 00	$20 00	$16 50	$20 50
163668	163664	185371	185368	000 round or grooved	18	16 00	20 00	16 50	20 50
163669	163665	185372	185369	0000 round or grooved	18	16 00	20 00	16 50	20 50
184200	Complete extra runners. (Two required per insulator.)				1	2 60	2 60	2 60	2 60

TYPE KB SECTION INSULATORS
750 Volts

This section insulator is exceptionally strong and light. It cannot buckle. All wearing parts are easily renewed. Two strong, well seasoned and impregnated hickory bars take the stress.

Vertical slots are provided in the hickory bars. Into these slots the end castings fit. The stress is thus transmitted from the castings to the bars. The bolts take no shearing stresses merely clamp the end castings to the bars. The KB section insulator will sustain a greater tensile stress than will a Phono-Electric 4/0 wire.

Sherardized malleable iron caps enclose the ends of the hickory bars and effectively protect against splitting. They also protect the ends of the wood against injury from "wild" trolley wheels.

A renewable flexible approach is arranged at each end. The approach takes most of the wear and prevents crystallization of the trolley wire. It can be easily renewed without disturbing the body of the section insulator or the trolley wires.

A hard fiber runner is provided. It has bronze tips which take the brunt of the arcing. By removing two cotter keys, the runner can easily be reversed or renewed.

The bolt holding the supporting yoke to the side bars prevents the fiber runner from rising up, even though the arcing tips are worn through.

Tapered chucks, the same as are used with the Westinghouse-Cleveland splicers, securely hold the trolley wire in the end castings.

Feeder lugs are arranged on each end casting. This makes it possible to feed energy into either end of the section insulator, or to connect a "jumper" across it.

The middle casting (supporting yoke) is regularly furnished tapped for ⅝-inch stud. When ¾-inch tap is wanted, it must be so ordered.

The insulation distance is 7 inches and the length over all, including the flexible approaches, is 34½ inches.

All iron parts are sherardized. Runner is of fiber. Micarta runner, Style No. 225647, can be supplied, adding 50 cents to list price of insulator.

Style Number			Size Wire	Each	
Round Wire	Grooved Wire	Fig. 8 Wire		Wt., Lbs.	List Price
199175	199179	199183	0	15	$18 00
199176	199180	199184	00	15	18 00
199177	199181	199185	000	15	18 00
199178	199182	199186	0000	15	18 00
180318	Extra fiber runner for above			1	1 90
225647	Extra micarta runner for above			1	2 40

TYPE KB SECTION INSULATORS
1500 Volts

The 1500-volt type KB section insulator has 16 inches of insulation distance; overall length is 45½ inches; otherwise it is the same as the 750-volt insulator.

Style Number		Size Wire	Each	
Round Wire	Groove Wire		Wt., Lbs.	List Price
248525	248527	0	27	$20 00
248526	248528	00	27	20 00
248509	248511	000	27	20 00
248510	248512	0000	27	20 00
248515	Fiber runner for above		2	2 90
248516	Micarta runner for above		2	3 60

Regularly supplied with fiber runner. If wanted with micarta runner, 75 cents is added to list price of insulator.

MINE SECTION INSULATOR WITH SWITCH

Type SW—For Voltages Up to 600

(Patented September 11, 1917)

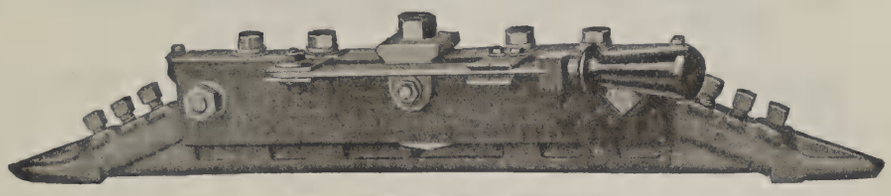


FIG. 1—WITH ONE SUPPORTING LUG

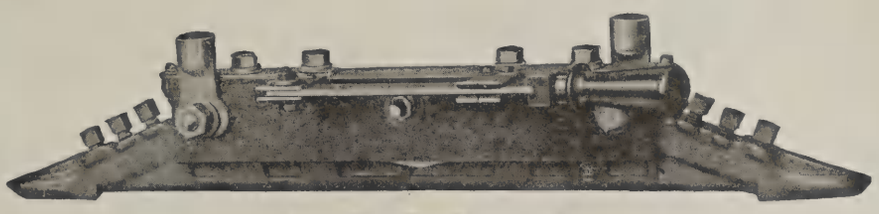


FIG. 2—WITH TWO SUPPORTING LUGS

This section insulator is for use in mines where it is desired to maintain sections of the trolley wire alive when needed, and dead otherwise. This saves electrical losses and protects the lives of workmen and animals.

Its construction is very rigid, it being specially designed for severe service. It consists of a heavy wooden beam made of straight-grained oil-impregnated air-dried hickory with bronze runner, approach, and switch.

The important feature of this section insulator is that the trolley wheel never engages the insulation member which is subject to no wear whatever. There are no movable parts in the runner to get out of order and there is no obstruction to the passage of the wheel when the switch is open. The bronze runner is separated by means of an air gap, the best insulating medium, so designed that it will allow the trolley wheel to pass over without arcing.

The switch is so designed that it does not reduce the headroom in either position and it can easily be shifted from right to left-hand side without disturbing the insulator. The hinged jaws hold the knife blade firmly by means of a phosphor-bronze stud.

The length overall of the insulator is 26½ inches; set screws are ½-inch by ⅞-inch sherardized.

These section insulators can be attached to the roof with the center supporting lug or with the two end supporting lugs, as desired.

Fig. 1 shows an insulator with one supporting lug, overall height only $4\frac{9}{16}$ inches. The center supporting lug has a swivel joint allowing of easy attachment.

Fig. 2 shows an insulator with two supporting lugs, overall height only $4\frac{13}{16}$ inches. These end lugs allow a lengthwise adjustment of 1¼ inches.

With One Supporting Lug

Style Number				Each	
Round Wire	Grooved Wire	Fig. 8 Wire	Size Wire	Wt., Lbs.	List Price
262939	262939	280452	2–0	12	$18 00
262939	262939	.....	3–0	12	18 00
262940	262940	262941	4–0	12	18 00

With Two Supporting Lugs

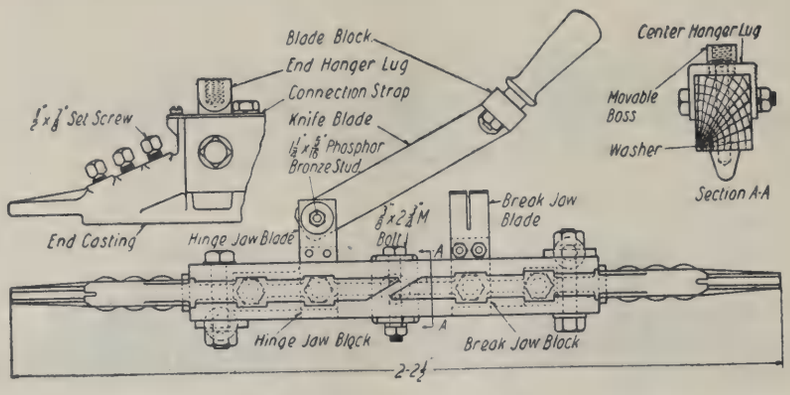
262942	262942	280453	2–0	12	18 00
262942	262942	.....	3–0	12½	18 00
262943	262943	262944	4–0	12½	18 00

Order by Style Number

840—65

SECTION INSULATORS—Continued

REPAIR PARTS FOR MINE SECTION INSULATOR WITH SWITCH

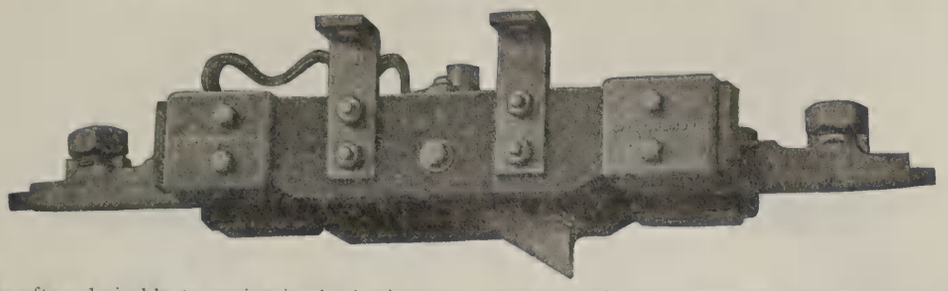


Style No.	Description	Per 100 Wt., Lbs.	Per 100 List Price
262925	End hanger lug, 2 per insulator	37½	32 00
262926	Hinge jaw block	17	36 00
262927	Break jaw block	16	40 00
262928	Knife blade	59	84 00
262929	Hinge jaw blade	8	24 00
262930	Break jaw blade	9	28 00
262931	Blade block	3	20 00
262932	Center hanger lug	66	28 00
262933	Connection strap	12	36 00
262934	1¼-inch x ⅝-inch phosphor bronze stud	3	12 00
263541	Movable boss	25	16 00

NOTE—Style No. 263541 and Style No. 262932 both required to make complete center hanger.

SECTION INSULATORS—Continued

AUTOMATIC SECTION INSULATORS—Patented—750 Volts



It is often desirable to maintain dead wires on branch sections of surface roads, or in mine entries, except at intervals when power is wanted. The value and utility of an entirely automatic device for this purpose is apparent. The illustrations show a combination section insulator and automatic line section switch which fully meets the requirements of the Pennsylvania Bituminous Mine Law, of 1911, section 41, page 67.

The trolley wheel of an in-bound car closes the switch and opens it on its return. Through the action of an ingenious device, the rocker which operates the switch cannot remain in an intermediate position. There is no arcing at the switch contact because the rocker is always energized regardless of whether the switch is open or closed.

By the use of this device, leakage losses are prevented and personal injuries averted.

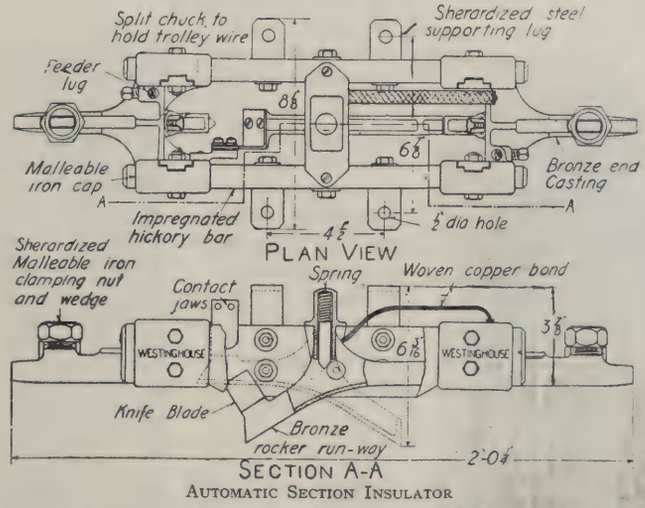
The construction of this automatic section insulator is as good as it is possible to make it. Side bars of impregnated hickory take the stress. All metal parts are either sherardized, malleable iron or of composition metal. The overall length is 24 inches.

End Castings and Rocker Run-Way Composition

Style Number				Each	
Round Wire	Grooved Wire	Fig. 8 Wire	Size of Wire	Wt., Lbs.	List Price
144830	144831	145977	0	20	$36 00
144831	144832	145978	00	20	36 00
144833	144834	145979	000	20	36 00
144835	143162	145980	0000	20	36 00

End Castings and Rocker Run-Way Malleable Iron

Style Number				Each	
Round Wire	Grooved Wire	Fig. 8 Wire	Size of Wire	Wt., Lbs.	List Price
241374	241375	241381	0	20	$27 00
241375	241376	241382	00	20	27 00
241377	241378	241383	000	20	27 00
241379	241380	241384	0000	20	27 00

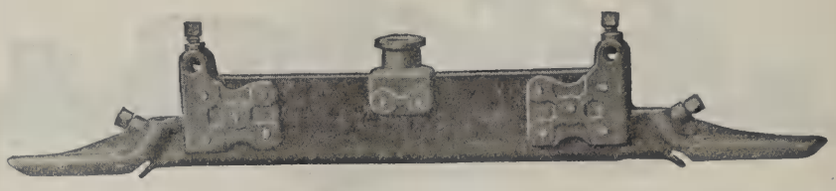


AUTOMATIC SECTION INSULATOR

REPAIR PARTS FOR AUTOMATIC SECTION INSULATOR

Style No.	Description	Per 100	
		Wt., Lbs.	List Price
239181	Contact jaw, right hand	50	12 00
239182	Contact jaw, left hand	50	12 00
199263	Supporting lug	100	60 00
239183	Hickory bar	300	96 00
247262	Shunt complete	100	96 00
247263	Knife blade	50	36 00
244650	Bronze rocker run-way	250	240 00
256263	Malleable iron rocker run-way	250	120 00
259160	Plunge rod	10	25 00
259161	Roller	5	10 00
259162	Spring	2	5 00

TYPE HM SECTION INSULATORS
750 Volts

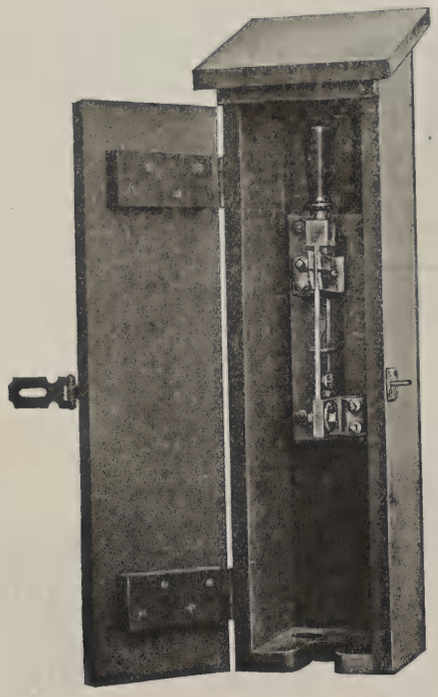


The type HM section insulator is light in weight, but durable. Two forms are supplied; form 1 having a straight-grained hard-wood runner, thoroughly dried and impregnated, and form 2 having a fiber runner. End castings with a feeder lug on each are securely attached. The runner is ⅝ inch thick and the overall length of the insulator is 23 inches.

Unless otherwise ordered, these insulators are furnished with center supporting casting tapped for ⅝-inch stud.

Size Wire	Style Number: Round Wire	Style Number: Grooved Wire	Style Number: Fig. 8 Wire	Each: Wt., Lbs.	Each: List Price
		Form 1			
0	127355	.....	125761	3.4	$8 80
00	127356	125760	125762	3.4	8 80
000	127357	119314	119312	3.6	8 80
0000	127358	119315	119313	3.6	8 80
		Form 2			
0	187638	.....	187645	3.4	9 80
00	187639	187642	187646	3.4	9 80
000	187640	187643	187647	3.6	9 80
0000	187641	187644	187648	3.6	9 80

LINE SECTION SWITCHES
For 750 Volts



The Westinghouse line section switch is used in cutting off one section of the trolley line from another or for sectionalizing the feeder. It is a type D single-pole single-throw quick-break knife switch with soldered terminals and is mounted on a slate base enclosed within a wooden case. When open, the switch drops into a slot in the bottom of the case, allowing the door of the box to be closed and locked, and thus rendering the closing of the switch by unauthorized persons impossible. When the switch is open and the door closed, the handle may be seen, but no live parts are exposed. This arrangement gives perfect safety to the lineman.

Style number includes switch complete (not fused) with slate base, mounted in wooden case.

Style No.	Capacity, Amp.	Height, Inches	Each: Wt., Lbs.	Each: List Price
		With Box		
125632	800	31	32	$28 80
125766	1200	31	40	33 00
		Without Box		
144341	800	[illegible]	21	24 00
144342	1200	[illegible]	30	28 00

LINE SECTION SWITCHES

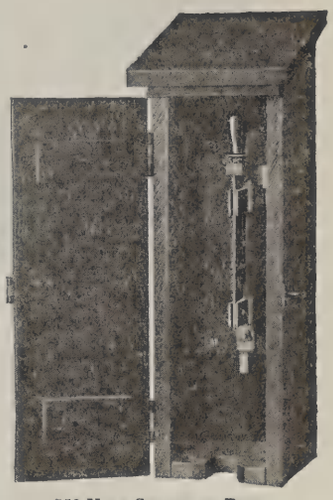
These are single-pole single-throw front-connected knife switches with quick-break contacts. They are mounted on slate bases and are enclosed in wooden boxes—the 750-volt switch is also furnished without the box. The terminals are arranged to take the leads from the bottom. The switches are not fused. The boxes are provided with strong hasps and staples.

FOR VOLTAGES UP TO 750 AND CAPACITIES UP TO 600 AMPERES

750-Volt Switch Without Box

The wooden box of the 750-volt switch is arranged so that when the switch is open the handle drops into a slot in the bottom of the box. This allows the door of the box to be closed and locked, thus making closing of the switch by unauthorized persons impossible. When in this position, the handle may be seen, acting as an indicator of the position the switch is in, but no live parts are exposed.

Style No.	Capacity, Amperes	Overall Height, Inches	Each Wt., Lbs.	Each List Price
		With Box		
272660	200	22½	13	$11 20
272662	400	26½	23	14 80
272664	600	28½	29	21 00
		Without Box		
272661	200	12⅝	5	7 80
272663	400	15¼	10	10 80
272665	600	17¾	16	16 80



750-Volt Switch in Box

1500-Volt Switch in Box

FOR VOLTAGES UP TO 1500 CAPACITIES OF 1200 AMPERES

These are heavy-service line section switches. No handle is provided with the switch blade, but the latter is arranged to be closed and opened by an insulated hook stick which is furnished with each switch—an attachment is provided inside the door for holding the hook stick when not in use.

Style No.	Capacity, Amperes	Overall Height, Inches	Each Wt., Lb.	Each List Price
242866	1200	33⅜	45	$80 00

Order by Style Number

WESTINGHOUSE CATENARY MATERIAL IN SERVICE

INTERNATIONAL RAILWAY CO.

Operates between Buffalo, N. Y., and Niagara Falls, N. Y.

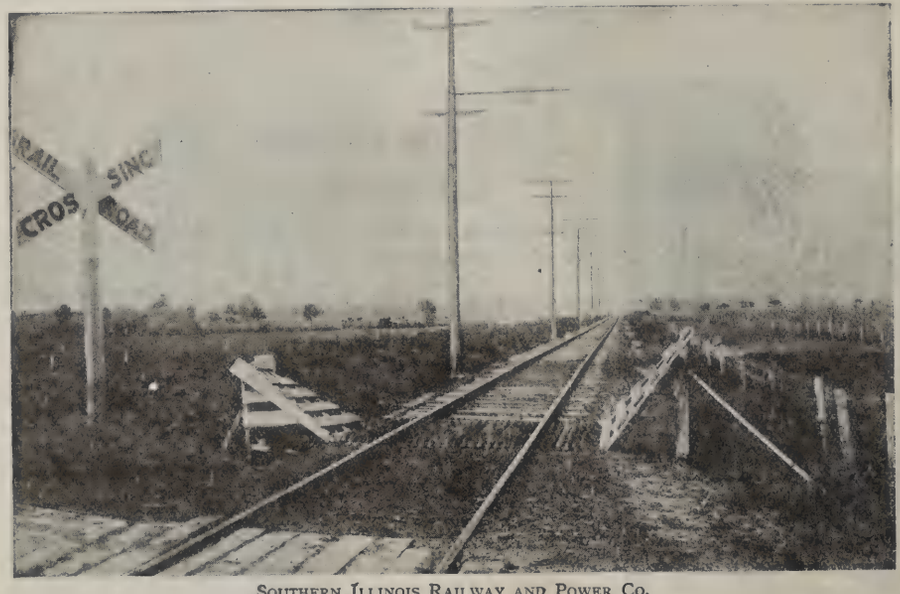
17 miles of Westinghouse Catenary construction.

Installed July 1st, 1918.

Trolley and 500,000 circular mill copper messenger wires are supported on bridges with average spacing 200 feet.

The trolley wire is suspended from messenger wire by catenary hangers spaced every 10 feet.

The operating voltage is 550 D. C.



SOUTHERN ILLINOIS RAILWAY AND POWER CO.

Operates between Eldorado, Ill. and Carrier Mills, Ill.

15½ miles of Westinghouse catenary construction.

Installed in 1913.

Trolley and messenger wires installed on wood poles spaced 150 feet.

The trolley is suspended from the messenger wire by catenary hangers spaced every 30 feet.

The operating voltage is 1200 volts D. C.

WESTINGHOUSE CATENARY MATERIAL IN SERVICE—Continued

INDIANAPOLIS & CINCINNATI TRACTION CO

Operates between Indianapolis, Ind. and Connersville, Ind., and branch to Greensburg, Ind.

100 miles of Westinghouse catenary construction.

Installed in 1905.

Trolley and messenger wires installed on wood poles spaced 100 and 120 feet.

The trolley is suspended from the messenger wire by catenary hangers spaced every 12½ feet.

The operating voltage is 3300 volts A. C.

The original trolley wire after being in service ten years shows very little wear and this company reports that they believe it will last ten years more

NEW YORK, WESTCHESTER & BOSTON RAILWAY CO.

Double trolley 11,000 volt Westinghouse catenary construction on the Harlem River Division of the N. Y. N. H. & H. R. R., showing a typical installation of Westinghouse type WM curve catenary hangers.

WESTINGHOUSE CATENARY MATERIAL IN SERVICE—Continued

HANOVER & YORK ST. RAILWAY CO.

Operates between Hanover, Pa. and York, Pa.
15½ miles of Westinghouse catenary construction.
100 foot pole spacing.
10-point suspension.
This catenary material has been in service 8 years.
Operating voltage is 6600 A. C.

OGDEN, LOGAN & IDAHO RAILWAY CO.

Operates between Ogden, Utah and Preston, Idaho.
52 miles of Westinghouse catenary construction.
150 foot pole spacing on tangent and from 90 feet to 150 feet on curves.
Five-point suspension.
Installed in 1915.
Operating voltage is 1500 D. C.

WESTINGHOUSE CATENARY MATERIAL IN SERVICE—Continued

ERIE RAILROAD CO.

Operates between Rochester, N. Y. and Mt. Morris, N. Y.
34 miles of Westinghouse catenary construction.
Pole spacing—80 feet to 120 feet.
Suspensions—10 foot spacing.
Installed in 1906 and 1907.
Operating voltage—11,000.

KANSAS CITY, CLAY CO., & ST. JOSEPH RAILWAY CO.

Operates between Kansas City, Mo. and Excelsior Springs, Mo., and Kansas City and St. Joseph, Mo.
89 miles of Westinghouse catenary construction.
Installed in 1912.

Trolley and messenger wires supported on wood poles spaced 150 feet.

The trolley is suspended from the messenger wire by catenary hangers spaced every 30 feet.

The operating voltage is 1200 volts, D. C.

WESTINGHOUSE CATENARY MATERIAL IN SERVICE—Continued

THE DENVER & INTERURBAN RAILROAD CO.

Denver and Boulder, Colorado main terminals. Branch to Eldorado Springs.

47 miles of Westinghouse catenary construction. 120 foot pole spacing standard on tangent. 7-inch maximum chord deflection on curves. This offset on center line to give maximum of three and one-half inches on pantagraph.

10 foot hanger spacing.

Installed in 1908.

11,000 volts.

No trolley breaks in seven and one-half years. No slack required to be pulled out of line in that time. Is in first class condition at present and has rendered extraordinary good service.

SALT LAKE & UTAH RAILROAD

Operates between Salt Lake City, Utah, and Provo, Utah.

49 miles of Westinghouse catenary construction.

Installed in 1914.

The trolley and messenger wires are supported on wood poles spaced 150 feet.

The trolley is suspended from the messenger wire by Westinghouse type GF flexible catenary hangers spaced every 30 feet.

The operating voltage is 1500 volts, D. C.

The overhead superintendent reported that he had been watching the performance of these hangers during one year of service at high speed operation and had not found a single failure.

CATENARY SUSPENSION TROLLEY LINE MATERIAL

Upon the introduction of the single-phase system of electric traction, it became necessary to change and improve upon the earlier standard methods of overhead trolley line construction in order to meet the new conditions. The numerous difficulties presented by the single-phase system were solved by the catenary construction, the important features of which are **high insulation** and **smooth under-run.**

As the Westinghouse Electric & Manufacturing Company was the pioneer in the construction of single-phase railways in the United States, so too it was the first company to design and build a catenary line. This line was built for the Indianapolis & Cincinnati Traction Company in 1905. Since then catenary construction has become standard for all single-phase systems, and its field of usefulness has extended to other systems.

Insulation—The method of construction of the catenary line allows the use of porcelain insulators at the poles instead of moulded composition insulators of the direct-suspension type. The better insulating qualities and greater permanence of porcelain are apparent.

Smooth Under-Running—In the catenary line the sag is in the messenger cable, the hangers being made of such length that the trolley wire is kept practically level. This gives the trolley a smooth under-run, eliminating the bumps due to sagging and swaying inherent in the direct suspension.

Pole Spacing—In direct-suspension construction, a pole spacing of more than 110 feet is objectionable or impracticable. In the catenary system with bracket arm or cross-span construction, a pole spacing of 150 feet on tangent track is the general practice; while with bridge construction 300 feet has proven entirely satisfactory. As each pole saved means additional saving in labor, insulators and other fixtures, the saving here often more than offsets the extra cost of catenary cable and hangers.

Application—Although the greatest field for catenary construction is on roads operated by one of the high-tension, alternating-current systems, because it so readily meets the insulation requirements, other features make it very desirable for use on direct-current systems of 500 volts or over. Many interurban roads operate their cars at such high speed that it is difficult to obtain satisfaction on the direct-suspension lines in which the sag of the trolley wires makes it difficult to keep the wheel on the wire. Here the catenary solves the problem with smooth under-run.

Many steam railroads find it advantageous to operate electric as well as steam trains on all or part of their lines. The magnified danger of poorer insulation of the direct-suspension line as well as the probability of more delays due to breakdown in the line make the catenary line more acceptable here. Then, too, such roads generally desire to operate their electric trains at high speeds in order to conform to their steam schedules, so that catenary line construction again has the advantage.

SPACING OF POLES AND HANGERS

Length of Span—With bracket-arm construction a pole spacing of 150 feet on tangent track has become general practice, and with bridge construction a maximum span of 300 feet on tangent track has proven to be entirely satisfactory.

Messenger Cable—For ordinary interurban construction a $\frac{7}{16}$-inch Siemens-Martin double galvanized 7-strand steel cable should be used, and where a greater factor of safety is required, a higher strength cable may be employed. At 70 degrees Fahrenheit the sag of a 150-foot messenger span will be about 16 inches at 2400 pounds tension.

Hangers—In general where pantagraph trolleys are used the hanger spacing should not exceed 15 feet, in order to obtain all the advantages of catenary construction. Where wheel trolleys are used, hangers may be spaced at a greater distance apart, but in that case if a break in the trolley occurs there may be danger of the ends at the break striking the ground. In the various types of hangers listed, the lengths are varied by ½-inch. It has been demonstrated conclusively by practice that for all practical purposes a variation in length of ¼-inch, more or less than theoretical length, will prove just as satisfactory as a hanger having the exact theoretical length.

Trolley Wire—Hard-drawn, copper trolley wire of standard grooved section, 4/0 B. & S. gauge, is recommended in most cases.

Steady Strains and Pull-Off Hangers—On curves of long radii it is sometimes desired to have a steady-strain or a pull-off hanger at each pole to keep the trolley wire at the desired point with reference to the center of the track. On curves of short radii it is necessary to have pull-off hangers in addition to steady strains or pull-offs at the poles to keep the trolley wire within a working distance from the center of the track. The pull-off hangers are connected by means of ¼-inch cables to a ⅜-inch bridle wire strung between poles. Fig. 1 shows the necessary spacing of pull-off hangers for wheel-trolley or roller-pantagraph operation. With the pole and pull-off hangers spacing shown in this figure the middle ordinate will not exceed 6 inches. In Figs. 2 and 3, for any given value of **H**, the middle ordinate, the displacement of the trolley can be equalized to one-half the middle ordinate. The pole spacing is such that the middle ordinate, with reference to poles only, does not exceed 16 inches.

DEFLECTION ANGLE AND MIDDLE ORDINATE OF THE TROLLEY WIRE

Wheel-Trolley Operation—On a curve of short radius the deflection angle of the trolley wire at the pull-off hanger is a more important consideration than the middle ordinate. The pull-off hangers should be spaced so that the deflection angle will not exceed 10 degrees on a curve having a radius smaller than 150 feet, and not more than 6 degrees on a curve having a radius greater than 150 feet. This will insure a smooth passage of the trolley wheel at the pull-off point. Fig. 2 gives diagrams of spans and pull-off hanger spacing suitable for this type of operation.

Sliding Pantagraph Trolley—On lines using sliding pantagraph trolleys the deflection angle of the trolley wire need not be considered, the important consideration being to keep the trolley wire as near as possible to the center of the track. The pole spacing should be such that the middle ordinate will not exceed 10 inches with a steady-strain insulator at each bracket arm. The trolley wire alignment can then be kept within 5 inches of the center of the track. Diagrams of spans suitable for this type of operation are shown in Fig. 3.

Roller-Pantagraph Trolley—In like manner, the deflection angle of this system need not be considered, the important consideration being to keep the trolley wire as near as possible to the center of the track. The middle ordinate should not exceed 6 inches, as the roller-pantagraph trolley is much shorter than a sliding shoe. It is, therefore, more economical to use the pull-off hangers in addition to steady strains. Diagrams for spans, suitable for this type of operation, are shown in Fig. 1.

Three-Point Suspension—Fig. 4 shows pole and hanger spacing with three-point suspension. For moderate speed-wheel trolley operation this construction can frequently be used to good advantage.

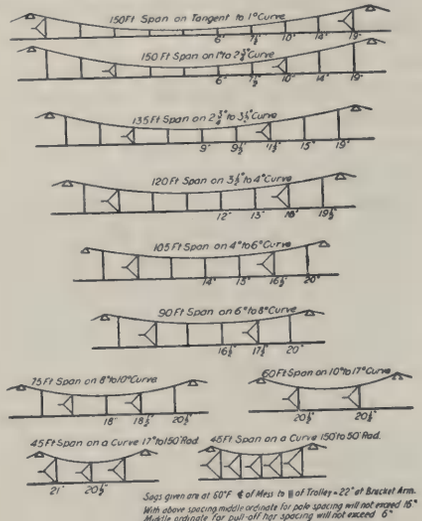

150 Ft Span on Tangent to 1° Curve
150 Ft Span on 1° to 2½° Curve
135 Ft Span on 2½° to 3½° Curve
120 Ft Span on 3½° to 4° Curve
105 Ft Span on 4° to 6° Curve
90 Ft Span on 6° to 8° Curve
75 Ft Span on 8° to 10° Curve
60 Ft Span on 10° to 17° Curve
45 Ft Span on a Curve 17° to 150 Rad.
45 Ft Span on a Curve 150 to 50' Rad.
Sags given are at 60° F. ℄ of Mess. to ℄ of Trolley = 22" at Bracket Arm.
With above spacing middle ordinate for pole spacing will not exceed 16"
Middle ordinate for pull-off hgr. spacing will not exceed 6"

FIG. 1—SPACING FOR WHEEL-TROLLEY OR ROLLER-PANTAGRAPH OPERATION

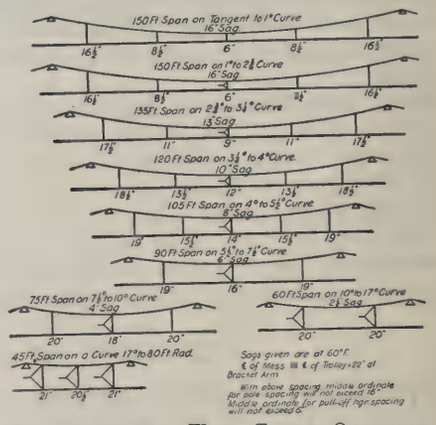

150 Ft Span on Tangent to 1° Curve
16" Sag
150 Ft Span on 1° to 2½° Curve
16" Sag
135 Ft Span on 2½° to 3½° Curve
13" Sag
120 Ft Span on 3½° to 4° Curve
10" Sag
105 Ft Span on 4° to 5½° Curve
8" Sag
90 Ft Span on 5½° to 7½° Curve
6" Sag
75 Ft Span on 7½° to 10° Curve
4" Sag
60 Ft Span on 10° to 17° Curve
2½" Sag
45 Ft Span on a Curve 17° to 80 Ft. Rad.
Sags given are at 60° F.
℄ of Mess. ≡ ℄ of Trolley + 22" at Bracket Arm
With above spacing middle ordinate for pole spacing will not exceed 16"
Middle ordinate for pull-off hgr. spacing will not exceed 6"

FIG. 2—SPACING FOR WHEEL-TROLLEY OPERATION

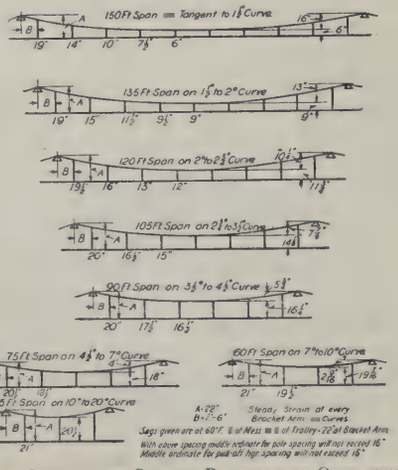

150 Ft Span ≡ Tangent to 1½° Curve
135 Ft Span on 1½° to 2° Curve
120 Ft Span on 2° to 2½° Curve
105 Ft Span on 2½° to 3½° Curve
90 Ft Span on 3½° to 4½° Curve
75 Ft Span on 4½° to 7° Curve
60 Ft Span on 7° to 10° Curve
45 Ft Span on 10° to 20° Curve
A: 22"
B: 5"-6"
Steady Strain at every Bracket Arm on Curves.
Sags given are at 60° F. ℄ of Mess. ≡ ℄ of Trolley - 22" at Bracket Arm.
With above spacing middle ordinate for pole spacing will not exceed 16"
Middle ordinate for pull-off hgr. spacing will not exceed 16"

FIG. 3—SPACING FOR SLIDING-PANTAGRAPH OPERATION

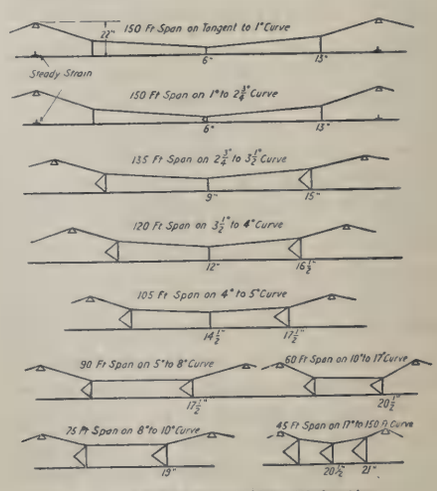
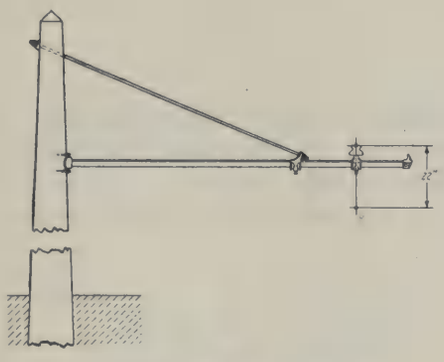

150 Ft Span on Tangent to 1° Curve
Steady Strain
150 Ft Span on 1° to 2½° Curve
135 Ft Span on 2½° to 3½° Curve
120 Ft Span on 3½° to 4° Curve
105 Ft Span on 4° to 5° Curve
90 Ft Span on 5° to 8° Curve
60 Ft Span on 10° to 17° Curve
75 Ft Span on 8° to 10° Curve
45 Ft Span on 17° to 150 Ft Curve
Sags given are at 60° F. ℄ of Mess. to ℄ of Trolley = 22" at Bracket Arm
With above spacing middle ordinate for pole spacing will not exceed 16"
Middle ordinate for pull-off hanger spacing will not exceed 6"

FIG. 4—THREE-POINT SUSPENSION

CATENARY SUSPENSION TROLLEY LINE MATERIAL—Continued



List of Material

1 Bracket arm complete.
1 Main line insulator and pin.
2 ½ x 4-inch lag screws.

FIG. 5

Material necessary to build one mile of catenary construction, 150-foot pole spacing, 5-point suspension as shown in Fig. 5:

35 Poles.
35 Bracket arms.
35 Main line insulators.
35 6-inch hangers.
70 8½-inch hangers.
70 16½-inch hangers.
5 Steady strains.
5 Steady strain ears.
2 Splicers.
5 Lightning arresters.
5 Feeder tap supports.
5 Feeder ears.
8 Guy anchors.
8 Wood strain insulators.
8 Porcelain strain insulators.
24 Guy clamps.
8 Pole shims.
8 Guy hooks.
100 ¼ x 4-inch lag screws.
4 Half strain ears.
4 Messenger anchor clamps.
5300 feet 3/0 or 4/0 trolley wire.
5300 feet $\frac{7}{16}$-inch double galvanized Siemens Martin messenger cable.
352 12-inch flexible rail bonds.
5 6-foot solid cross bonds.
900 feet ⅜-inch double galvanized Siemens Martin cable.

Construction like Fig. 5 requires the trolley wire to be steadied at certain intervals to guard against side sway. This can be accomplished by using a bracket arm and fittings as shown in Fig. 2 every 1000 feet on tangents.

List of Material

1 Bracket arm complete.
1 Main line insulator and pin.
2 ½ x 4-inch lag screws.
1 ⅝-inch eye bolt.
2 1¼-inch wood strain insulators.
1 Suspension.
1 Trolley ear.

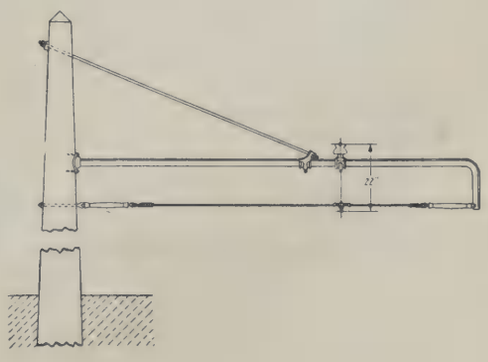


FIG. 6

Fig. 7 shows the usual form of bracket arm catenary construction used for wheel trolley operation. This method is employed where the poles are placed on the outside of the curve, but when the poles are placed on the inside of the curve a method similar to Fig. 8 is used, which is very simple and also very satisfactory in every respect.

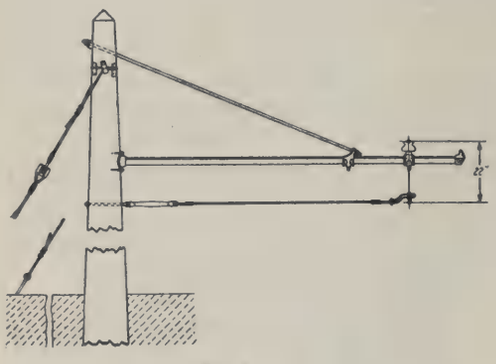


FIG. 7

List of Material—

1 Bracket arm complete.
1 Main line insulator and pin.
1 Single curve suspension.
1 Trolley ear.
1 5/8-inch eye bolt.
1 1¼ wood strain insulator.
4 ½ x 4-inch lag screws.
2 pole shims.
1 5/8-inch anchor rod.
2 Guy clamps.
1 Type PG or PS strain insulator.
2 Guy hooks.

Fig. 8 shows a method which is quite frequently used when the poles are on the inside of the curve, when it is not desirable to change them to the outside on account of the fact that a feeder and telephone line which may be carried on the same poles would have to be carried across the trolley to the other side of the track, which is not considered good practice.

List of Material—

1 Bracket arm complete.
1 Main line insulator and pin.
1 Single curve suspension.
1 Trolley ear.
1 1¼ wood strain insulator.
1 5/8-inch eye bolt.
4 ½ x 4-inch lag screws.
4 Guy clamps.
4 Pole shims.
2 Guy hooks.
1 Anchor rod.
1 Type PG or PS strain insulator.

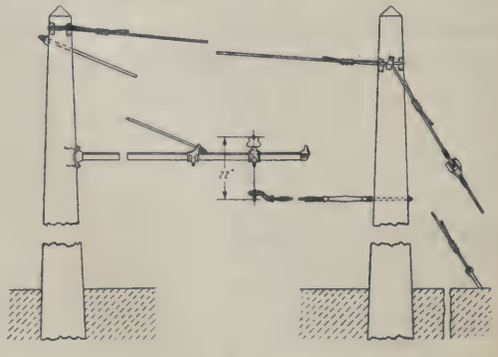


FIG. 8

For 1500-volt pantagraph operation the bill of material shown for Figs. 7 and 8 will be satisfactory except the steady strains and pull-offs that should be as per Figs. 9 and 10.

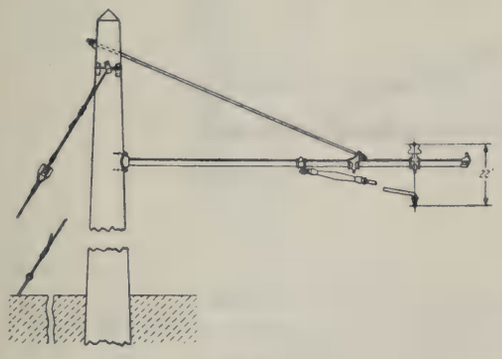


FIG. 9

List of Material—

1 Bracket arm complete.
1 Main line insulator and pin.
1 Steady strain insulator.
1 Trolley ear.
2 Pole shims.
4 Lag screws ½ x 4 inches long.
1 Anchor rod.
2 Guy clamps.
1 PG or PS porcelain strain insulator.
2 Guy hooks.

List of Material—

1 Bracket arm complete.
1 Main line insulator and pin.
1 Steady strain insulator.
1 Trolley ear.
6 Lag screws ½ x 4 inches long.
4 Guy clamps.
4 Pole shims.
2 Guy hooks.
1 Anchor rod.
1 PG or PS porcelain strain insulator.

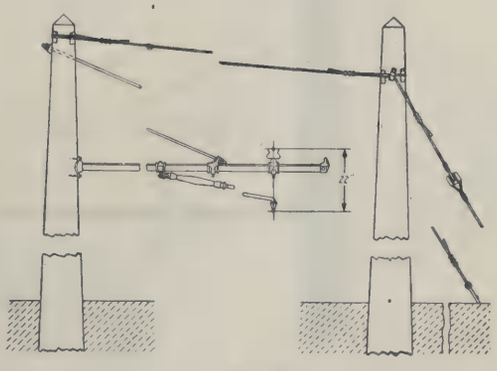
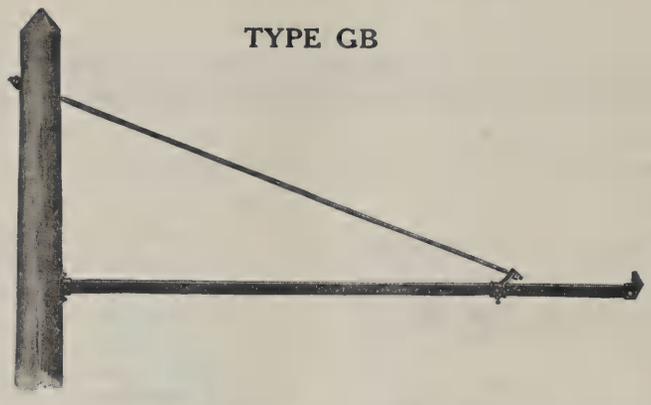


FIG. 10

BRACKET ARMS
FOR CATENARY SUSPENSION

TYPE GB



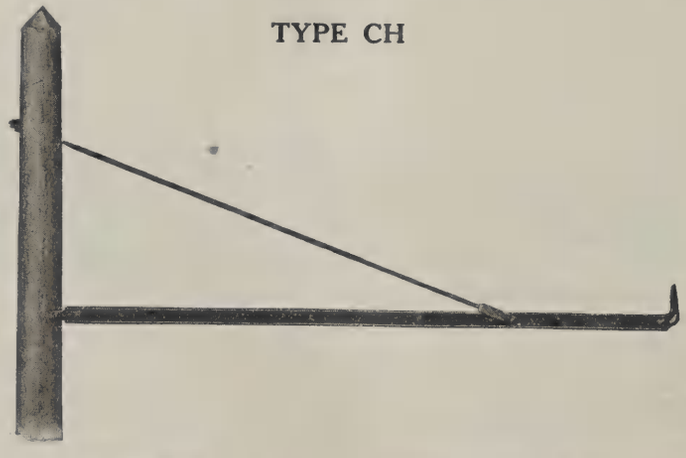
The type GB bracket arm consists of a 2¼ by 2¼ by ¼-inch T-iron with either ½ or ⅝-inch tension rod and fittings. The pole socket and end castings are held by means of ½-inch machine bolts. The tension-rod clamp is held in position by means of a ⅝-inch cup-pointed set screw.

With the standard distance of 7½ feet from pole to center of track a 9-foot arm is satisfactory, but frequently it is necessary to locate the pole at a greater distance from the center of the track and in this case a longer arm is used.

This bracket arm is suitable for types J and JC insulator pins, but these are not included as parts of complete bracket arms.

Style number includes the bracket arm complete, as described. Two ½ by 4-inch lag screws are required for holding the pole socket to the pole. These are not included in the bracket arm equipment.

TYPE CH



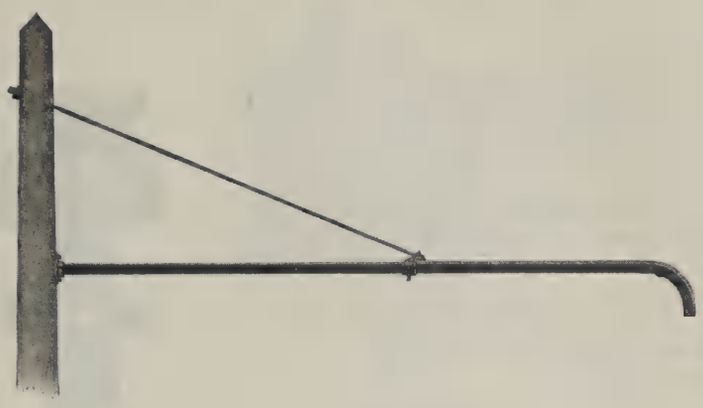
The type CH bracket arm consists of a 3-inch I-beam with tension rod, steel tension-rod clamp, hook-end casting and steel pole clamp. There is a distinct advantage in using a 3-inch I-beam, as this section has a much greater strength for the same weight than any other commercial section. The point of application of the tension rod can therefore be much nearer the pole than with other sections, which is oftentimes an advantage.

Style number and price include the arm complete except that two ½ by 4-inch lag screws are required extra for fastening the pole clamp to the pole.

Type GB Style No.	Type CH Style No.	Description	Type GB Approx. Wt., Lbs. Each	Type CH Approx. Wt., Lbs. Each	Type GB List Price Each	Type CH List Price Each
196262	175898	9-foot arm with ½-inch x 8-foot, 9-inch tension rod	54	60	$8 80	$10 50
196263	175899	10-foot arm with ½-inch x 9-foot, 9-inch tension rod	59	66	9 50	11 25
196264	175900	11-foot arm with ½-inch x 10-foot, 9-inch tension rod	64	72	10 20	12 00
196265	175901	12-foot arm with ½-inch x 11-foot, 9-inch tension rod	69	78	11 00	12 75
171064	175902	9-foot arm with ⅝-inch x 8 foot, 9-inch tension rod	57	63	9 75	11 50
196266	175903	10-foot arm with ⅝-inch x 9-foot, 9-inch tension rod	64	70	10 75	12 50
196267	163641	11-foot arm with ⅝-inch x 10-foot, 9-inch tension rod	71	77	11 75	13 50
196268	163645	12-foot arm with ⅝-inch x 11-foot, 9-inch tension rod	78	84	12 75	14 50

When desired without the end casting deduct 45 cents from the list price.
Regularly furnished painted black but can be galvanized when so ordered at an increased price.

TYPE GC EXTENSION ARM



The type GC bracket arm consists of a 2¼ by 2¼ by $\frac{5}{16}$-inch T-iron with end depressed for taking a pull-off or steady-strain cable, together with a ⅝-inch tension-rod 8 feet 9 inches long and fittings. With a distance of 7½ feet from the inside of the pole to the center of the track, a bracket arm with the over-all dimensions of 12 feet is satisfactory for 600-volt service.

With a distance of 22 inches from trolley to messenger cable at the insulator, the depression should be 8½ inches for pantagraph trolley operation in order that the pantagraph shoe will clear.

This type of construction is not recommended where operating voltage exceeds 3300.

Style number and price include the bracket arm complete.

		Each	
Style No.	Description	Wt., Lbs.	List Price
175904	12-foot, 6-inch arm with 1-foot 2¾-inch depression	81	$13 50
175906	12-foot arm with 8½-inch depression	78	13 50
241304	13-foot arm with 10¾ inch depression	85	14 50

Regularly furnished painted black but can be furnished galvanized when so ordered at an increased price.

FEEDER TAP SUPPORT

750 Volts

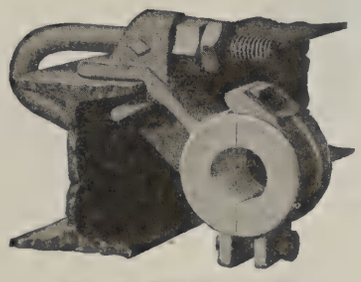


Fig. 22—Style No. 119152

This insulated support is used to support the feeder taps from the arm where the bracket type of construction is used. The hole in the insulating bushing is one inch in diameter. Castings and bolts are sherardized.

		Per 100	
Style No.	Description	Wt., Lbs.	List Price
119152	Support for I beam or T iron complete with spool	175	**$160.00**

MESSENGER INSULATORS

TYPE J

6600 Volts

The type J messenger insulator consists of a chocolate glazed porcelain insulator cemented to a japanned or sherardized malleable iron pin. The design of this porcelain insulator is such as to secure greatest mechanical strength and electrical efficiency. The insulator pin completely surrounds the bracket arm and is securely held in position by means of a $\frac{5}{8}$-inch set screw.

This insulator can be used with a 2¼ by 2¼ by ¼-inch or a 2¼ by 2¼ by $\frac{5}{16}$-inch T-iron bracket arm and has been used satisfactorily for 600-1200, and 6600-volt operation.

Dry arcover	40,000 volts
Wet arcover	20,000 volts
Diameter pin hole	1⅜ inches
Diameter insulator	4½ inches
Height, top of bracket arm to groove	5 inches

STYLE NO. 170051

Style No.	Description	Per 100 Approx. Wt., Lbs.	Per 100 List Price
	Complete		
172929	Messenger insulator with japanned pin, complete	500	$145 00
170051	Messenger insulator with sherardized pin, complete	500	145 00
	Parts		
91466*	Porcelain insulator, only for 500 to 6600 volts	250	*
172928	Insulator pin only, japanned	250	100 00
170052	Insulator pin only, sherardized	250	100 00

TYPE JC

6600 and 11000 Volts

The type JC messenger insulator consists of a chocolate-glazed porcelain insulator of such proportion as to secure the greatest mechanical strength and electrical efficiency. The pin holes are designed for 1⅜-inch standard pin and are unglazed. The insulator is securely cemented to a malleable iron pin which is provided with a ½-inch hook bolt for fastening the insulator to either a 3-inch I-beam or a 2¼ by 2¼ by $\frac{5}{16}$-inch T-iron bracket arm.

STYLE NOS. 92113 AND 167815

6600 VOLTS

STYLE NOS. 91266 AND 193947

11000 VOLTS

	Style Number 92113 and 167815	Style Number 91266 and 193947
Dry arcover voltage	40,000	66,000
Wet arcover voltage	15,000	27,000
Maximum working voltage under favorable conditions	6,600	11,000
Diameter of top groove (in.)	1	1⅛
Diameter of side groove (in.)	¾	¾
Diameter of pin hole (in.)	1⅜	1⅜
Height, top of bracket arm to groove (inches)	4¾	7
Diameter of insulator (in.)	4½	7

Style No.	Description	Per 100 Approx. Wt., Lbs.	Per 100 List Price
	Complete		
92113	Main line insulator, complete, japanned pin, 6600 volts	400	$145 00
167815	Main line insulator, complete, sherardized pin, 6600 volts	400	145 00
91266	Main line insulator, complete, japanned pin, 11,000 volts	950	250 00
193947	Main line insulator, complete, sherardized pin, 11,000 volts	950	250 00
	Parts		
91466*	Porcelain insulator for Style Nos. 92113 and 167815	250	*
250085	Porcelain insulator for Style Nos. 91266 and 193947	500	‡
66131	Japanned insulator pin for Style No. 92113	200	100 00
167816	Sherardized insulator pin for Style No. 167815	200	100 00
92210	Japanned insulator pin for Style No. 91266	400	130 00
186784	Sherardized insulator pin for Style No. 193947	400	130 00

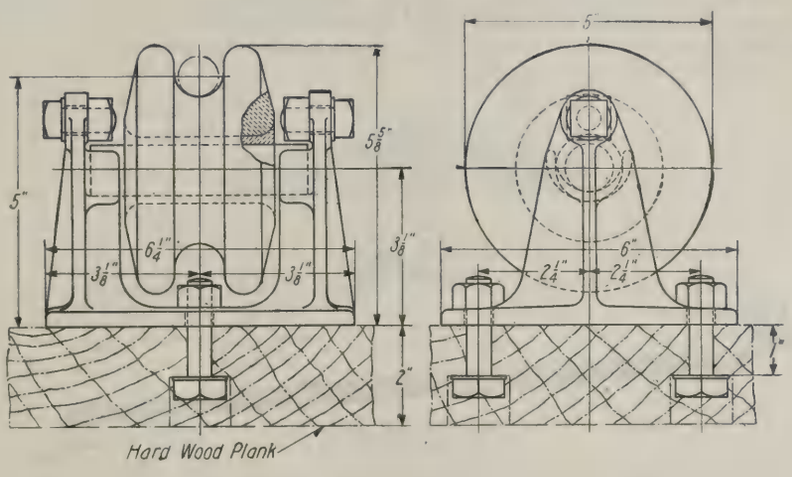
* See Porcelain Insulator Section.

‡On application

MESSENGER INSULATORS—Continued

TYPE MB
750 Volts

STYLE No. 253015
750 Volts



The type MB messenger insulator for bridge construction consists of a wet process porcelain spool with a steel shaft resting in sockets on an iron frame. This frame can be attached to the top member of the bridge. The porcelain spool will engage any size wire up to and including 500,000 c. m. stranded copper cable. Where the type MB messenger insulator is used there is a minimum amount of wear on the messenger cable as the cable is free to adjust itself as its length changes due to changes in temperature. No tie wires are necessary as the groove in the spool is deep enough to hold the messenger wire on all but very sharp curves.

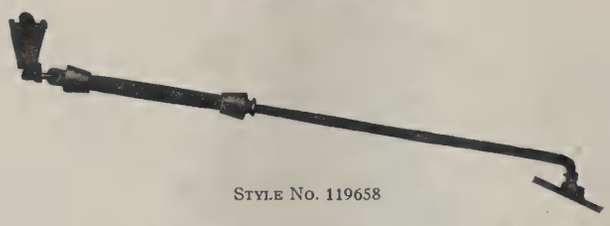
Style No.	Description	Per 100 Approx. Wt., Lbs.	Per 100 List Price
253015	Complete sherardized	1000	$580 00
253016	Complete japanned	1000	580 00
253017	Porcelain spool and pin only, sherardized	425	330 00
253018	Porcelain spool and pin only, japanned	425	330 00
253019	Base casting only, sherardized	575	250 00
253020	Base casting only, japanned	575	250 00

Style number does not include bolts for fastening insulators to timber.

STEADY STRAINS

TYPE AC

1500 and 3300 Volts



STYLE No. 119658

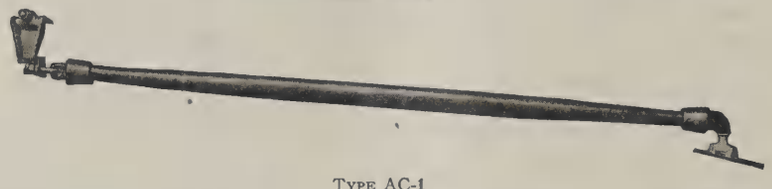
The type AC steady-strain insulator is used mostly for wheel trolley operation for voltages up to 3300. The wood part has an extension made of a ¾-inch steel rod with a bent and threaded end for screwing into the trolley clamp. This rod is strong enough to resist a considerable blow from the trolley pole should the wheel leave the wire. The bracket-arm connection is provided with a U-bolt for taking the end casting of the steady-strain arm. In this way a connection is secured which has flexibility in all directions, and in case of breakage of the trolley wire the steady strain can swing sideways, and thus avoid a bending strain. Style number 119658 has 12 inches of insulation, and style number 119659 has 24 inches of insulation.

Style No.	Line Voltage	EACH Wt., Lbs.	EACH List Price
119658	1500	15	$4 25
119659	3300	15	4 75

Style numbers do not include trolley clamp, but do include bracket arm clamp.

TYPE AC-1

6600 Volts



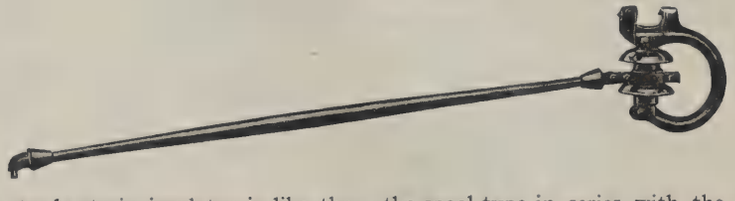
TYPE AC-1

Style No.	Line Voltage	EACH Wt., Lbs.	EACH List Price
92510	6600	15	$7 00

Style number does not include trolley clamp, but does include bracket arm clamp.

TYPE AP

11000 Volts



The type AP steady-strain insulator is like the type AC except that it has a porcelain insulator of the spool type in series with the wood insulator. This type is used for voltages up to 11,000.

Style No.	Line Voltage	EACH Wt., Lbs.	EACH List Price
92512	11000	22	$16 50

PARTS

For Types AC, AC-1 and AP Steady-Strains

Style No.	Description	EACH Wt., Lbs.	EACH List Price
49874	Steady-strain ear, ¾-inch stud	.8	$ 84
92511	Bracket clamp for style Nos. 92510, 119658 and 119659	5	2 00
68221*	Porcelain insulator for Style No. 92512	4.5	*
92513	Insulator bracket for Style No. 92512		5 75
88921	Strain insulator with end castings for Style Nos. 92510 and 92512		5 00

* See Strain Insulator Section.

STEADY STRAIN SUSPENSION

TYPE CB

Style No.	Description	Diameter Stud, Inches	Per 100 Wt., Lbs.	Per 100 List Price
166963	Malleable iron, sherardized	5/8	92	$42 00
166964	Malleable iron, sherardized	3/4	103	52 00
121602	Composition	5/8	82	90 00
121603	Composition	3/4	98	100 00

STEADY STRAIN EAR

TYPE F

Style No.	Description	Per 100 Wt., Lbs.	Per 100 List Price
49372	Malleable iron, sherardized with 5/8-inch tap	100	$84 00
49374	Malleable iron, sherardized with 3/4-inch tap	95	84 00
49373	Composition, with 5/8-inch tap	110	170 00
49375	Composition, with 3/4-inch tap	105	170 00

HANGERS

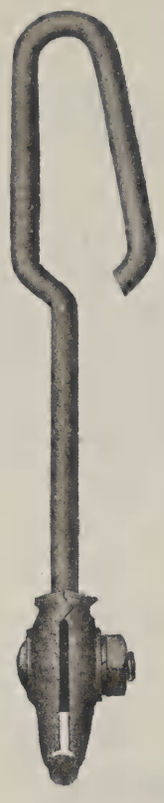
TYPE AB CROSS-SPAN MESSENGER HANGER

Type AB cross-span hanger is designed for suspending the messenger cable from the cross-span cable. The hanger consists of a malleable-iron casting and two ½-inch steel U-bolts provided with nuts and check nuts. All parts are sherardized.

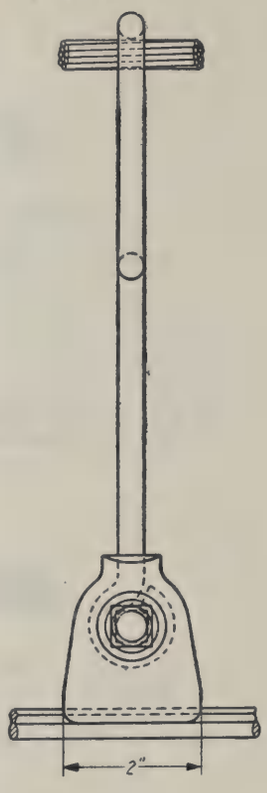
Style No.	Per 100 Wt., Lbs.	Per 100 List Price
165174	175	$100 00

HANGERS—Continued

TYPE NF CATENARY HANGER
For 00 to 0000 Groove Trolley Wire



A lineman can close the loop that fits around the messenger cable by a grip of the hand which makes a wrench the only tool necessary to install this catenary hanger.



This hanger is made with duplicate malleable iron clamps attached to a ⅜-inch steel rod by a $\frac{7}{16}$-inch carriage bolt. All parts are sherardized.

Style No.	Length, Inches	Per 100 Wt., Lbs.	Per 100 List Price
248556	6	88	$39 60
248557	6½	89½	39 90
248558	7	91	40 20
248559	7½	92½	40 50
248560	8	94	40 80
248561	8½	95½	41 10
248562	9	97	41 40
248563	9½	98½	41 70
248564	10	100	42 00
248565	10½	101½	42 30
248566	11	103	42 60
248567	11½	104½	42 90
248568	12	106	43 20
248569	12½	107½	43 50
248570	13	109	43 80
248571	13½	110½	44 10
248572	14	112	44 40
248573	14½	113½	44 70
248574	15	115	45 00
248575	15½	116½	45 30
248576	16	118	45 60
248577	16½	119½	45 90
248578	17	121	46 20
248579	17½	122½	46 50
248580	18	124	46 80
248581	18½	125½	47 10
248582	19	127	47 40
248583	19½	128½	47 70
248584	20	130	48 00
248585	20½	131½	48 30
248586	21	133	48 60

TYPE B RIGID CATENARY HANGERS

The type B rigid catenary hanger consists of a drop-forged steel trolley clamp, a malleable iron reducer coupling, a ½-inch steel hanger rod, and a sheet-steel messenger clamp. The trolley clamp, the reducer coupling and the hanger rod are the same as those used with type BG flexible hanger except that the hanger rod is not looped, but is adapted to the use of the messenger clamp. The messenger clamp is provided with a ½-inch machine bolt which securely fastens the messenger clamp to the hanger rod. This type of hanger is made for a $\frac{7}{16}$-inch messenger cable and for either a 3/0 or a 4/0 standard grooved trolley wire. All parts of the hanger are sherardized.

Style No.		Length of Hanger, Inches	Per 100	
For 000 Grooved	For 0000 Grooved		Approx. Wt., Lbs.	List Price
158628	158665	4½	114	$74 50
158629	158666	5	116	75 00
158630	158667	5½	118	75 50
158631	158668	6	120	76 00
158632	158669	6½	122	76 50
158633	158670	7	125	77 00
158634	158671	7½	128	77 50
158635	158672	8	130	78 00
158636	158673	8½	133	78 50
158637	158674	9	136	79 00
158638	158675	9½	138	79 50
158639	158676	10	141	80 00
158640	158677	10½	144	80 50
158641	158678	11	146	81 00
158642	158679	11½	149	81 50
158643	158680	12	152	82 00
158644	158681	12½	154	82 50
158645	158682	13	157	$83 00
158646	158683	13½	160	83 50
158647	158684	14	162	84 00
158648	158685	14½	165	84 50
158649	158686	15	168	85 00
158650	158687	15½	170	85 50
158651	158688	16	173	86 00
158652	158689	16½	176	86 50
158653	158690	17	178	87 00
158654	158691	17½	181	87 50
158655	158692	18	184	88 00
158656	158693	18½	186	88 50
158657	158694	19	189	89 00
158658	158695	19½	192	89 50
158659	158696	20	194	90 00
158660	158697	20½	197	90 50
158661	158698	21	200	91 00

TYPE BG FLEXIBLE CATENARY HANGERS

The type BG flexible hanger consists of a drop-forged steel trolley clamp, a malleable iron reducer coupling and ½-inch steel hanger rod, provided with an oblong loop with sufficient opening at the bottom to admit the messenger cable. A few taps of a hammer close the opening, so that the hanger is positively located on the messenger cable. The hanger has absolute freedom of movement on the messenger cable, so there is no pounding of the trolley wheel at the hanger or the tendency to kink the trolley wire by relative movement of trolley and messenger cable. Slack can be easily removed from the trolley wire without disturbing the hanger. The reducer coupling is internally threaded at each end. The hanger rod is screwed into the one end while the other end screws over the threaded end of the trolley clamp in such a way as to grip powerfully the trolley wire as the coupling is tightened on the clamp. Hangers are made with clamps for 3/0 and 4/0 B. & S. gauge standard grooved wire. All parts of the hanger are sherardized. The upper end of the hanger rod is made in the shape of a loop which permits a vertical movement between it and the messenger cable of about 1½ inches.

Style No.		Length of Hanger, Inches	Per 100	
For 000 Grooved	For 0000 Grooved		Approx. Wt., Lbs.	List Price
175836	176459	6	89	$70 50
175837	176460	6½	92	71 00
175838	176461	7	95	71 50
175839	176462	7½	98	72 00
175840	176463	8	101	72 50
175841	176464	8½	104	73 00
175842	176465	9	107	73 50
175843	176466	9½	110	74 00
175844	176467	10	113	74 50
175845	176468	10½	116	75 00
175846	176469	11	119	75 50
175847	176470	11½	122	76 00
175848	176471	12	125	76 50
175849	176472	12½	128	77 00
175850	176473	13	131	77 50
175851	176474	13½	134	78 00
175852	176475	14	137	$78 50
175853	176476	14½	140	79 00
175854	176477	15	143	79 50
175855	176478	15½	146	80 00
175856	176479	16	149	80 50
175857	176480	16½	152	81 00
175858	176481	17	155	81 50
175859	176482	17½	157	82 00
175860	176483	18	160	82 50
175861	176484	18½	163	83 00
175862	176485	19	166	83 50
175863	176486	19½	169	84 00
175864	176487	20	172	84 50
175865	176488	20½	175	85 00
175866	176489	21	178	85 50

TYPE B-3 FLEXIBLE CATENARY HANGERS

The type B-3 flexible hanger consists of a malleable-iron trolley clamp, a taper-threaded nut, and a ½-inch looped hanger rod, the latter being similar to that of the BG flexible hanger. The shank of the trolley clamp is provided with a tapered external thread and a ½-inch internal thread for engaging the end of the hanger rod. When the nut is screwed down on the shank of the trolley clamp the trolley wire and the end of the hanger rods are simultaneously gripped. The top of the shank is spun over so that the two halves of the clamp cannot fall apart when the nut is backed off. The same hanger is adapted to receive either a 3/0 or 4/0 standard grooved wire. Owing to the greater length of the clamp a somewhat greater holding power is obtained than with the type BG flexible hanger. All parts are sherardized. This hanger is made with a loop at the top to fit over the messenger cable allowing a play of 1½ inches.

This type of hanger has given excellent satisfaction when used for three-point suspension with 150-foot spans.

Style No.	Length of Hanger, Inches	Per 100 Approx. Wt., Lbs.	Per 100 List Price
175805	6	114	$110 00
175806	6½	117	110 50
175807	7	120	111 00
175808	7½	123	111 50
175809	8	126	112 00
175810	8½	129	112 50
175811	9	132	113 00
175812	9½	135	113 50
175813	10	138	114 00
175814	10½	141	114 50
175815	11	144	115 00
175816	11½	147	115 50
175817	12	150	116 00
175818	12½	153	116 50
175819	13	156	117 00
175820	13½	159	117 50
175821	14	162	$118 00
175822	14½	165	118 50
175823	15	168	119 00
175824	15½	171	119 50
175825	16	174	120 00
175826	16½	177	120 50
175827	17	180	121 00
175828	17½	183	121 50
175829	18	186	122 00
175830	18½	189	122 50
175831	19	192	123 00
175832	19½	195	123 50
175833	20	198	124 00
175834	20½	201	124 50
175835	21	204	125 00
.....	....	...	.....

TYPE FE CATENARY HANGERS

The type FE catenary hanger consists of a malleable-iron, two-screw trolley clamp, a ½-inch steel hanger rod, and a drop-forged hook for attaching to messenger cable. A few turns of the hanger rod securely fastens the messenger attachment, and after the trolley is clamped in place it is impossible for the hanger rod to turn and loosen.

This hanger is designed especially for use with a ⅝-inch messenger cable and steel trolley wire where frequent adjustment of the trolley wire is not required. It is suitable for use with either 3/0 or 4/0 standard grooved trolley wire. All parts are sherardized.

Style No.	Length of Hanger, Inches	Per 100 Approx. Wt., Lbs.	Per 100 List Price
175910	6	145	$103 00
149802	6½	147½	103 50
175911	7	150	104 00
149786	7½	152½	104 50
175912	8	155	105 00
149803	8½	157½	105 50
175913	9	160	106 00
149787	9½	162½	106 50
175914	10	165	107 00
175915	10½	167½	107 50
149804	11	170	108 00
175916	11½	172½	108 50
149788	12	175	109 00
175917	12½	177½	109 50
175918	13	180	110 00
175919	13½	182½	110 50
149805	14	185	$111 00
175920	14½	187½	111 50
175921	15	190	112 00
149789	15½	192½	112 50
175922	16	195	113 00
175923	16½	197½	113 50
175924	17	200	114 00
149806	17½	202½	114 50
175925	18	205	115 00
175926	18½	207½	115 50
175927	19	210	116 00
149790	19½	212½	116 50
175928	20	215	117 00
175929	20½	217½	117 50
149807	21	220	118 00
.....	....	.....	.....

TYPE FS FLEXIBLE CATENARY HANGERS

The type FS flexible hanger consists of a malleable-iron three-screw trolley clamp and a hanger rod made of ⅛-inch by ⅞-inch strap steel. The hanger rod is looped over the messenger cable. When the hanger is in place a link with oblong hole is pushed up close to the loop and the edge of the strap is given a slight bend. This secures the hanger against all possible chance of slipping off the messenger cable. The same hanger will take either a 3/0 or 4/0 trolley wire. This hanger is made with a loop at the top to fit over the messenger cable, allowing a play of 1¾ inches. All parts are sherardized.

Style No.	Length of Hanger, Inches	Per 100 Approx. Wt., Lb.	Per 100 List Price
175867	6	76	$54 00
175868	6½	77	54 30
175869	7	79	54 60
175870	7½	81	54 90
175871	8	82	55 20
175872	8½	84	55 50
175873	9	86	55 80
175874	9½	87	56 10
175875	10	89	56 40
175876	10½	91	56 70
175877	11	92	57 00
175878	11½	94	57 30
175879	12	96	57 60
175880	12½	98	57 90
175881	13	99	58 20
175882	13½	101	58 50
175883	14	102	$58 80
175884	14½	104	59 10
175885	15	106	59 40
175886	15½	108	59 70
175887	16	109	60 00
175888	16½	111	60 30
175889	17	112	60 60
175890	17½	114	60 90
175891	18	116	61 20
175892	18½	117	61 50
175893	19	119	61 80
175894	19½	121	62 10
175895	20	122	62 40
175896	20½	124	62 70
175897	21	126	63 00
.....	....	...	.....

TYPE GF FLEXIBLE CATENARY HANGERS

The type GF has the same ½-inch steel rod that is used in the types BG and B-3 hangers together with a 4-inch composition clinch ear made for 3/0 or 4/0 standard groove trolley wire, tapped to engage the ½-inch steel rod.

The composition clinch ear is made with a dry sand core, the inside not being machined, leaving a rough surface where the ear engages the trolley wire. After the ear is properly installed the rough surface adheres to the trolley wire and has a greater holding power than any composition ear having the inner surface smooth. It gives perfect clearance to the trolley wheel.

The composition used in the ear is made of the strongest materials obtainable for this class of work, and, while not very pliable, it "stays put" when properly installed and will stand the strain required of any catenary hanger.

Style No. For 000 Grooved	Style No. For 0000 Grooved	Length of Hanger, Inches	Per 100 Approx. Wt., Lbs.	Per 100 List Price
193963	194050	6	89	$61 50
193964	194051	6½	92	62 00
193965	194052	7	95	62 50
193966	194053	7½	98	63 00
193967	194054	8	101	63 50
193968	194055	8½	104	64 00
193969	194056	9	107	64 50
193970	194057	9½	110	65 00
193971	194058	10	113	65 50
193972	194059	10½	116	66 00
193973	194060	11	119	66 50
193974	194061	11½	122	67 00
193975	194062	12	125	67 50
193976	194063	12½	128	68 00
193977	194064	13	131	68 50
193978	194065	13½	134	69 00
193979	194066	14	137	69 50
193980	194067	14½	140	$70 00
193981	194068	15	143	70 50
193982	194069	15½	146	71 00
193983	194070	16	149	71 50
193984	194071	16½	152	72 00
193985	194072	17	155	72 50
193986	194073	17½	157	73 00
193987	194074	18	160	73 50
193988	194075	18½	163	74 00
193989	194076	19	166	74 50
193990	194077	19½	169	75 00
193991	194078	20	172	75 50
193992	194079	20½	175	76 00
193993	194080	21	178	76 50
193994	194081	21½	181	77 00
193995	194082	22	184	77 50
.....	.....	....	...	.....

TYPE FC FLEXIBLE ANCHOR HANGERS

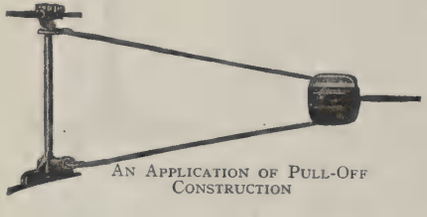
The type FC flexible anchor hanger consists of a malleable-iron trolley clamp and a malleable-iron messenger clamp connected by a ⅝-inch steel hanger rod as illustrated. A clevis attachment is provided for connecting the anchor guy cable.

The end of the hanger rod is flattened and secured to the trolley ear by a ½-inch bolt, thus forming a flexible connection at this point. All parts are sherardized.

Style No.	Length of Hanger, Inches	Per 100 Approx. Wt., Lbs.	Per 100 List Price
158837	6	305	$162 50
158838	6½	309	163 25
158839	7	313	164 00
158840	7½	317	164 75
158841	8	321	165 50
158842	8½	325	166 25
155843	9	329	167 00
158844	9½	333	167 75
158845	10	337	168 50
158846	10½	341	169 25
158847	11	345	170 00
158848	11½	349	170 75
158849	12	353	171 50
158850	12½	357	172 25
158851	13	361	173 00
158852	13½	365	173 75
158853	14	369	$174 50
158854	14½	373	175 25
158855	15	377	176 00
158856	15½	381	176 75
158857	16	385	177 50
158858	16½	389	178 25
158859	17	393	179 00
158860	17½	397	179 75
158861	18	401	180 50
158862	18½	405	181 25
158863	19	409	182 00
158864	19½	413	182 75
158865	20	417	183 50
158866	20½	421	184 25
158867	21	425	185 00
.....	....	...	.....

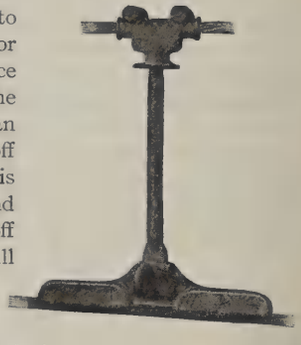
TYPE FC FLEXIBLE PULL-OFF HANGERS

The type FC flexible pull-off hanger is used on curves to pull the trolley wire and messenger cable over the center of the track.



An Application of Pull-Off Construction

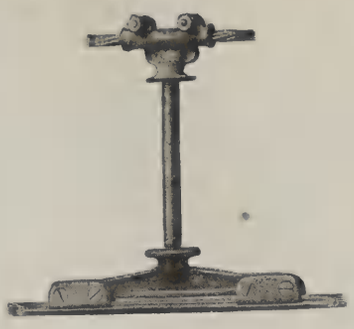
Its construction is similar to that of type FC flexible anchor hanger, except that in the place of the clevis attachment the trolley clamp is provided with an eye nut for attaching a pull-off cable. The messenger clamp is provided with a flange around the hanger rod so that a pull-off cable can easily be applied. All parts are sherardized.



Style No.	Length of Hanger, Inches	Per 100 Approx. Wt., Lbs.	Per 100 List Price
158872	6	251	$162 50
158873	6½	255	163 25
158874	7	259	164 00
158875	7½	263	164 75
158876	8	267	165 50
158877	8½	271	166 25
158878	9	275	167 00
158879	9½	279	167 75
158880	10	283	168 50
158881	10½	287	169 25
158882	11	291	170 00
158883	11½	295	170 75
158884	12	299	171 50
158885	12½	303	172 25
158886	13	307	173 00
158887	13½	311	173 75
158888	14	315	$174 50
158889	14½	319	175 25
158890	15	323	176 00
158891	15½	327	176 75
158892	16	331	177 50
158893	16½	335	178 25
158894	17	339	179 00
158895	17½	343	179 75
158896	18	347	180 50
158897	18½	351	181 25
158898	19	355	182 00
158899	19½	359	182 75
158900	20	363	183 50
158901	20½	367	184 25
158902	21	371	185 00
.....	....	...	.....

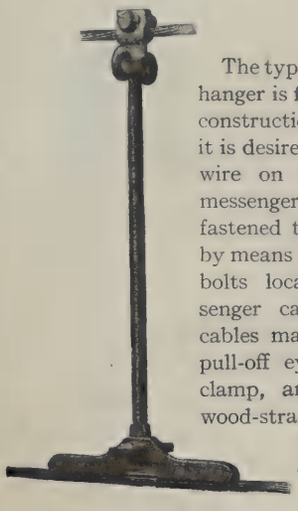
TYPE FL PULL-OFF HANGERS

The type FL pull-off hanger is like the type FC flexible pull-off hanger except in place of having a flexible jointed trolley clamp and eye-nut, it has a rigid trolley clamp provided with a flange around the 5/8-inch hanger rod, so that a pull-off cable can easily be applied. All parts are sherardized.



Style No.	Length of Hanger, Inches	Per 100 Approx. Wt., Lbs.	Per 100 List Price
176883	6	241	$125 00
176884	6½	245	125 75
176885	7	249	126 50
176886	7½	253	127 25
176887	8	257	128 00
176888	8½	261	128 75
176889	9	265	129 50
176890	9½	269	130 25
176891	10	273	131 00
176892	10½	277	131 75
176893	11	281	132 50
176894	11½	285	133 25
176895	12	289	134 00
176896	12½	293	134 75
176897	13	297	135 50
176898	13½	301	136 25
176899	14	305	$137 00
176900	14½	309	137 75
176901	15	313	138 50
176902	15½	317	139 25
176903	16	321	140 00
176904	16½	325	140 75
176905	17	329	141 50
176906	17½	333	142 25
176907	18	337	143 00
176908	18½	341	143 75
176909	19	345	144 50
176910	19½	349	145 25
176911	20	353	146 00
176912	20½	357	146 75
176913	21	361	147 50
.....	....	...	.....

TYPE FG CROSS-SPAN STEADY HANGERS



The type FG cross-span steady hanger is for use with cross-span construction on curves or where it is desired to steady the trolley wire on tangent track. The messenger clamp is securely fastened to the messenger cable by means of two ½-inch machine bolts located above the messenger cable. The cross-span cables may be attached to the pull-off eyes on the messenger clamp, and trolley clamp; or wood-strain insulator with clevis end can be connected direct to the eyes.

The trolley clamp is connected to the hanger rod by means of a ½-inch stud having an eye casting at either end in place of the nut. With this construction a small amount of movement is obtained at the end of the ear, thus preventing kinks should relative movement between messenger and trolley take place, and also prevents crystallization at the end of the ear. The trolley clamp is similar to that of the type FC curve pull-off and anchor hangers. The hanger rod is 5/8-inch in diameter. All parts are sherardized.

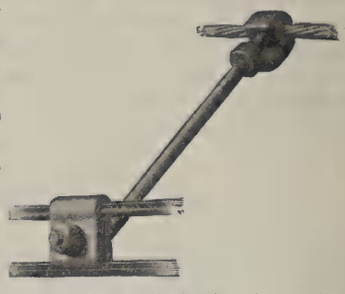
Style No.	Length of Hanger, Inches	Per 100 Approx. Wt., Lbs.	Per 100 List Price
175931	22	425	$270 00

TYPE WM CURVE HANGERS

(Patented)

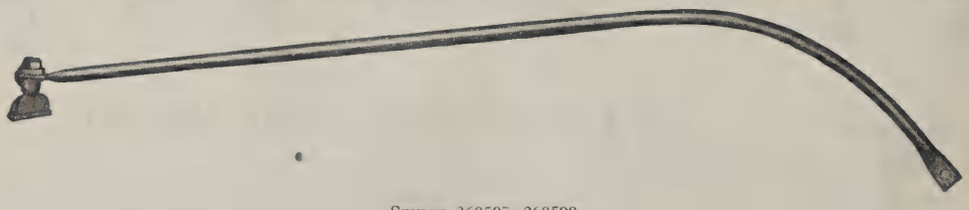
The type WM curve hanger is designed for use on curves where the double-trolley construction is employed. By means of this type of hanger it is possible to suspend the trolley wire from the messenger cable and, at the same time have the trolleys follow the curve of the track. The angle of the hanger rod with the horizontal is varied according to the degree of curvature. This construction is adapted for curves up to and including four degrees and is used more especially with suspension type of insulator.

The hanger consists of a drop-forged messenger hook adapted for $\frac{5}{8}$-inch steel cable, and constructed like that of the type FE hanger, and a $\frac{1}{2}$-inch steel hanger rod specially made to give the curve necessary, and to fit the malleable-iron trolley clamp on which it is bolted. The trolley clamp may be used for either a 3/0 or a 4/0 standard grooved contact trolley and a 4/0 standard grooved upper trolley wire.



In order to determine the proper hanger, the degree of the curve and the desired pole spacing must be given. **We will furnish on request complete information applying to catenary construction where the type WM curve hanger can be used to advantage.**

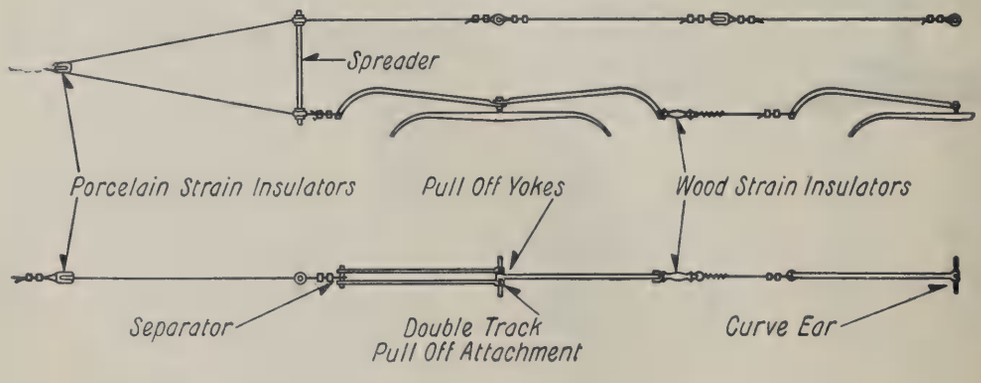
TYPE JR CATENARY PULL-OFF FOR PANTAGRAPH-TROLLEY OPERATION



STYLES 268597--268598

Style No.	Description	Per 100 Wt. Lbs.	Per 100 List Price
250293	Pull-off yoke only, Japanned	500	$130 00
250294	Pull-off yoke, Sherardized	500	143 00
268597	Pull-off yoke, complete with FP ear, Japanned	575	172 00
268598	Pull-off yoke, complete with FP ear, Sherardized	575	208 00

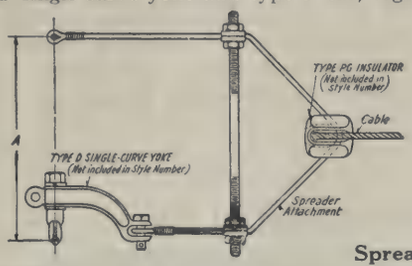
APPLICATION OF TYPE JR PULL-OFF ATTACHMENTS



TYPE SP CURVE PULL-OFF HANGERS

For Wheel Trolley Operation Only

The type SP curve pull-off hanger consists of a type D single-curve yoke and type F ear, together with a spreader attachment of variable lengths, and messenger cable and fittings. The type D single-curve yoke is made of galvanized malleable iron and furnished as illustrated. The type F ear is made of either galvanized malleable iron or of composition 10 inches long. The spreader attachment consists of a $\frac{5}{8}$-inch steel rod provided with a clamp for taking the pull-off cable at each end. The clamp is made of malleable iron and all parts are sherardized. Each rod has sufficient thread for a 2-inch adjustment.



Spreader Attachment

Style No.	Dimension A	Per 100 Wt., Lbs.	Per 100 List Price
176930	6 to 8	184	$65 00
176931	8 to 10	200	70 00
176932	10 to 12	216	75 00
176933	12 to 14	232	80 00
176934	14 to 16	248	85 00
176935	16 to 18	264	90 00
176936	18 to 20	280	95 00
176937	20 to 22	296	100 00

CLAMPS

TYPE FD INTERMEDIATE TWO-SCREW CLAMP

The type FD intermediate two-screw clamp is intended for suspending grooved-steel contact wire from a grooved-copper trolley wire in the double-trolley type of construction. The intermediate clamp is located midway between the regular catenary hangers. It is free to move longitudinally along the trolley wire, but is firmly clamped to the contact wire. This allows for the unequal expansion and contraction and insures the contact wire against kinks due to relative lateral movement. This type of construction has proved to be admirably adapted for heavy service.

All parts are sherardized.

Separation between wires is $1\frac{3}{4}$ inches; length, 2 inches.

Style No.	Size of Trolley Wire, B. & S. Gauge Upper	Lower	Per 100 Approx. Wt., Lbs.	Per 100 List Price
162649	000	000 or 0000 grooved	50	$42 00
149826	0000	000 or 0000 grooved	50	42 00

TYPE CJ INTERMEDIATE CATENARY CLAMP

The type CJ catenary clamp is similar to type FD. Instead of being held in position by means of two flat-head screws, it is held firmly in place by means of a single carriage bolt, $\frac{1}{2}$ by $1\frac{1}{2}$ inches, with positive lock washer. This clamp is made in two sizes for two 3/0 and two 4/0 grooved wires. This type is for pantagraph operation only.

Separation between wires is 2 inches. Length 2 inches. All parts are sherardized.

Style No.	Size of Trolley Wire, B. & S. Gauge Upper	Lower	Per 100 Wt., Lbs.	Per 100 List Price
193996	000	000	50	$30 00
194084	0000	0000	50	30 00

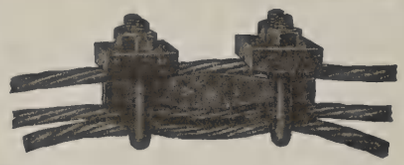
TYPE CA MESSENGER ANCHOR CLAMP

The type CA messenger anchor clamp is used for attaching a strain guy to the messenger cable. The clamp consists of a malleable iron body with eye connection and a malleable-iron cap. The body and cap have a waved surface for gripping the cable, and are held together by four $\frac{1}{2}$-inch machine bolts. Slipping of the clamp on a $\frac{7}{16}$-inch galvanized iron cable takes place at about 6000 pounds. All parts are sherardized.

Style No.	Per 100 Wt., Lbs.	Per 100 List Price
163751	275	$100 00

TYPE EA ANCHOR CLAMP

The type EA anchor clamp is for use at anchor points and should be installed in the center of the span. The messenger span or cable passes over the space block and the two strain guys pass below. One cable connects the anchor points and the other the two adjacent pull-off hangers. With this form of anchor clamp it is necessary to install an extra anchor pole diagonally opposite the trolley pole used for the other anchor point.

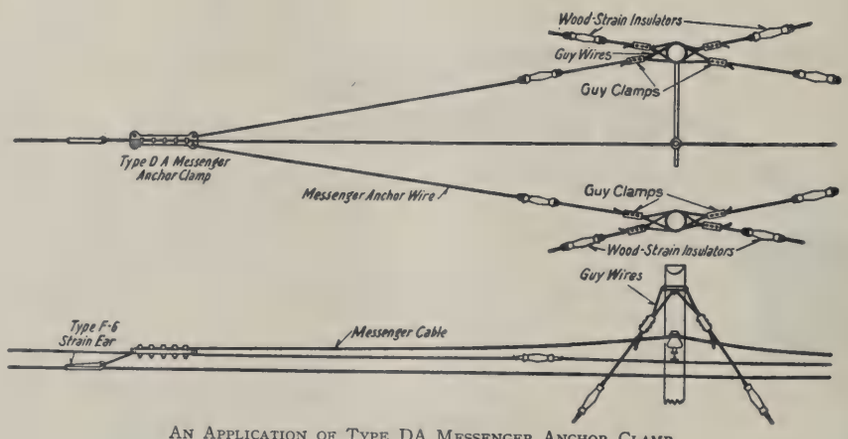


Style No.	Description	Each	
		Wt., Lbs.	List Price
92141	Anchor clamp, sherardized	6	$1 30

TYPE DA MESSENGER ANCHOR CLAMP

The type DA messenger anchor clamp can be used where it is desired to connect four strain guys. This clamp consists of a sherardized malleable-iron casting and five ½-inch U-bolts. Slipping of the clamp occurs at about 8500 pounds when applied to a $\frac{7}{16}$-inch cable.

Style No.	Each	
	Wt., Lbs.	List Price
165173	5	$2 40

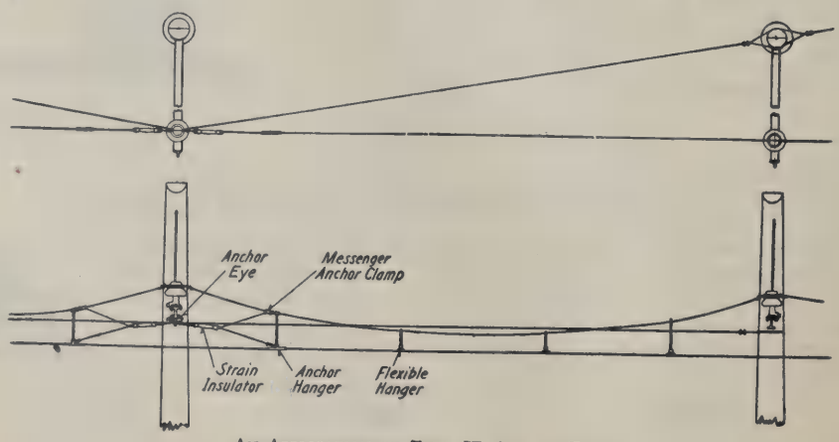


An Application of Type DA Messenger Anchor Clamp

TYPE JB ANCHOR EYE

The type JB anchor eye is designed for attaching to the bottom flange of I-beam bracket arm type CH directly under the messenger insulator. The anchor guy cables pass through the anchor eye to the anchor pole as shown in the following illustration.

Style No.	Each	
	Wt., Lbs.	List Price
122323	2	$1 25



An Application of Type JB Anchor Eye

CROSSINGS

TYPE KC INSULATED ADJUSTABLE CROSSING

For 550 Volts D. C. and 6600 Volts A. C.

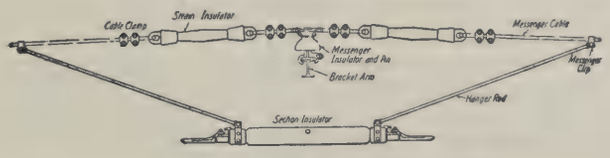
The type KC adjustable crossing is designed for insulating a 550-volt direct-current line from a 6600-volt alternating-current line. Both parts of the crossing are suitable for wheel-trolley operation, and the metallic portion is also suitable for pantagraph trolley operation. The insulated portion is for the 550-volt direct-current line and the metallic portion is for the 6600-volt alternating-current line. The alternating-current trolley wire is 3½ inches below the direct-current trolley, thus preventing the graph shoe from coming in contact with the direct-current line. Section insulators suitable for 6600 volts should be located in the alternating-current line at each side of the crossing.

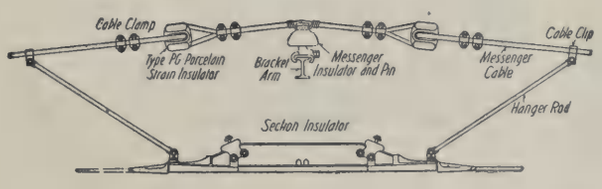
The insulated portion is made of well-seasoned hickory, oil impregnated. The runner, which is subject to wear, is made of fibre and is easily renewed. An adjustment from 60 to 90 degrees can be obtained and grooved trolley wire from 2/0 to 4/0 can be used. All metallic parts subject to the action of the trolley or pantagraph shoe are of composition metal, and all iron or steel parts are sherardized.

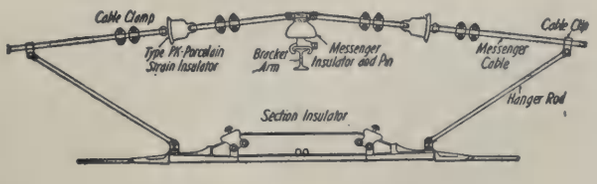
Style No.	Description	Length Overall Inches	Length of Insulation, Inches	Each — Weight, Lbs.	Each — List Price
175930	Type KC crossing, complete	85½	70½	30	$65 00

SECTION INSULATORS

TYPICAL SECTION-INSULATOR CONSTRUCTION







SECTION INSULATORS—Continued

TYPE KB FOR WHEEL-TROLLEY OPERATION

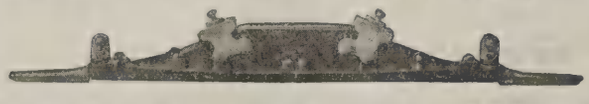
The type KB section insulator is of the side-bar type. The tension of the trolley wire is taken by well-seasoned and impregnated hickory side bars. With this construction the tension of the trolley wire is transmitted almost central with the insulation parts, and the tendency to buckle is thus eliminated. The side bars are recessed to fit over the end castings, thus relieving the bolts from any shearing strain. The trolley wire is securely held by a slotted chuck fitting in a conical socket, and after an initial hold has been taken the chuck automatically tightens its grip on the wire. Renewable approaches are provided which prevent crystallization of the trolley wire at the section insulator. A renewable fibre runner is provided with bronze arcing tips. These tips prevent the end castings from being damaged by the arc resulting at the breaking end. Suspension rods which are easily adjusted for a range of from 17 to 32 inches from center of trolley to center of messenger at the insulator are provided.

Style number does not include messenger cable clamp, thimbles, or suspension clips. The size of messenger cable should always be specified.

With Bronze End Castings

Style No.	Line Voltage	Size of Trolley Wire	Length Overall, Inches	Length of Side Rods Inches	Length of Insulation Inches	Each Weight, Lbs.	Each List Price
175933	750	000 groove	34¼	10½	8	22	$30 00
175934	750	0000 groove	34¼	10½	8	22	30 00
175935	1500	000 groove	45 5/16	21 9/16	16	27	35 00
168165	1500	0000 groove	45 5/16	21 9/16	16	27	35 00
			With Malleable Iron End Castings				
241871	750	000 groove	34¼	10½	8	22	25 00
241872	750	0000 groove	34¼	10½	8	22	25 00
241873	1500	000 groove	45 5/16	21 9/16	16	27	30 00
241874	1500	0000 groove	45 5/16	21 9/16	16	27	30 00

TYPE HC-2 FOR WHEEL TROLLEY OR PANTAGRAPH OPERATION



The type HC-2 section insulator is of single-bar type and consists of a middle insulated portion and bronze end castings provided with renewable approaches. The trolley is securely held by a clamping plate and two bolts. A renewable fibre runner made in two parts is provided. Each half of this runner can be removed by the removal of a ¼-inch machine bolt. Arcing tips riveted to a fibre runner protect the end castings from pitting due to the arc when the circuit is broken by the passage of the trolley wheel or pantagraph shoe. The approach has a certain amount of flexibility that prevents crystallization of the trolley wire.

Style number includes section insulator complete, but no messenger cable, hanger rods, insulators or fittings. When ordering, the size of messenger should always be specified.

With Bronze End Castings

Style No.	Line Voltage	Size Groove Trolley Wire	Length Overall, Inches	Length of Renewable Runner, Inches	Each Weight Lbs.	Each List Price
185535	750	000	41	8	23	$27 50
185536	750	0000	41	8	23	27 50
185594	1500	000	51	18	28	32 50
185595	1500	0000	51	18	28	32 50
			With Malleable Iron End Castings			
185592	750	000	41	8	23	22 50
185593	750	0000	41	8	23	22 50
185596	1500	000	51	18	28	27 50
185597	1500	0000	51	18	28	27 50

ACCESSORIES FOR TYPES KB AND HC-2 SECTION INSULATORS

Style No.	Description	Per 100 Wt., Lbs.	Per 100 List Price
185537	Hanger rod for 28 inch maximum to 16 inch minimum center of messenger to center of Trolley Wire at Insulator	192	$162 50
91219	Cable clip for 7/16 inch and ½ inch diameter messenger cable	20	25 00
185530	Cable clip for ⅝ inch diameter messenger cable	25	25 00
102146	Cable clamp for 7/16 inch and ½ inch diameter cable	See hardware section	
102147	Cable clamp for ⅝ inch diameter cable	See hardware section	
184200	Renewable fibre runner (750 V) for HC 2-section insulator (two required)	See direct suspension sec.	
185550	Renewable fibre runner (1500 V) for HC 2-section insulator (two required)	200	350 00
225647	Renewable micarta runner (750 V) for KB section insulator	See direct suspension sec.	
248516	Renewable micarta runner (1500 V) for KB section insulator	See direct suspension sec.	
180318	Renewable fibre runner (750 V) for KB section insulator	See direct suspension sec.	
248515	Renewable fibre runner (1500 V) for KB section insulator	See direct suspension sec.	
188425	Renewable approach for 000 groove trolley wire	See direct suspension sec.	
188426	Renewable approach for 0000 groove trolley wire	See direct suspension sec.	
167527	Chuck for 000 groove trolley wire	See direct suspension sec.	
167529	Chuck for 0000 groove trolley wire	See direct suspension sec.	

SECTION INSULATORS—Continued

TYPE HS-2 FOR PANTAGRAPH-TROLLEY OPERATION

TYPE HS-2 INSULATOR WITHOUT GLIDERS

The type HS-2 section insulator is designed for sectionalizing where a main contact trolley wire and an auxiliary or feeder trolley is used, having a distance center to center of 1¾ inches.

The insulating portions consist of a well-seasoned and impregnated hickory bar with a sufficient creepage distance to thoroughly insulate for the given voltage. The insulator is suitable for 3/0 or 4/0 grooved trolley or feed wire, and steel contact wire.

In the type HS-2 the approaches are attached to the end castings by means of one heavy machine bolt. The approaches are suitable for 3/0 and 4/0 wire. Each section insulator is tested before shipment, the test load being 8000 pounds and the working load 4000.

Style No.	Voltage	Length Overall, Inches	Insulation, Distance, Inches	Each — Weight, Lbs.	Each — List Price
		With Gliders			
197558	11000	106½	72	41	$41 50
197559	6600	82½	48	36	38 50
197560	3300	64½	30	32	35 75
		Without Gliders			
190318	11000	106½	72	35	-- --
197145	6600	82½	48	30	29 75
197144	3300	64½	30	28	27 50

TYPE HS-3 FOR PANTAGRAPH-TROLLEY OPERATION

TYPE HS-3 INSULATOR WITH GLIDERS

The type HS-3 is similar in design to the type HS-2 except that the parts are of lighter construction. The type HS-3 can be used with single trolley construction for 4/0 trolley wire or with double-trolley construction for 2/0 feeder and 2/0 contact wire. The test load of the type HS-3 is 6000 pounds and the working load 3000 pounds.

Where it is desired to have the contact shoe pass over the section insulator without interrupting the section circuit the insulator with gliders is recommended. Where this is not considered essential the gliders may be omitted.

Style No.	Voltage	Length Overall, Inches	Insulation, Distance, Inches	Each — Weight, Lbs.	Each — List Price
		With Gliders			
197563	11000	102¼	72	37	$33 00
197564	6600	78¼	48	32	29 75
197565	3300	60¼	30	28	27 50
		Without Gliders			
197561	11000	102¼	72	29	24 25
188897	6600	78¼	48	26	22 00
197562	3300	60¼	30	24	20 00

Style number includes insulator complete except messenger insulator and cable fittings. The size of messenger cable and material used, together with maximum tension, should always be given in ordering messenger insulators.

Styles No. 281850 and 281851 are special and are similar to Styles 197564 and 190318 respectively except the wood is of select maple gum impregnated.

TYPE DT INSULATOR BODY WITHOUT GLIDERS

TYPE DT FOR PANTAGRAPH-TROLLEY OPERATION ONLY

The type DT section insulator is designed for use with a main contact trolley wire and an auxiliary or feeder trolley. The trolley wires are held by a sheet metal arm pivoted at the end of the insulator body. The insulated portion consists of a well-seasoned and impregnated hickory bar with a creepage distance suitable for the given voltage. The end castings may be provided with gliders. These gliders overlap so that the circuit is not broken by the passage of the pantagraph shoe, and all flashing and injurious arcing is therefore eliminated. This section insulator is for high-speed sliding-contact operation.

FOUR BOLT TROLLEY CLAMP

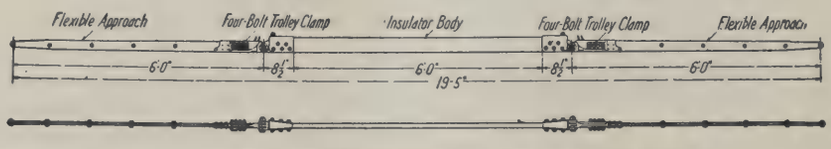
TYPE DT FLEXIBLE APPROACH

This section insulator is suitable for 3/0 or 4/0 grooved trolley wire with center to center of trolley wires 1¾ inches.

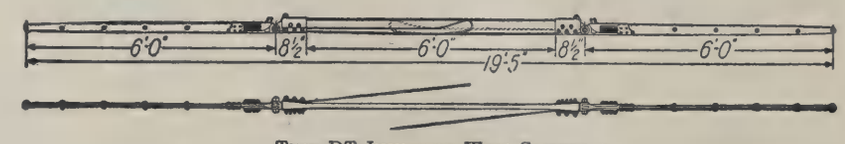
Style number includes section insulator complete except for the messenger cable and fittings, which are extra.

Style No.	Description	Voltage	Length Overall, Inches	Length of Insulation, Inches	Each Weight, Lbs.	Each List Price
176570	Complete with gliders	11000*	233	72	125	$70 00
194375	Complete without gliders	11000*	233	72	105	63 00

* Can be supplied for lower voltages upon special order.



TYPE DT COMPLETE WITHOUT GLIDERS



TYPE DT INSULATOR WITH GLIDERS

WOOD STRAIN INSULATORS

In the production of wood strain insulators the Westinghouse Company claims first position in points of quality in-put and quantity out-put. The eyes, clevises and tapped fittings are malleable iron sherardized, with the metal properly distributed to insure maximum strength and adaptability.

One of the most important considerations in the design of these insulators is the angle at which the malleable iron caps are swaged on, which angle must be exactly parallel to the reverse cone seat of the insulator proper. We have determined conclusively that there is only one angle for each diameter of insulator which gives the maximum holding power. Obviously, the more this angle is increased the greater is the disturbance to the metal under the swaging process, while on the other hand, the more the angle is reduced the less becomes its resistance to the action of the cone.

Westinghouse wood strain insulators are made of straight-grained, well-seasoned, air-dried selected hickory. After being accurately turned to size, the sticks are oil-impregnated and given two coats of transparent insulating varnish which makes possible an inspection of the grain of the wood. The end-castings are pressed tight on the stick, giving a water-tight joint. Great care is taken so that the pressure is not great enough to injure the wood.

Every wood strain insulator is subjected to a test load before shipment so as to eliminate defective wood or end-castings. The end-castings are sherardized and are strong enough to part the best hickory obtainable.

WITH TWO EYES—END CASTINGS SHERARDIZED

Style No.	Description	Test Load Lbs.	Average Breaking Load Lbs.	Per 100 Weight, Lbs.	Per 100 List Price
179475	1 -inch diameter, 5 inches of insulation	3500	7000	144	$ 75 00
179476	1¼-inch diameter, 5 inches of insulation	5000	10000	188	85 00
179488	1½-inch diameter, 5 inches of insulation	8000	12500	500	160 00
171794	1 -inch diameter, 12 inches of insulation	3500	7000	170	90 00
179477	1¼-inch diameter, 12 inches of insulation	5000	10000	250	105 00
179489	1½-inch diameter, 12 inches of insulation	8000	12500	550	200 00
179478	1¼-inch diameter, 24 inches of insulation	5000	10000	300	145 00
179490	1½-inch diameter, 24 inches of insulation	8000	12500	637	320 00
179479	1¼-inch diameter, 48 inches of insulation	5000	10000	500	370 00
179491	1½-inch diameter, 48 inches of insulation	8000	12500	863	480 00

Regularly furnished with eyes at right angles, but can be furnished with eyes in the same place when so ordered.

WITH ONE EYE AND ONE CLEVIS—END CASTINGS SHERARDIZED

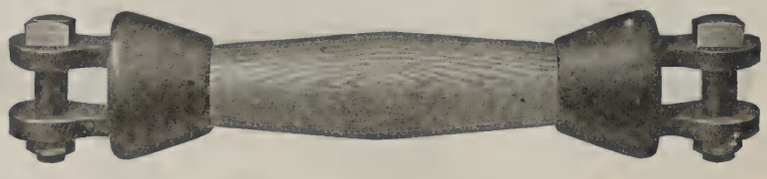
Style No.	Description	Test Load Lbs.	Average Breaking Load Lbs.	Per 100 Weight, Lbs.	Per 100 List Price
179481	1 -inch diameter, 5 inches of insulation	3500	7000	154	$ 90 00
179483	1¼-inch diameter, 5 inches of insulation	5000	10000	232	100 00
179482	1 -inch diameter, 12 inches of insulation	3500	7000	170	105 00
179484	1¼-inch diameter, 12 inches of insulation	5000	10000	260	120 00
179485	1¼-inch diameter, 24 inches of insulation	5000	10000	325	160 00

These insulators can be furnished with eye and clevis bolt in the same plane when so ordered. Regularly furnished at right angles.

WITH TWO TAPPED ENDS—END CASTINGS SHERARDIZED

Style No.	Description	Test Load Lbs.	Average Breaking Load Lbs.	Per 100 Weight, Lbs.	Per 100 List Price
125533	1 -inch dia., 5 inches of insulation, tap ⅝–11	3500	7000	140	$115 00
125535	1¼-inch dia., 5 inches of insulation, tap ¾–10	5000	10000	194	125 00
125537	1¼-inch dia., 12 inches of insulation, tap ¾–10	5000	10000	225	145 00

WITH TWO CLEVISES—END CASTINGS SHERARDIZED



Style No.	Description	Test Load Lbs.	Average Breaking Load Lbs.	Per 100 Weight, Lbs.	Per 100 List Price
125527	1 -inch diameter, 5 inches of insulation	3500	7000	200	$105 00
125529	1¼-inch diameter, 5 inches of insulation	5000	10000	253	115 00
125531	1¼-inch diameter, 12 inches of insulation	5000	10000	275	135 00

These insulators can be furnished with clevises at right angles. Regularly furnished in the same plane.

WOOD STRAIN INSULATORS—Continued

WITH ONE EYE AND ONE TAPPED END—END CASTINGS SHERARDIZED

Style No.	Description	Test Load Lbs.	Average Breaking Load Lbs.	Per 100 Weight, Lbs.	Per 100 List Price
121734	1 -inch dia., 5 inches of insulation, tap 5/8–11	3500	7000	141	$ 95 00
123359	1¼-inch dia., 5 inches of insulation, tap 5/8–11	5000	10000	220	105 00
123360	1¼-inch dia., 5 inches of insulation, tap ¾–10	5000	10000	194	105 00
121738	1¼-inch dia., 12 inches of insulation, tap 5/8–11	5000	10000	241	125 00
121739	1¼-inch dia., 12 inches of insulation, tap ¾–10	5000	10000	241	125 00
121740	1¼-inch dia., 24 inches of insulation, tap 5/8–11	5000	10000	288	165 00
121741	1¼-inch dia., 24 inches of insulation, tap ¾–10	5000	10000	291	165 00

WITH ONE CLEVIS AND ONE TAPPED END—END CASTINGS SHERARDIZED

Style No.	Description	Test Load Lbs.	Average Breaking Load Lbs.	Per 100 Weight, Lbs.	Per 100 List Price
125539	1 -inch dia., 5 inches of insulation, tap 5/8–11	3500	7000	157	$110 00
125541	1¼-inch dia., 5 inches of insulation, tap ¾–10	5000	10000	235	120 00
125543	1¼-inch dia., 12 inches of insulation, tap ¾–10	5000	10000	275	140 00

TYPE RC ADJUSTABLE WOOD STRAIN INSULATOR—END CASTINGS SHERARDIZED

This is a most useful adaptation of the ordinary form of wood strain insulator, having, as it does, an adjustment of 4 inches. The insulator proper and the malleable steel terminals constitute the same high grade product which distinguish our regular wood strains and are of corresponding dimensions.

It is expected that this strain insulator will largely supplant the Brooklyn type.

WITH TWO EYES

Style No.	Description	Adjustment, Inches	Per 100 Wt., Lbs.	Per 100 List Price
126035	1¼-inch diameter, 5 inches of insulation	14 to 18	350	$200 00
127124	1¼-inch diameter, 12 inches of insulation	21 to 25	530	265 00
157645	1½-inch diameter, 5 inches of insulation	19¼ to 23¼	700	350 00

WITH EYE AND CLEVIS

165093	1¼-inch diameter, 5 inches of insulation	19¼ to 23¼	530	$250 00

TRIPLE WOOD STRAIN INSULATORS
Metal Parts Sherardized

The triple wood strain insulator, with 48 inches of insulation, is designed for very severe service and is suitable for a working load of 12,000 pounds.

It consists of three wood strain insulators in multiple, connected by malleable iron triple-hook castings. In case one insulator should fail the two remaining insulators will sustain the load until repairs can be made. Each triple wood insulator is subjected to a test load of 25,000 pounds before shipment. The ultimate strength is approximately 50000 pounds.

Style No.		Wt., Lbs., Each	List Price Each
158118	Hickory oil impregnated	40	$25 00
263546	Maple gum impregnated	40	27 25

DOUBLE WOOD STRAIN INSULATORS
Metal Parts Sherardized

This insulator is similar to Style No. 158118 except it has only two wood strain insulators. It is subjected to a test load of 16,000 pounds before shipment. The ultimate strength is approximately 35,000 pounds. 48 inches of insulation.

Style No.		Wt., Lbs. Each	List Price Each
216171	Hickory oil impregnated	26	$15 00
273438	Maple gum impregnated	26	16 50

SINGLE WOOD STRAIN INSULATORS
Metal Parts Sherardized

For use with double and triple insulators, part of Styles 158118, 216171, 263546 and 273438.

Style No.		Description	Each Wt., Lbs.	Each List Price
202066	Hickory oil impregnated	1½-inch diameter, 48 inches of insulation	9	$5 30
263545	Maple gum impregnated	1½-inch diameter, 48 inches of insulation	9	6 05

WESTINGHOUSE GIANT STRAIN INSULATORS

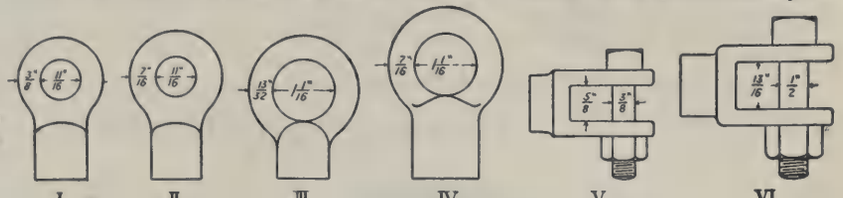
600 VOLTS

These cylindrical composition strain insulators are properly named "Giant" because no other form of moulded strain insulator of similar dimensions can compare with them in tensile or dielectric strength.

As shown in the illustration below, sheet mica is the only insulating material under stress, the composition insulation being used solely to exclude moisture and to lengthen the creepage surface. Breakdown voltages invariably take the surface path.

The average tensile and dielectric strength of the two sizes is approximately as follows:

Size, Ins.	Lbs.	Volts
2	6500	9800
2½	8000	12700



I II III IV V VI

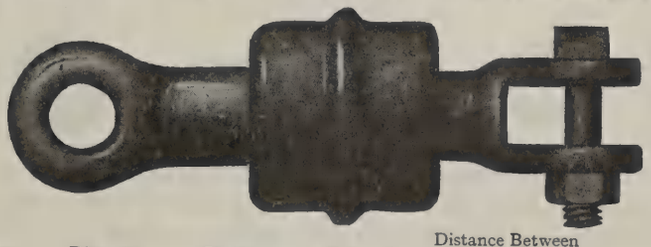
WITH TWO MALLEABLE IRON EYES—GALVANIZED

	Diameter Body, Inches	Diameter Eyes, Inches	Eyes Like Fig. No.	Distance Between Centers of Eyes, Inches	Per 100 Wt., Lbs.	Per 100 List Price
	2	11/16	I	5 5/16	130	$ 98 00
49394	2	11/16 and 1 1/16	I and III	5 1/8	130	108 00
49395	2	1 1/16	III	4 15/16	130	118 00
92149	2½	11/16	II	6 1/4	245	144 00
84143	2½	11/16 and 1 1/16	II and IV	6 3/16	245	154 00
49397	2½	1 1/16	IV	6 1/8	245	164 00

NOTE—Style No. 49443 is particularly adapted for use with type D pull-overs, although any of the giant strains may be used.

When so ordered, any of the above insulators will be furnished with the eyes at right angles.

WITH MALLEABLE IRON EYES AND CLEVIS—GALVANIZED



Style No.	Diameter Body, Inches	Diameter Eyes, Inches	Clevis Opening, Inches	Eye and Clevis Like Fig. Nos.	Distance Between Centers of Eye and Clevis Bolt Inches	Per 100 Wt., Lbs.	Per 100 List Price
84145	2	11/16	5/8	I–V	5 3/32	135	$108 00
49396	2	1 1/16	5/8	III–V	4 29/32	135	118 00
84144	2½	11/16	13/16	II–VI	6 5/32	250	164 00
49398	2½	1 1/16	13/16	IV–VI	6 3/32	250	174 00

When so ordered, any of the above insulators will be furnished with the eye at right angles to the clevis bolt.

The body dimensions do not include the beading at the center of these insulators.

The eye dimensions are the inside diameters.

WESTINGHOUSE GLOBE STRAIN INSULATORS

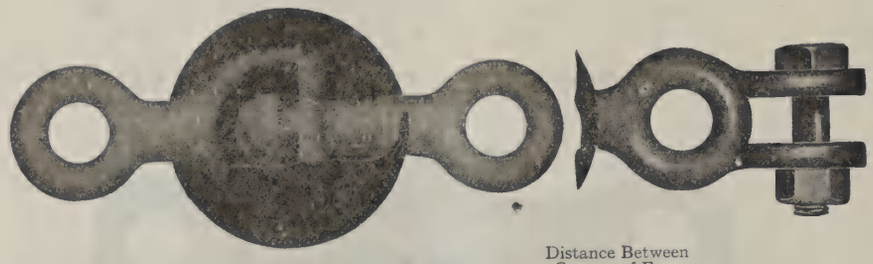
600 VOLTS

These spherical composition strain insulators are used in span wire and bridle-wire pull-off where the strain is not excessive. The rated working strain, in pounds, is approximately 1000 times the diameter in inches, allowing an ample factor of safety. As in all proper designs of line insulators, the ultimate dielectric strength is manifested across the surface of the insulator.

The ends of the metal fittings which are embedded in the composition are elliptical, the head of the one being at right angles to the ring of the other, which practically assures maintaining the mechanical hold in the event of injury to the insulation.

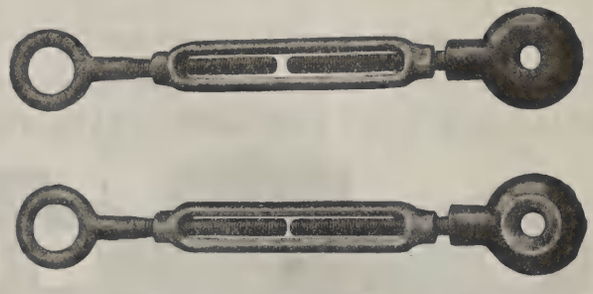
The 2½-inch globe strains may be used in connection with type D pull-overs.

EYE AND CLEVIS GALVANIZED



Style No.	Description	Distance Between Centers of Eyes or Eye and Clevis	Per 100 Wt., Lbs.	Per 100 List Price
92146	2-inch diameter—two ½-inch eyes	3¾	70	$ 70 00
92147	2½-inch diameter—two ⅝-inch eyes	4 5/16	105	90 00
97512	2-inch diameter—with eye and clevis	5	100	85 00
97513	2½-inch diameter—with eye and clevis	5 11/16	132	105 00

TYPE TC INSULATED TURNBUCKLES



The type TC is a drop-forged steel turnbuckle having one eye insulated with Westinghouse composition; those with cylindrical eyes are for attachment to bolt, and with oval eyes for use with cable. All metal parts are galvanized.

Style Nos. With Cylindrical Eye	Style Nos. With Oval Eye	Dimensions, Inches Adjustment	Diameter Bolts	Distance Between Eye Centers When Contracted	Per 100 Approx. Net Wt., Lbs.	Per 100 List Price
120867	119919	6	½	13½	220	$220 00
126496	126524	6	⅝	13½	260	270 00
126498	126526	9	½	15½	260	280 00
126500	126528	9	⅝	15½	365	330 00
120869	119921	12	⅝	18½	410	390 00

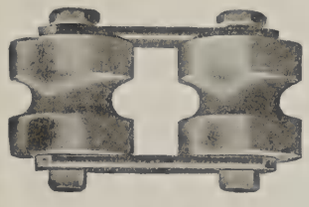
INSULATED FORK BOLTS

All metal parts are sherardized.

Style No.	Size, Inches	Description	Per 100 Approx. Net Wt., Lbs.	Per 100 List Price
138260	½x12	With porcelain spool	190	$ 80 00
138262	⅝x12	With porcelain spool	255	95 00
138264	⅝x14	With porcelain spool	270	100 00
138266	½x12	With composition spool	185	100 00
138268	⅝x12	With composition spool	250	115 00
138270	⅝x14	With composition spool	265	120 00

SPOOL-TYPE STRAIN INSULATORS

600 VOLTS

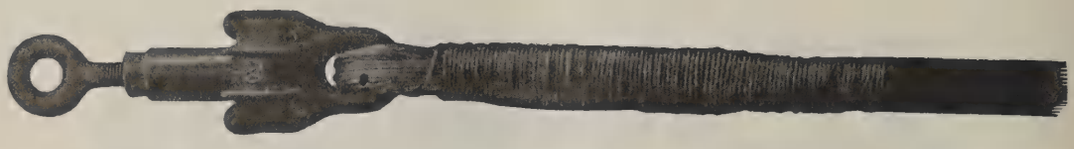


This insulator consists of two $\frac{3}{16}$-inch by 1-inch strap irons, two $\frac{3}{8}$-inch bolts, and two spool insulators. The creepage distance is approximately $1\frac{3}{8}$ inches. The metal parts are galvanized.

Style No.	Description	Per 100 Wt., Lbs.	Per 100 List Price
101942	With porcelain spools	125	$100 00
127061	Porcelain spool only	33	10 00

WESTINGHOUSE BROOKLYN STRAIN INSULATORS
750 VOLTS

STYLE NO. 281781



STYLE NO. 281781 ENGAGING A 1,000,000 C. M. CABLE DEAD ENDED

These turnbuckle insulators consist of a metal head and insulated body. The body is made of Westinghouse moulded insulation and contains a metal sleeve into which a drop forged eye bolt is threaded. A brass ferrule protects the insulation from the wear of the metal cap.

The cap is made of two malleable iron castings held together by fillister head brass screws.

The eye in the cap is made oval to facilitate dead ending heavy cables. The standard size will accommodate cables up to 500,000 circular mils and the large size, cables up to 1,000,000 circular mils.

The Standard Size Brooklyn Strain Insulator has a ⅝-inch eye bolt with 3 inches take-up. The eye in the cap has a minimum diameter of one inch and a maximum diameter of 1¼ inches.

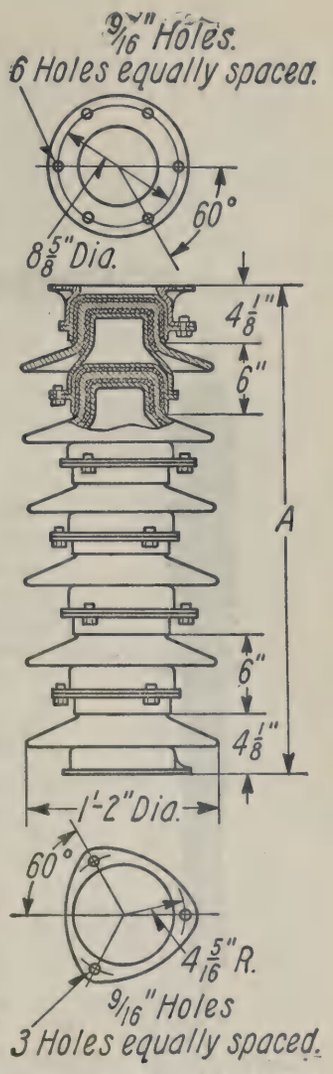
The Large Size Brooklyn Strain Insulator has a ¾-inch eye bolt with 3½ inches take-up. The eye in the cap has a minimum diameter of 1 1/16 inches, and a maximum diameter of 1¾ inches.

Style No.	Description	Per 100 Wt. Lbs.	Per 100 List Price
281780	Standard size, sherardized	262	$250.00
281781	Large size, sherardized	513	360.00

PILLAR INSULATORS

These pillar or post type insulators are made up in units which can be bolted together to make up an insulator for any voltage. The units from which this insulator is constructed are built up on 6-inch centers. Each additional unit adding 6 inches to the height of the insulator. Each unit consists of a porcelain bell provided with a cemented on cap and a cemented in hollow pin, which is used as the base for the complete pillar insulators, styles No. 245987, to No. 245995 inclusive. These caps and pins are each provided with 3 lugs that fit together and are secured by ½-inch machine bolts. In this way any section can be removed and replaced by another with the use of no other tool than a wrench. The method of bolting together is such that rusting cannot prevent the joint being opened when desired and no adjustment is required in fitting in a new section.

These insulators are suitable for both indoor and outdoor use. There is no possibility of any turning of the units with respect to each other. They are the strongest and most rugged of this kind manufactured. The porcelain is mahogany glazed, the metal parts are regularly furnished painted black, but can be galvanized at an increased price if so ordered.



Insulators are regularly furnished with top casting Style No. 246112, as listed. A few special top castings and bases have been designed for different applications, but the pillar insulator with top casting Style No. 246112 is sufficient for all ordinary purposes.

Style No.	Description	Line Voltage	Dry Arcover Voltage	Wet Arcover Voltage	Dim. A Inches	Each Ship. Wt., Lbs.	Each List Price
245987	2 Units with top cast	30000	120000	60000	14⅝	110	$28 50
245988	3 Units with top cast	47000	175000	95000	20⅝	155	41 00
245989	4 Units with top cast	65000	235000	130000	26⅝	200	53 50
245990	5 Units with top cast	80000	285000	160000	32⅝	230	66 00
245991	6 Units with top cast	97000	330000	195000	38⅝	290	78 50
245992	7 Units with top cast	115000	375000	230000	44⅝	315	91 00
245993	8 Units with top cast	130000	410000	265000	50⅝	395	103 50
245994	9 Units with top cast	140000	450000	300000	56⅝	445	116 00
245995	10 Units with top cast	150000	485000	335000	62⅝	500	128 50
246112	Top casting only	.....	.....	.....	....	7	3 50
226244	Single unit without top casting	.....	.....	.....	....	40	12 50

This pillar insulator can be suspended when required and used in tension as indicated in the following table.

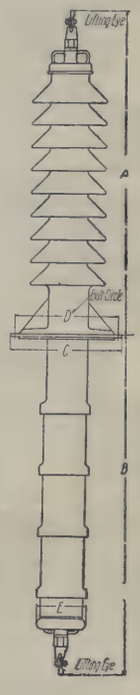
Mechanical Data

Style No.	Ultimate Bending Load in Pounds	Ultimate Pulling Load in Pounds
245987	3940	10000
245988	2800	10000
245989	2160	10000
245990	1760	10000
245991	1490	10000
245992	1290	10000
245993	1130	10000
245994	1010	10000
245995	920	10000

CONDENSER TYPE ROOF BUSHINGS

The condenser type roof bushing may be used to advantage wherever it is required to pass conductors vertically at high potential through material at ground potential. They should not be used at an angle to the vertical exceeding 10 degrees and cannot be used in a horizontal position. Nominally made for a maximum current of 200 amperes, but the current capacity can be increased at slight cost. A pressed tube copper terminal is regularly furnished at both ends and can be set at any angle or direction.

Prices will be quoted on application.



Style No.	Maximum Line Voltage	Leakage Dist. Outdoor End	Approximate Dimensions						Approx. Wt. Lbs., Each	
			A	B	C	D	E	Bolts	Net	Crated
268250	45000	3′-4″	3′-3″	3′-7″	1′-4¾″	1′-3 ″	9¼″	4 of ⅝″	275	550
268251	73000	4′-9″	4′-2″	4′-4″	1′-9″	1′-7¼″	9¼″	6 of ⅝″	425	700
268252	95000	7′-6″	5′-1″	5′-3″	1′-9″	1′-7¼″	9½″	6 of ⅝″	575	1100
268253	115000	9′-7″	5′-11″	6′-0″	1′-9″	1′-7¼″	9½″	6 of ⅝″	725	1425
268254	135000	11′-8″	6′-7″	6′-8″	1′-9″	1′-7¼″	1′-3″	6 of ¾″	1100	2000
268255	155000	14′-2″	7′-3″	7′-4″	1′-9″	1′-7¼″	1′-3″	6 of ¾″	1500	2500

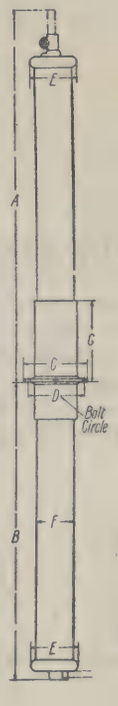
Current transformers may be mounted below the flange on voltages up to 115000. Higher voltages will require a suspension from the underside of the roof to carry the current transformer. The minimum satisfactory primary current for operating relays or indicating instruments is approximately 75 amperes. Dimension *E* in the above table will be increased if a current transformer is mounted on the bushing.

CONDENSER TYPE WALL OR FLOOR BUSHINGS

The condenser type wall or floor bushings can be used at any angle. They cannot be used outdoors or where water will condense on the bushing and are for inside service only.

They are nominally for a maximum current of 200 amperes, but the current capacity can be increased at slight cost.

Prices will be quoted on application.



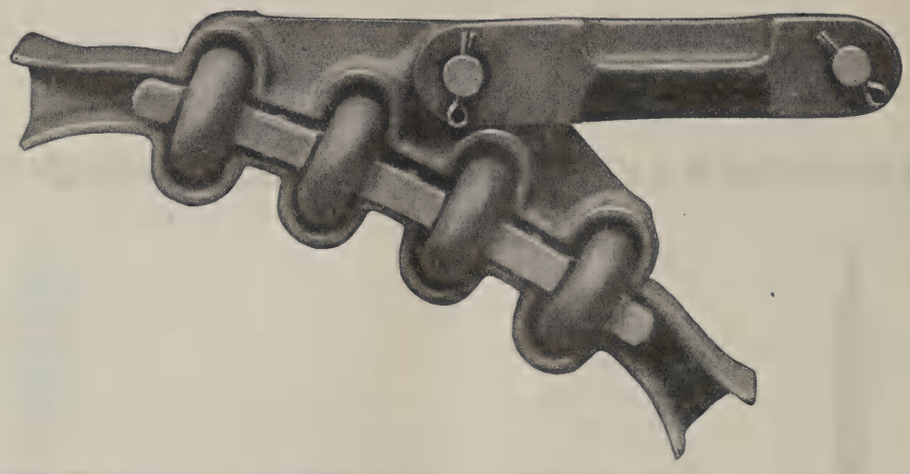
Style No.	Max. Line Voltage	Dimensions								Approx. Wt., Lbs. Each	
		A	B	C	D	E	F	G	Bolts	Net	Crated
268346	73000	4′-4″	3′-11″	1′-1″	11″	9¼″	5¼″	1′-3″	4 of ⅝″	225	400
268347	95000	5′-4″	4′-11″	1′-1″	11″	9¼″	7½″	1′-3″	4 of ⅝″	350	660
268348	115000	6′-0″	5′-5″	1′-1″	11″	9¼″	8½″	1′-3″	4 of ⅝″	450	800
268349	135000	6′-8″	6′-1″	1′-8″	1′-5¼″	1′-3¼″	9½″	1′-3″	6 of ⅝″	700	1200
268350	155000	7′-4″	6′-9″	1′-8″	1′-5½″	1′-3¼″	10½″	1′-3″	6 of ¾″	1075	1600

These bushings are furnished with pressed tube copper terminals which can be set at any angle or direction.

TRANSMISSION LINE FITTINGS

SUSPENSION STRAIN CLAMPS—Type TB

Without Arcing Horns

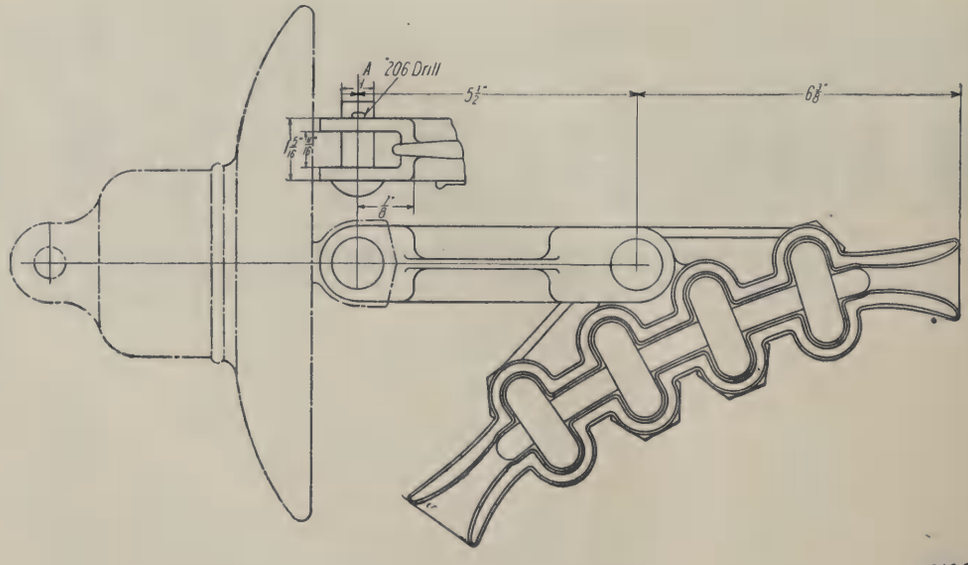


The type TB suspension strain clamp is designed for use with high-tension transmission lines using suspension-type insulators. The only loose part to be handled is the malleable-iron shoe which protects the cable from the action of the hook bolts. This shoe is provided with a wave surface corresponding with the waves in the clamp, thus obtaining a powerful grip on the cable. The end of the clamp has a large radius so that the cable cannot be injured where it leaves the clamp.

With standard clevis, the clamp is suitable for suspension insulators 10 inches in diameter. By substituting a longer clevis (on special order) a suspension insulator of greater diameter can be used.

Style No.	Diameter of Conductor Min.	Max.	Diam. of Pin "A"	Per 100 Weight Lbs.	Per 100 List Price
		For Conductors up to and including 0000			
247351	.25 inch	.50 inch	½ inch	950	$420 00
202036	.25 inch	.50 inch	⅝ inch	950	420 00
		For Conductors from 0000 up to and including 300,000 cir. mils.			
287547	.46 inch	.62 inch	½ inch	1030	565 00
271881	.46 inch	.62 inch	⅝ inch	1030	565 00
271880	.46 inch	.62 inch	¾ inch	1030	565 00

All parts Sherardized.



846-26

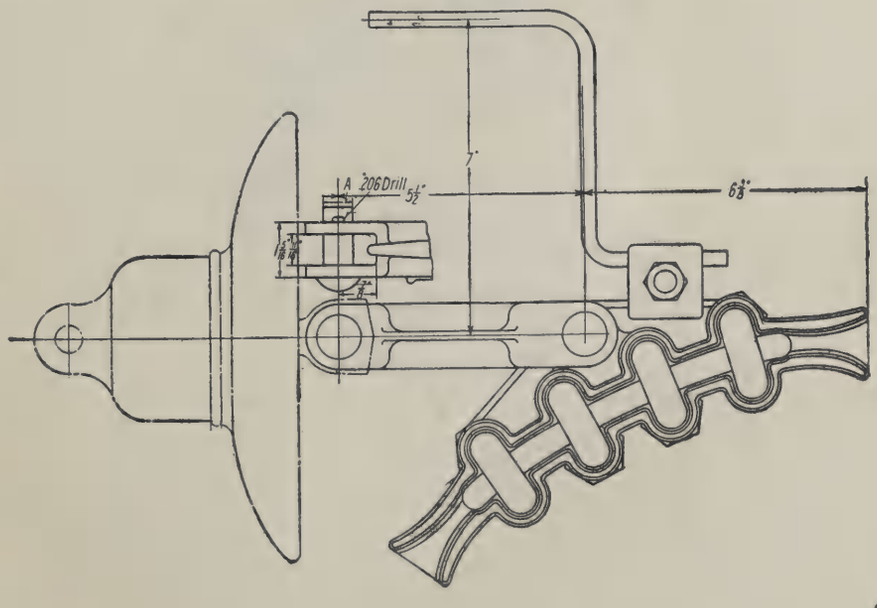
TRANSMISSION LINE FITTINGS—Continued

SUSPENSION STRAIN CLAMPS—Type TB

With Arcing Horn

Style No.	Diameter of Conductors Min.	Max.	Diam. of Pin "A"	Per 100 Weight Lbs.	Per 100 List Price
For Conductors up to and including 0000					
277957	.25 inch	.50 inch	⅝ inch	1075	$475 00
277958	.25 inch	.50 inch	½ inch	1075	475 00
271882	Arcing Horn only			125	55 00
For Conductors from 0000 up to and including 300,000 cir. mil.					
281134	.46 inch	.62 inch	¾ inch	1155	620 00
281135	.46 inch	.62 inch	⅝ inch	1155	620 00
268599	.46 inch	.62 inch	½ inch	1155	620 00
271882	Arcing Horn only			125	55 00

All parts are Sherardized.



846-27A

TRANSMISSION LINE FITTINGS—Continued

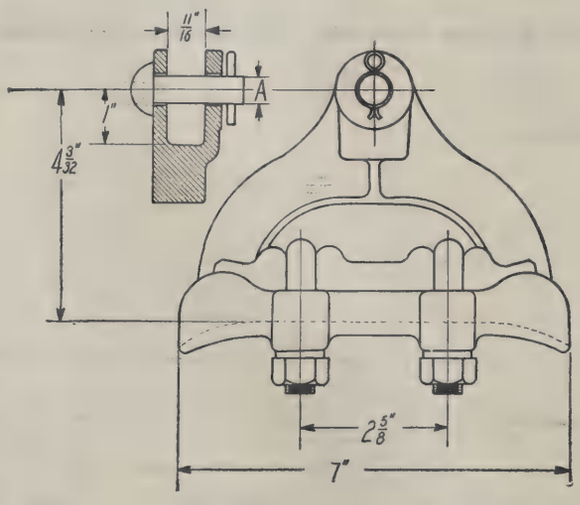
SUSPENSION WIRE CLAMPS—Type FR

Without Arcing Horns

For Conductors from 0 to 0000

Style No.	Diameter of Conductor Min.	Max.	Diam. of Pin "A"	Per 100 Weight Lbs.	Per 100 List Price
287548	.37 in.	.46 in.	½ in.	400	$200 00
287549	.37 in.	.46 in.	⅝ in.	400	200 00

All Parts are Sherardized.

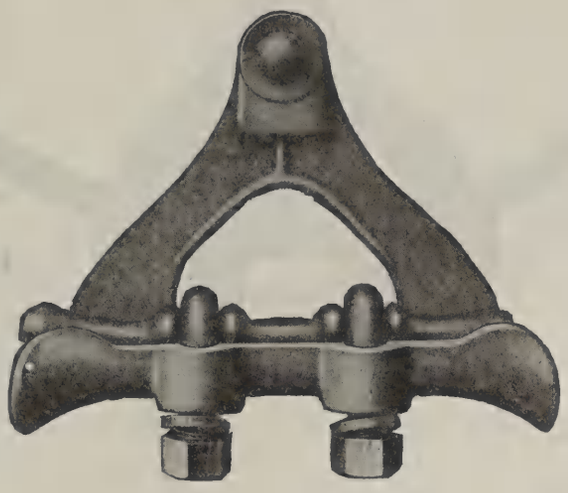


TRANSMISSION LINE FITTINGS—Continued

SUSPENSION WIRE CLAMPS—Type FR

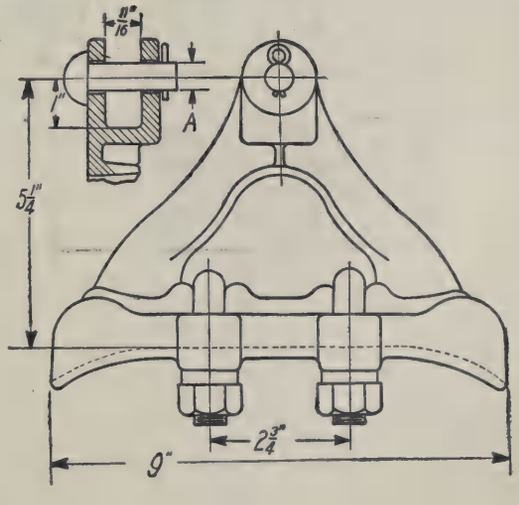
Without Arcing Horns

For Conductors 0000 to 300,000 cir. mils.



Style No.	Diameter of Conductor Min.	Max.	Diam. of Pin "A"	Per 100 Weight, Lbs.	List Price
287557	.46 inch	.62 inch	½ inch	650	$340 00
287558	.46 inch	.62 inch	⅝ inch	650	340 00

All parts are Sherardized.



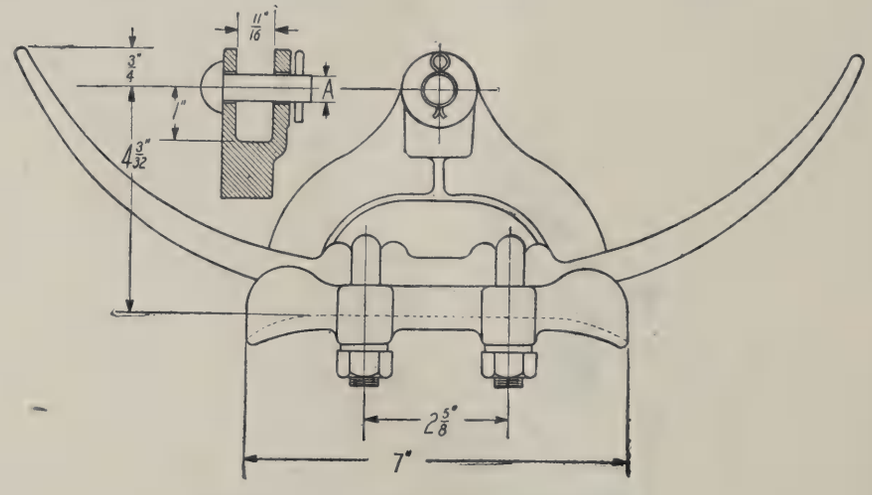
SUSPENSION WIRE CLAMPS—Type FR

With Arcing Horns

For Conductors from 0 to 0000

Style No.	Diameter of Conductor Min.	Diameter of Conductor Max.	Diam. of Pin "A"	Per 100 Weight Lbs.	Per 100 List Price
281140	.37 in.	46 in.	½"	460	$240 00
281139	.37 in.	46 in.	⅝"	460	240 00

All Parts are Sherardized.

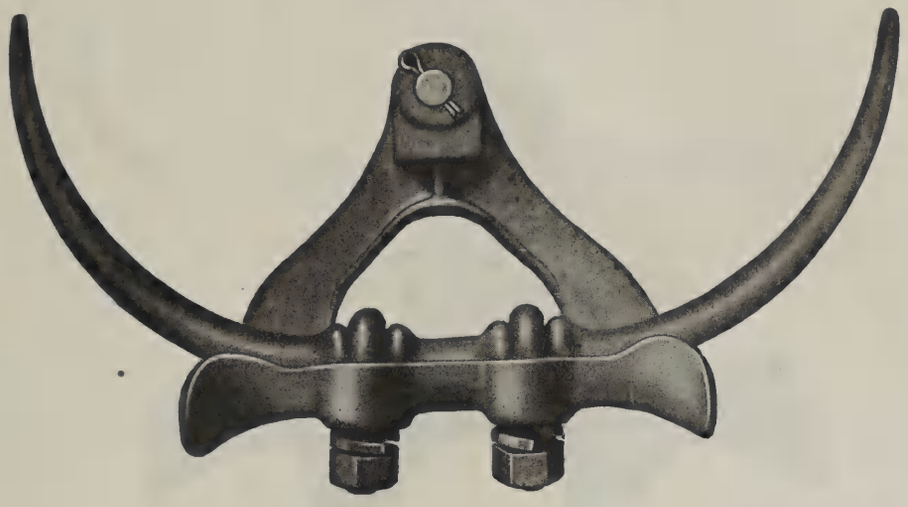


TRANSMISSION LINE FITTINGS—Continued

SUSPENSION WIRE CLAMPS—Type FR

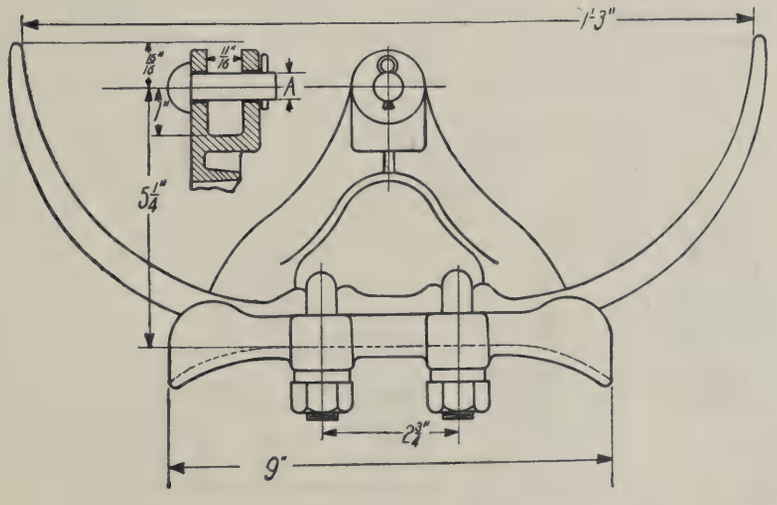
With Arcing Horns

For Conductors 0000 to 300,000 cir. mils.



Style No.	Diameter of Conductor Min.	Max.	Diam. of Pin "A"	Per 100 Weight, Lbs.	List Price
273474	.46 inch	.62 inch	½ inch	730	$390 00
273475	.46 inch	.62 inch	⅝ inch	730	390 00

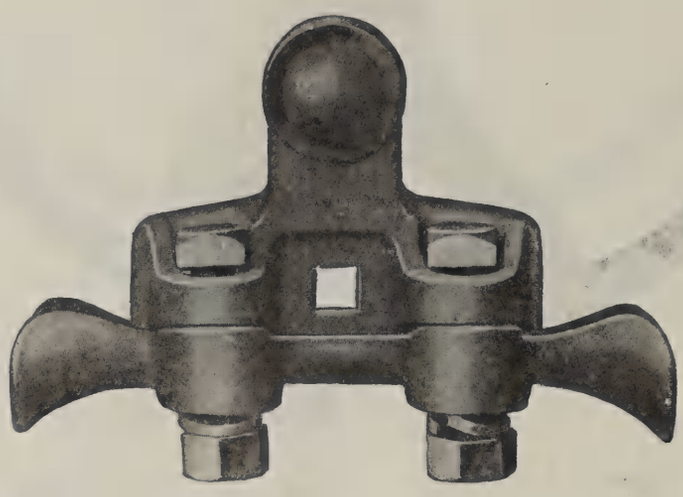
All parts are Sherardized.



TRANSMISSION LINE FITTINGS—Continued

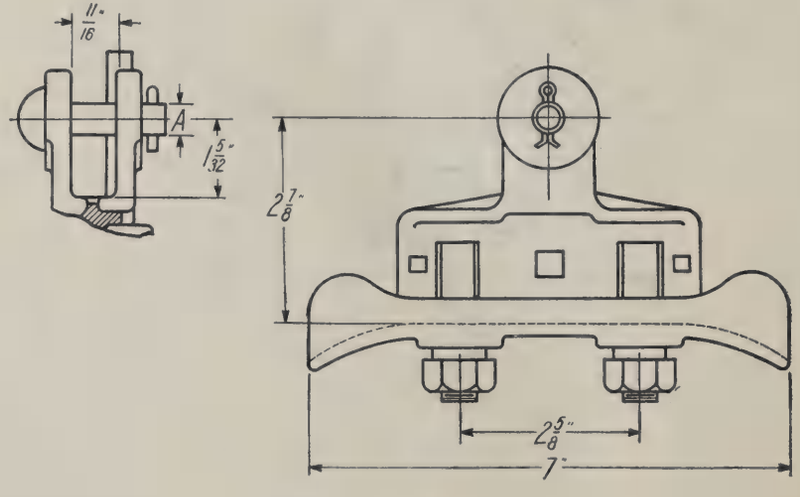
SUSPENSION WIRE CLAMPS—Type AD
Without Arcing Horns

For Conductors 0 to 000, Inclusive



Style No.	Diameter of Conductor Min.	Max.	Diam. of Pin "A"	Per 100 Weight Lbs.	Per 100 List Price
251254	.37 inch	.46 inch	½ inch	425	$160 00
184086	.37 inch	.46 inch	⅝ inch	425	160 00

All parts are Sherardized.



TRANSMISSION LINE FITTINGS—Continued

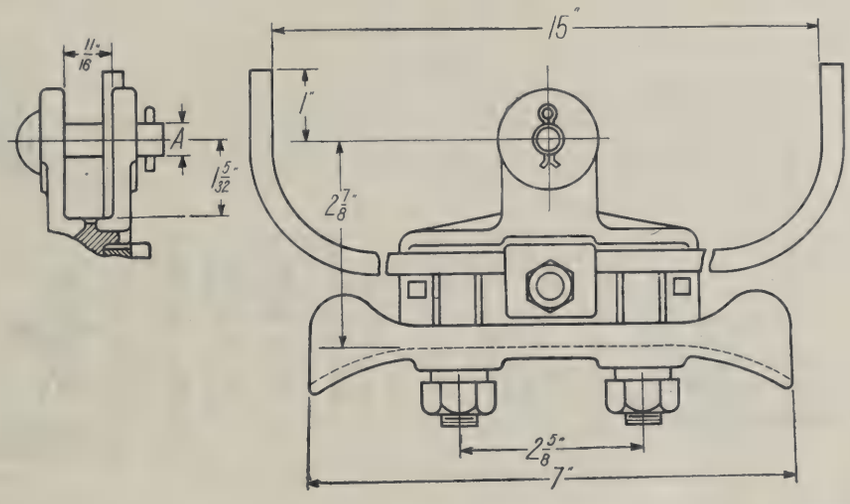
SUSPENSION WIRE CLAMPS—TYPE AD

With Arcing Horns

For 0 to 000 Wire Inclusive

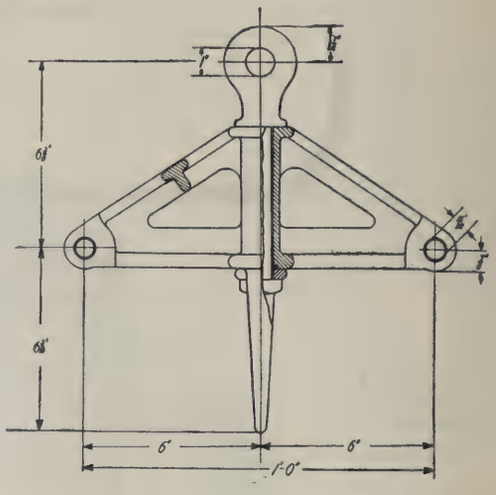
Style No.	Diameter of Min. Conductor, Max.	Diam. of Pin "A"	Per 100 Weight, Lbs.	Per 100 List Price
273472	.37 inch .46 inch	½ inch	406	$220 00
273473	.37 inch .46 inch	⅝ inch	406	220 00

All parts are Sherardized.

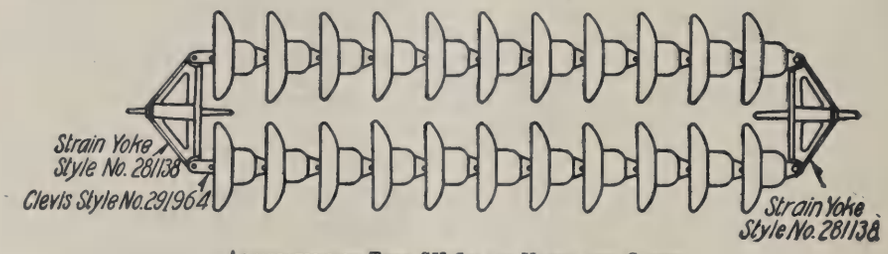


STRAIN YOKES—Type SK

Sheraradized

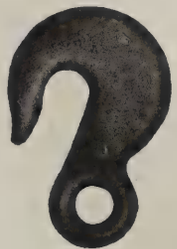


Style No.	Description	Per 100 Weight Lbs.	Per 100 List Price
281138	Top Yoke with eye, with arcing horn	980	$620 00
293694	Top Yoke with eye, without arcing horn	800	540 00
293689	Bottom Yoke with eye, with arcing horn, with ½" clevis links	1180	780 00
293690	Bottom Yoke with eye, with arcing horn, with ⅝" clevis links	1180	780 00
293696	Bottom Yoke with eye, without arcing horn, with ½" clevis links	1000	700 00
293697	Bottom Yoke with eye, without arcing horn, with ⅝" clevis links	1000	700 00

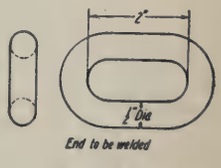


APPLICATION OF TYPE SK STRAIN YOKES AND CLEVIS

STYLE NO.
286016 OR 291964



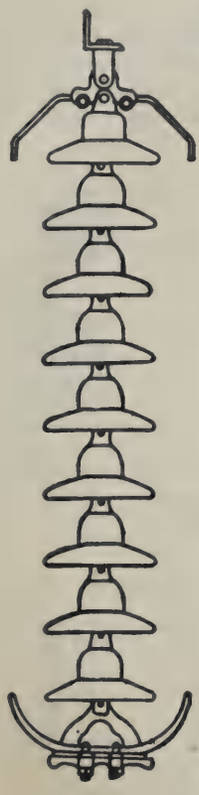
STYLE NO.
272537



STYLE NO.
188857

Style No.	Description	Per 100 Weight Lbs.	Per 100 List Price
286016	Clevis with ½ inch pin, Sherardized	100	$80 00
291964	Clevis with ⅝ inch pin, Sherardized	100	80 00
272537	Drop forged hook, Sherardized	100	70 00
188857	Welded suspension link, Sherardized	35	10 00

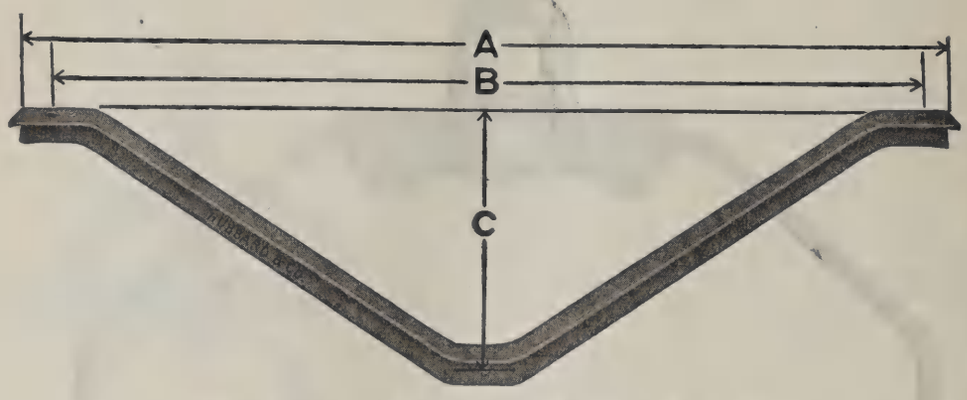
ARCING HORN FOR UPPER SUSPENSION—Type O



This device is used to provide arcing horns at the cross arm end of a string of suspension insulators. It is used on tangent line. It consists of a malleable iron casting, a large oval eye and recessed grooves to take two square iron rods which are held in place by means of two carriage bolts. The arcing horns are adjustable; standard distance between points is 15 inches.

Style No.	Description	Per 100 Weight Lbs.	Per 100 List Price
287556	Arcing horn complete Sherardized	300	$90 00

ANGLE CROSS-ARM BRACES



ANGLE STEEL CROSS-ARM BRACE, SHOWING METHOD OF MEASURING

In the construction of heavy pole lines, particularly for high-voltage circuits, a one-piece cross-arm brace made of angle steel is in general use. The Angle, or Drop Brace, as it is sometimes called, gives greater strength and rigidity to the arm than can be secured with standard flat braces. It is fastened to the arm by a carriage bolt at each end, and to the pole by a lag screw.

The sizes listed below are standard with a number of large operating companies. All braces have three $\frac{9}{16}$-inch holes, although any other size of holes will be furnished on order.

Braces of any desired dimensions can be furnished, and in ordering special sizes, please give the dimensions A, B and C, as indicated in the illustration, and state size of holes and size of angle desired. Regularly furnished hot galvanized but can be furnished plain when specified.

Style No.	Size Angle	Dimensions in Inches A	B	C	Per 100 Wt., Lbs.	List Price
252740	1½x1½x$\frac{3}{16}$	40	37	12	720	$ 47 50
196081	1½x1½x$\frac{5}{16}$	45	42	12	780	50 00
196082	1½x1½x$\frac{3}{8}$	51	48	14¾	885	55 50
196083	1¾x1¾x$\frac{5}{16}$	63	60	18	1295	78 00
196084	1¾x1¾x$\frac{3}{8}$	69	66	20	1365	82 00
252741	1¾x1¾x$\frac{5}{16}$	75	72	18	1450	86 50
196085	2 x2 x$\frac{3}{16}$	75	72	22	1830	104 50

STANDARD CROSS-ARM BRACES

CROSS-ARM BRACE

These braces have a $\frac{7}{16}$-inch hole at one end and a $\frac{9}{16}$-inch hole at the other. Supplied hot galvanized unless otherwise ordered. Plain braces and special sizes supplied on special order.

Style No.	Size, Inches	Per 100 Approx. Net Wt., Lbs.	List Price	Style No.	Size, Inches	Per 100 Approx. Net Wt., Lbs.	List Price
102259	20x1 x$\frac{3}{16}$	100	$ 8 00	102289	24x1¼x¼	200	$14 90
102273	20x1$\frac{7}{16}$x$\frac{3}{16}$	142	10 60	102276	26x1$\frac{7}{16}$x$\frac{3}{16}$	184	13 75
102287	20x1¼x¼	167	12 45	102290	26x1¼x¼	216	16 15
102260	22x1 x$\frac{3}{16}$	110	8 80	102277	28x1$\frac{7}{16}$x$\frac{3}{16}$	198	14 80
102274	22x1$\frac{7}{16}$x$\frac{3}{16}$	156	11 65	102291	28x1¼x¼	233	17 40
102288	22x1¼x¼	183	13 70	102278	30x1$\frac{7}{16}$x$\frac{3}{16}$	212	15 80
102261	24x1 x$\frac{3}{16}$	120	9 60	102292	30x1¼x¼	250	18 60
102275	24x1$\frac{7}{16}$x$\frac{3}{16}$	170	12 70				

THROUGH BOLTS

All bolts up to 12 inches have 4-inch thread. All bolts longer than 12 inches have 6-inch thread. Hot galvanized.

Style No.	Size, Inches	Approx. Net Wt., Lbs. Per 100	List Price Per 100
137231	½x10	65	$ 8 02
137232	½x11	71	8 54
137233	½x12	76	9 06
137234	½x13	82	9 58
137235	½x14	87	10 10
137236	½x15	93	10 62
137237	½x16	98	11 14
137238	½x17	104	11 66
137239	½x18	109	12 18
137240	½x19	115	12 70
137241	½x20	120	13 22
137242	⅝x10	105	$11 66
137243	⅝x11	113	12 42
137244	⅝x12	121	13 18
137245	⅝x13	130	13 94
137246	⅝x14	138	14 70
137247	⅝x15	146	15 46
137248	⅝x16	155	16 22
137249	⅝x17	163	16 98
137250	⅝x18	171	17 74
137251	⅝x19	180	18 50
137252	⅝x20	188	19 26
196637	¾x10	157	$17 05
196638	¾x11	169	18 15
196639	¾x12	181	19 25
196640	¾x13	193	20 35
196641	¾x14	205	21 45
196642	¾x15	216	22 55
196643	¾x16	228	23 65
196644	¾x17	240	24 75
196645	¾x18	252	25 85
196646	¾x20	275	28 05

STANDARD MACHINE BOLTS

With Square Heads and Hot-Pressed Square Nuts

All parts hot galvanized. The length of thread is approximately three times the diameter.

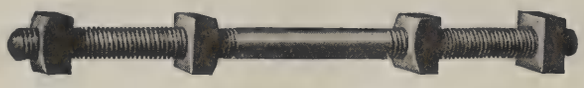
Style No.	Size, Inches	Approx. Net Wt., Lbs. Per 100	List Price Per 100
196713	⅜x4	16.5	$3 20
136849	⅜x4½	18.0	3 36
136850	⅜x5	19.5	3 52
136851	⅜x5½	21.0	3 68
136852	⅜x6	22.5	3 84
136858	½x4	32.8	4 90
136859	½x4½	35.4	5 16
136860	½x5	38.1	5 42
136861	½x5½	40.7	5 68
136862	½x 6	43.4	$ 5 94
136863	½x 6½	46.0	6 20
136864	½x 7	48.7	6 46
136866	½x 8	54.0	6 98
136867	½x 9	59.5	7 50
136868	½x10	65.0	8 02
136872	⅝x 8	88.2	10 14
136873	⅝x 9	96.5	10 90
136874	⅝x10	104.8	11 66
136875	⅝x11	113.1	$12 42
136876	⅝x12	121.4	13 18
136878	¾x [illegible]	131.6	14 85
136879	¾x 9	143.8	15 95
136880	¾x10	156.0	17 05
136881	¾x11	168.2	18 15
136882	¾x12	180.4	19 25
136883	¾x13	192.6	20 35
136884	¾x14	204.8	21 45

CARRIAGE BOLTS

The length of thread is approximately three times the diameter. All parts are hot galvanized.

Style No.	Size, Inches	Approx. Net Wt., Lbs. Per 100	List Price Per 100
137266	⅜x2½	12	$2 22
196714	⅜x3	13	2 38
137268	⅜x3½	14	2 54
137270	⅜x4	16	2 70
137272	⅜x4½	18	2 86
137273	⅜x5	19	3 02
137275	½x4	30	$4 09
196715	½x4½	33	4 37
137276	½x5	35	4 65
196716	½x5½	38	4 93
137277	½x6	40	5 21

SPACING BOLTS



Cross-arm spacing or double arming bolts are threaded at both ends and fitted with four nuts, but no washers, the latter being supplied on separate order. 12-inch bolts are threaded 5 inches; 13 and 14-inch bolts, 6 inches; 15 and 16-inch bolts, 7 inches; and 17-inch and longer bolts, 8 inches. These bolts are hot galvanized.

Style No.	Size Inches	Approx. Net Wt., Lbs. Per 100	List Price Per 100	Style No.	Size Inches	Approx. Net Wt., Lbs. Per 100	List Price Per 100	Style No.	Size Inches	Approx. Net Wt., Lbs. Per 100	List Price Per 100
196802	½x12	71	$12 70	196803	⅝x12	143	$19 44	196804	¾x12	225	$28 80
196805	½x13	85	13 22	196806	⅝x13	150	20 20	196807	¾x14	249	31 00
196808	½x14	89	13 74	196809	⅝x14	158	20 96	196810	¾x15	260	32 10
196811	½x15	93	14 26	196812	⅝x15	165	21 72	196813	¾x16	272	33 20
196814	½x16	97	14 78	196815	⅝x16	173	22 48	196816	¾x17	283	34 30
196817	½x17	100	15 30	196818	⅝x17	180	23 24	196819	¾x18	295	35 40
196820	½x18	104	15 82	196821	⅝x18	188	24 00	196822	¾x20	318	37 60
196823	½x20	112	16 86	196824	⅝x20	202	25 52	196825	¾x22	341	39 80
196826	½x22	120	17 90	196827	⅝x22	216	27 04	196828	¾x24	364	42 00

DROP FORGED EYE BOLTS
With Nut and Washer

The lengths given below are measured from center of eye to end of bolt. All parts hot galvanized.

Style No.	Dimensions, Inches: Diameter Bolt	Dimensions, Inches: Length	Length Thread	Approx. Net Wt. Lbs. Per 100	List Price Per 100
83393	½	5	3⅛	35	$15 00
136898	½	6	4	56	15 00
136818	½	7	5	62	15 52
101953	½	10	6	77	17 08
101954	½	12	6	87	18 12
101955	½	14	6	97	19 20
101956	½	16	6	107	20 24
136817	⅝	8	6	111	20 02
101957	⅝	10	6	128	21 54
101958	⅝	12	6	144	23 06
101959	⅝	14	6	160	24 58
101960	⅝	16	6	177	26 10
196717	¾	12	6	214	32 25
196718	¾	14	6	238	34 45
196719	¾	16	6	262	36 65
196720	¾	18	6	268	35 85

STANDARD LAG SCREWS

Fetter drive or twist drive will be furnished if specified on order. Regularly furnished hot galvanized.

Standard Lag Screw
(With Gimlet Point)

Style No.	Size Inches	Approx. Net Wt. Lbs. Per 100	List Price Per 100	Style No.	Size Inches	Approx. Net Wt. Lbs. Per 100	List Price Per 100
196721	⅜x2	8	3 96	137300	½x3	20	$4 92
196722	⅜x2½	9	3 22	137301	½x3½	22	5 19
137294	⅜x3	10	3 48	137302	½x4	24	5 55
137295	⅜x3½	11	3 74	137303	½x4½	26	5 91
137296	⅜x4	12	4 00	137304	½x5	29	6 27
196723	⅜x4½	13	4 26	137306	½x6	34	6 99
196724	⅜x5	14	4 52	137307	½x7	39	7 71
				137309	½x8	44	8 48

WASHERS

POSITIVE LOCK WASHERS

Style No.	Dimensions, Inches: Bolt Fit	Diameter Hole	Outside Diameter	Thickness	Approx. Net Wt., Lbs. Per 1000	List Price Per 100
137372	⅜	13/32	25/32	3/16	12	$1 00
137373	½	17/32	1 1/16	3/16	22	1 20
137374	⅝	21/32	1 5/16	3/16	35	1 25
137375	¾	13/16	1 5/8	3/16	63	1 50
137376	⅞	15/16	1 29/32	1/4	83	1 70
137377	1	1 1/16	1 13/16	1/4	111	2 25

Furnished sherardized unless otherwise ordered.

ROUND PLATE WASHERS

Style No.	Dimensions, Inches: Bolt Fit	Diameter Hole	Outside Diameter	Thickness, Wire Gauge	Approx. Net Wt., Lbs. Per 1000	List Price Per 100
137360	⅜	7/16	1	14	16	$0 35
137362	½	9/16	1 3/8	12	42	0 53
137364	⅝	11/16	1 3/4	10	75	0 85
137365	¾	13/16	2	9	112	1 15

Furnished hot galvanized unless otherwise ordered.

SQUARE PLATE WASHERS

Style No.	Bolt Fit, Inches	Size, Inches	Approx. Net Wt., Lbs. Per 100	List Price Per 100
137331	½	2 x2 x1/8	15	$1 25
137333	½	2¼x2¼x5/16	25	2 00
137335	½	3 x3 x5/16	45	3 75
137336	⅝	2 x2 x1/8	14½	1 25
137338	⅝	2¼x2¼x5/16	25	2 00

Style No.	Bolt Fit, Inches	Size, Inches	Approx. Net Wt., Lbs. Per 100	List Price Per 100
137340	5/8	3x3x1/4	45	$ 3 75
137341	5/8	4x4x1/4	83	6 75
137343	3/4	3x3x1/4	44	3 75
137344	3/4	4x4x1/4	82	6 75
137345	3/4	5x5x1/4	130	10 00

Furnished hot galvanized unless otherwise ordered.

"BULL-DOG" WIRE ROPE CLAMPS

Malleable Iron Clamp. Steel Bolt. Hot Galvanized

"Bull-Dog" Clamp

Style No.	Size of Strand, Inches	Per 100: Approx. Net Wt., Lbs.	List Price
102143	¼	20	$ 5 25
102144	5/16	21	5 60
102145	⅜	33	10 50
102146	½	69	15 00
102147	⅝	82	20 25
102148	¾	120	27 75

ANCHOR OR GUY RODS

Style No.	Dimensions: Diameter, Inches	Dimensions: Length, Feet	Per 100: Approx. Net Wt., Lbs.	Per 100: List Price
196725	½	5	355	46 00
188737	½	6	410	52 80
188738	½	7	465	59 60
188740	⅝	5	550	64 00
188741	⅝	6	650	74 00
188742	⅝	7	750	84 00
188743	⅝	8	850	94 00
188744	¾	6	975	108 00
188745	¾	7	1125	122 70
188746	¾	8	1275	137 40
188747	¾	9	1475	152 00
188748	1	8	2320	256 70
188749	1	10	2850	308 60

Furnished hot galvanized unless otherwise ordered.

WIRE-ROPE THIMBLES

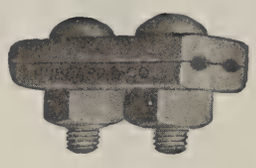
Hot Galvanized

Style No.	Size of Strand, Inches	Per 100: Approx. Net Wt., Lbs.	Per 100: List Price
102151	⅜	9½	$4 65
102152	½	22	5 25
130787	⅝	75	5 50

Furnished with ends open when specified.

STANDARD ROLLED STEEL GUY CLAMPS

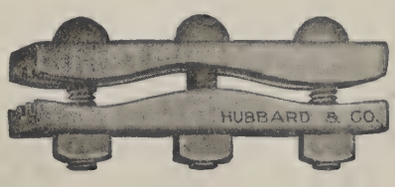
Hot Galvanized



Style No.	Description	Size of Strand, Inches	Length of Clamp, Inches	Per 100: Approx. Net Wt., Lbs.	Per 100: List Price
130582	Two-bolt clamp	¼ to $\frac{7}{16}$	3	115	$17 00
130583	Three-bolt clamp	¼ to $\frac{7}{16}$	4	185	22 85
215991	Three-bolt clamp	¼ to ½	6	210	27 25

SCHAPER FORGED GUY CLAMPS

Hot Galvanized



The plates of this clamp are drop forged of open hearth steel with grooves for guy wire of from ¼ to ½-inch diameter. ½-inch track bolts are furnished, and these, together with the deep wave of the wire grooves, give the Schaper forged clamp great holding power. The clamp is 5½ inches long and 1½ inches wide.

Style No.	Per 100: Wt., Lbs.	Per 100: List Price
252743	210	$48 25

STRAIN PLATES AND POLE SHIMS
Hot Galvanized

STRAIN PLATE

POLE SHIM

Strain Plates and Pole Shims

Style No.		Size, Inches	Per 100 Approx. Net Wt., Lbs.	Per 100 List Price
196221	Strain Plate	4 x 8	85	$8 75
187273	Pole Shim	1 x 3/16 x 8	45	4 00
187274	Pole Shim	1¼ x 3/16 x 8	60	4 75

POLE STEPS FOR TUBULAR STEEL POLES
Regularly Furnished Plain

Open hearth steel 1½ inches wide, 3/16-inch thick, is used in making steps for tubular poles. The steps are 6 inches long from pole to tip, which is turned up ½-inch. Machine bolts ½-inch diameter, 1½ inches long, are furnished with these steps.

SOLID STEP

SPLIT STEP

Solid Steps

Style No.	Nominal Size Pole, Inches	Actual Outside Diameter of Pole, Inches	Per 100 Weight, Lbs.	Per 100 List Price
126603	4	4½	215	$28 50
126604	4½	5	230	30 50
126605	5	5½	245	32 50
126606	6	6⅝	260	35 00
252753	7	7⅝	295	38 50
252754	8	8⅝	320	42 25
252755	9	9⅝	345	46 00
252756	10	10¾	375	50 00

Split Steps

Style No.	Nominal Size Pole, Inches	Actual Outside Diameter of Pole, Inches	Per 100 Weight, Lbs.	Per 100 List Price
252757	4	4½	260	$35 00
252758	4½	5	275	37 00
252759	5	5½	290	39 00
252760	6	6⅝	315	41 25
252761	7	7⅝	340	45 00
252762	8	8⅝	365	48 75
252763	9	9⅝	390	52 50
252764	10	10¾	420	56 50

POLE STEPS FOR WOOD POLES

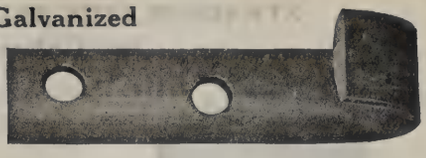
IRON POLE STEP

OAK POLE STEP

Style No.	Description	Size, Inches	Per 100 Approx. Net Wt., Lbs.	Per 100 List Price
135018	Oak, painted	1½ x 2¼ x 7	50	$1 40
82752	Iron, galvanized	⅝ dia. x 9	66	4 50
102119	Iron, galvanized	⅝ dia. x 9	81	5 55
136627	Iron, galvanized	⅝ dia. x 10	90	6 05

GUY HOOKS
Hot Galvanized

STYLE No. 206609

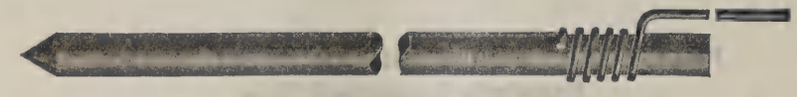


STYLE No. 196220

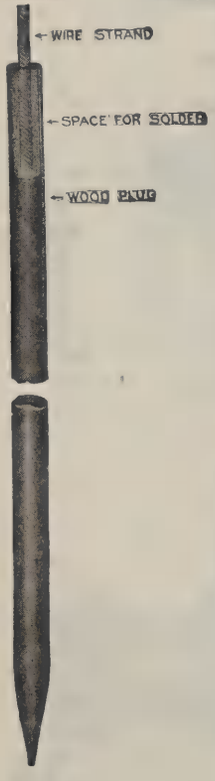
Made of half oval steel with flat side to the pole.

Style No.	Size, Inches	Description	Per 100 Approx. Net Wt., Lbs.	Per 100 List Price
206609	1¾ x ⅜ x 4	With one ½-inch hole	75	$10 00
196220	1½ x ⅜ x 6	With two $\frac{5}{16}$-inch holes	75	10 00

GROUND RODS
Hot Galvanized



Style No.	Diameter Rod Inches	Length Rod Feet	Ground Wire	Per 100 Approx. Net Wt., Lbs.	Per 100 List Price
196010	⅜	5	Without*	180	$21 80
196011	⅜	6	Without	215	25 70
196012	½	6	Without	395	50 80
196013	½	7	Without	460	57 60
196014	⅝	6	Without	600	60 00
196915	⅝	8	Without	800	80 00
196016	½	5	With†	340	58 00
196017	½	6	With	405	64 80
196018	⅝	6	With	615	80 00



*Ground rods without wire are punched with a hole one inch from the end of the rod for inserting the wire.

This hole is $\frac{3}{16}$-inch diameter in the ⅝-inch rods; $\frac{5}{32}$-inch in the ½-inch; and ⅛-inch in the ⅜-inch.

†Ground rods with ground wire have 5 turns of No. 10 (B. & S. gauge) soft copper wire soldered to the rod with 5 inches free end.

GROUND PIPES
Hot Galvanized

This ground pipe is an efficient form of driven ground rod, as it has four times as great an area in contact with the soil as a solid rod of equal weight. Its low resistance is due to the excellence of the connection made with the grounding wire or strand, which, as will be seen in the illustration, is made by filling the upper end of the pipe with molten solder after driving, and then inserting the grounding wire.

It is made of the best grade of ¾-inch wrought iron pipe, 8 feet long, is forged to a long, sharp point, and then thoroughly hot-dip galvanized, inside and out, after which the wooden plug is inserted a depth of 8 inches.

On account of its great stiffness, it is possible to drive the ground pipe in soils and to depths impossible with the ordinary ground rod.

Style No.	Per 100 Wt., Lbs.	Per 100 List Price
252768	875	$85 00

CROSS-ARMS

CROSS-ARM SPECIFICATIONS

McCormick Fir—Yellow Douglas Fir; straight grained; close grained, 85 per cent Heart, free from bark, shakes, rot, rotten or unsound knots, loose heart, worm holes, large pitch pockets, checks or wane, or sound knots larger than three-quarters of an inch in diameter.

Mississippi Yellow Pine—Genuine Mississippi Longleaf Yellow Pine, guaranteed every arm at least 75 per cent Heart (or all heart, if so specified) and free from defects, except small, sound knots, not over one inch in diameter, measurement to be made at right angles to the longitudinal axis of the knot.

Standard Grade Yellow Pine—Free from loose or unsound knots, or other defects which would injure the arm. Painted red or dipped in hot creosote oil.

To get delivered price per hundred Arms take discount from List Price and add actual freight at freight rate to destination, using weight shown in list and adopting nearest cent per hundred arms. Use exact length of arm in figuring weight.

Minimum Carload Weight—Fir 40,000 pounds. Yellow Pine, 34,000 pounds.

Special arms can be furnished from warehouses in the following sizes:

From Chicago, Fir and Yellow Pine: 2¾x3¾, 3x4¼, 3¼x4¼, 3½x4½, 3¾x4¾, and 4x5.

From Kansas City, Fir and Yellow Pine: 2¾x3¾ and 3¼x4¼.

From Minnesota Transfer, Fir only: 2¾x3¾, 3x4¼, 3¼x4¼, 3½x4½, 3¾x4¾ and 4x5.

Arms of other sizes can be shipped from factories in carloads with other material to warehouses and reshipped to destination.

FREIGHT RATE TABLE

By which to compute the price per hundred Fir Cross-Arms delivered at any rate either in carloads from the coast or in any quantity from warehouse stocks.

Per 100 Arms.....	10	20	30	40	50	60	70	80	90
3¼x4¼-									
3 feet.....	1.02	2.04	3.06	4.08	5.10	6.12	7.14	8.16	9.18
4 feet.....	1.36	2.72	4.08	5.44	6.80	8.16	9.52	10.88	12.24
5 feet.....	1.70	3.40	5.10	6.80	8.50	10.20	11.90	13.60	15.30
6 feet.....	2.04	4.08	6.12	8.16	10.20	12.24	14.28	16.32	18.36
8 feet.....	2.72	5.44	8.16	10.88	13.60	16.32	19.04	21.76	24.48
8½ feet.....	2.89	5.78	8.67	11.56	14.45	17.34	20.23	23.12	26.01
10 feet.....	3.40	6.80	10.20	13.60	17.00	20.40	23.80	27.20	30.60
3x4¼—									
6 feet.....	1.92	3.84	5.76	7.68	9.60	11.52	13.44	15.36	17.28
8 feet.....	2.56	5.12	7.68	10.24	12.80	15.36	17.92	20.48	23.04
10 feet.....	3.20	6.40	9.60	12.80	16.00	19.20	22.40	25.60	28.80
2¾x3¾—									
24 inches.....	.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00	4.50
30 inches.....	.625	1.25	1.875	2.50	3.125	3.75	4.375	5.00	5.625
36 inches.....	.75	1.50	2.25	3.00	3.75	4.50	5.25	6.00	6.75
42 inches.....	.875	1.75	2.625	3.50	4.375	5.25	6.125	7.00	7.875
62 inches.....	1.30	2.60	3.90	5.20	6.50	7.80	9.10	10.40	11.70
82 inches.....	1.70	3.40	5.10	6.80	8.50	10.20	11.90	13.60	15.30
102 inches.....	2.125	4.25	6.375	8.50	10.625	12.75	14.875	17.00	19.125
120 inches.....	2.50	5.00	7.50	10.00	12.50	15.00	17.50	20.00	22.50
3½x4½—									
3 feet 2 inches.....	1.27	2.53	3.80	5.07	6.33	7.60	8.87	10.13	11.40
5 feet 7 inches.....	2.23	4.47	6.70	8.93	11.17	13.40	15.63	17.87	20.10
8 feet.....	3.20	6.40	9.60	12.80	16.00	19.20	22.40	25.60	28.80
9 feet 2 inches.....	3.67	7.33	11.00	14.67	18.33	22.00	25.67	29.33	33.00

Rule—To get delivered price per hundred arms, take discount from list price per hundred arms f. o. b. mill and add actual freight, as per table above, at freight rate to destination. Use the nearest cent per hundred arms when quoting.

Example—Wanted to get price per hundred on a 3¼x4¼x8-foot arm delivered on a 68.7 cent freight rate.

Basis.....	$105.00
Less Discount (assuming 53-50 per cent)...	$24.675
Freight at 60 cents.....	16.32
Freight at 8 cents ($\frac{1}{10}$ of 80 cents).....	2.176
Freight at 7 cents ($\frac{1}{100}$ of 70 cents).....	.1904
	$43.3614

Using nearest cent per hundred, the price to quote would be $43.36 per hundred arms.

UNIVERSAL CROSS-ARM LIST

On Washington Fir and Mississippi Long Leaf Yellow Pine for Shipment from Mills or any Warehouse Point

STANDARD ARMS

Spacings C	Spacings S	Spacings E	Brace	Size and Length	Price Per 100 Arms	Weight Per Arm Fir Pounds	Weight Per Arm Yellow Pine Pounds
Electric Light Arms				3¼x4¼			
28	....	4	25	3 feet 2 pin	$39.375	10.2	13.2
16	12	4	28	4 feet 4 pin	52.50	13.6	17.6
18	17	4	28	5 feet 4 pin	65.625	17.	22.
22	21	4	32	6 feet 4 pin	78.75	20.4	26.4
16	12	4	32	6 feet 6 pin	78.75	20.4	26.4
18	17½	4	32	8 feet 6 pin	105.00	27.2	35.2
16	12	4	32	8 feet 8 pin	105.00	27.2	35.2
16	9¾	4	32	8½ feet 10 pin	119.125	28.9	37.4
17½	15¾	4	42	10 feet 8 pin	131.25	34.	44.
16	12	4	42	10 feet 10 pin	131.25	34.	44.
16	9⅝	3⅞	42	10 feet 12 pin	131.25	34.	44.
Railroad Arms				3x4¼			
22	21	4	32	6 feet 4 pin	73.125	19.2	24.6
16	12	4	32	6 feet 6 pin	73.125	19.2	24.6
18	17½	4	32	8 feet 6 pin	97.50	25.6	32.8
16	12	4	32	8 feet 8 pin	97.50	25.6	32.8
17½	15¾	4	42	10 feet 8 pin	121.875	32.	41.
16	12	4	42	10 feet 10 pin	121.875	32.	41.
Telephone Arms				2¾x3¾			
18	....	3	..	24 inches 2 pin	20.00	5.	6.5
24	....	3	..	30 inches 2 pin	25.00	6.25	8.⅛
30	....	3	25	36 inches 2 pin	30.00	7.5	9.75
16	10	3	28	42 inches 4 pin	35.00	8.75	11.⅜
16	10	3	28	62 inches 6 pin	51.67	13.	16.8
16	10	3	28	82 inches 8 pin	68.33	17.	22.2
16	10	3	28	102 inches 10 pin	85.00	21.25	27.⅝
16	9⅝	3⅞	28	120 inches 12 pin	100.00	25.	32.5
N. E. L. A. Arms				3½x4½			
30	....	4	28	3 feet 2 inches 2 pin	59.37	12.⅔	15.83
30	14½	4	38	5 feet 7 inches 4 pin	89.06	22.⅓	27.92
30	14½	4	38	8 feet 6 pin	118.75	32.	40.
30	12	4	38	9 feet 2 inches 8 pin	148.44	36.⅔	45.83

SPECIAL ARMS

Size	Price Per Lineal Foot or Fraction	Weight Per Lineal Foot Fir Lbs.	Weight Per Lineal Ft. Yellow Pine Lbs.
2¾x3¾	10.00 c	2.5	3.25
3 x4¼	12.187c	3.2	4.1
3¼x4¼	13.125c	3.4	4.4
3½x4½	14.844c	4.	5.
3½x4¾	15.625c	4.2	5.3
3½x5	16.406c	4.4	5.57
3¾x4¾	16.667c	4.5	5.67

Size	Price Per Lineal Foot or Fraction	Weight Per Lineal Foot Fir Lbs.	Weight per Lineal Ft. Yellow Pine Lbs.
3¾x5	17.50 c	4.7	5.95
3¾x5¾	20.00 c	5.4	6.8
4 x5	18.594c	5.	6.33
4 x6	22.135c	6.	7.52
4¾x5¾	25.00 c	6.7	8.5
5 x6	27.344c	7.3	9.29

Important—In ordering cross-arms, be very careful to specify just what is wanted, and, if other than standard boring, send sketch or blue print with order. Arms specially made are of no use for general stock, and cannot be returned if mistake is made in ordering.

All arms bored for one ⅝-inch center bolt unless otherwise specified.

Pin holes will be bored, unless otherwise specified, as follows:

Electric Light Arms.....1½ inch
Railroad Arms.....$\frac{9}{16}$ inch
Telephone Arms.....1¼ inch
N. E. L. A. Arms.....1½ inch

Special arms as ordered.

Any change required from standard spacing, pin holes or bolt holes as here given, must be distinctly specified on the order.

NOTE—If sizes other than given above are required, prices must be figured by following operation:

Rules for Figuring Prices on Special Sized Arms

Add one-quarter inch to height and width of finished size required to get "rough size."

If length required runs into inches, take next higher foot length.

NOTE—This gives the "rough" size and length, or the block from which the arm is made. Multiply height by width (rough size) in inches, divide by twelve, and multiply by length in feet.

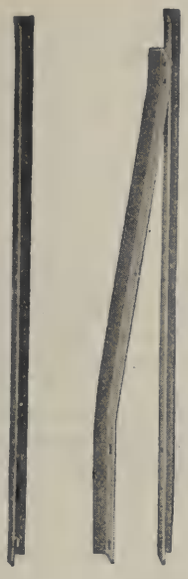
NOTE—This gives number feet Board Measure in Block.

Multiply Board Measure by 10 to get list price in cents per lineal foot.

Multiply Board Measure by 2.7 (Fir) or 3.4 (Yellow Pine) to get weight per lineal foot.

GROUND WIRE BAYONETS

Hot Galvanized



All bayonets have two $\frac{11}{16}$-inch holes for $\frac{5}{8}$-inch through bolts, and their upper ends have two $\frac{9}{16}$-inch holes, which allow the use of the Belcher or the rolled steel ground wire clamps. The spacing between through bolt holes is 10 inches for the 36-inch, 12 inches for the 48-inch, 15 inches for the 66-inch and 20 inches for the 84-inch bayonets. Bayonets are fastened to the back of the pole by the upper cross arm bolt and a lag screw or a second through bolt.

Corner bayonets are for use at all points at which double arms are required, such as corners in the line, long spans, railroad crossings, etc., and are very much stronger than straight bayonets, even when the latter are made of extra heavy angles. A corner bayonet consists of two angles, one bent, the other straight, fastened together by two $\frac{1}{2}$-inch machine bolts. The angle is bent for an 8-inch pole top, but the angles may be spread to fit any size of pole without interfering with the security of the bolted connection upon which depends the strength of the bayonet. The through bolt holes in the bent leg of the bayonet are slotted $\frac{11}{16}$-inch wide by $1\frac{1}{2}$ inches long, to allow for any inaccuracy in boring bolt holes in the poles.

Straight Bayonets

Style No.	Length, Inches	Size Angle, Inches	Per 100 Wt., Lbs.	Per 100 List Price
252787	36	2 x2 x$\frac{1}{4}$	1000	$ 55 00
252788	48	2$\frac{1}{2}$x2$\frac{1}{2}$x$\frac{1}{4}$	1640	82 00
252789	66	2$\frac{1}{2}$x2$\frac{1}{2}$x$\frac{1}{4}$	2255	102 00
252790	84	3 x3 x$\frac{1}{4}$	3430	137 00

Corner Bayonets

252791	36	2 x2 x$\frac{3}{16}$	1370	$ 82 00
252792	48	2 x2 x$\frac{3}{16}$	1825	105 00
252793	66	2 x2 x$\frac{1}{4}$	3350	173 00
252794	84	2$\frac{1}{2}$x2$\frac{1}{2}$x$\frac{1}{4}$	5500	254 00

OFFSET BAYONETS FOR OVERHEAD GROUND WIRE

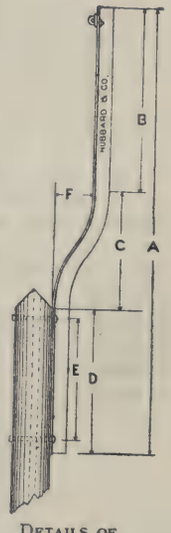
Hot Galvanized

The offset type of bayonet is used when an overhead ground wire is installed on a single-circuit transmission line employing pole top pin or ridge iron construction, as illustrated on page 80. The bayonets listed are suitable for use on lines of 24, 36 and 52 inch conductor spacing, respectively, and have two $\frac{11}{16}$-inch holes for $\frac{5}{8}$-inch through bolts, the upper ends having two $\frac{9}{16}$-inch holes, which allow the use of either of the Belcher ground wire clamps listed on previous page.

The use of offset bayonets is, in general, restricted to the installation of ground wires on existing circuits.

The Belcher clamps are not included in bayonet prices.

Style No.	Dimensions in Inches: Length	Size Angle	B	C	D	E	F	Per 100 Wt., Lbs.	Per 100 List Price
252795	54	2$\frac{1}{2}$x2$\frac{1}{2}$x$\frac{1}{4}$	24$\frac{1}{2}$	12$\frac{1}{4}$	17$\frac{1}{4}$	15	7	1850	$120 00
252796	72	2$\frac{1}{2}$x2$\frac{1}{2}$x$\frac{1}{4}$	40$\frac{1}{2}$	12$\frac{1}{4}$	19$\frac{1}{4}$	17	7	2500	150 00
252797	81	3 x3 x$\frac{1}{4}$	34	21$\frac{1}{2}$	26$\frac{1}{2}$	22	7	3310	195 00



Details of Offset Bayonets

BO-ARROW ARMS

The 24 and 30-inch Bo-Arrow single and double arming sets are made of 2½ x 2½ x ¼-inch open hearth steel angle, the larger arms of 3 x 3 x ¼-inch angle.

The price is the same for type A or type B arms, for forged steel or clamp pins, respectively.

Through bolts are not included in Bo-Arrow and bayonet prices on account of the great variation in the lengths required for the different classes of poles used. Three bolts are needed for a single or double arming set and two for a corner bayonet, the proper size being about 2 inches longer than the top diameter of the pole. When bayonets are used with single arms, two washers are required per arm; without bayonets, three washers. No washers are needed with double arming sets or corner bayonets.

SINGLE BO-ARROW ARMS

A Bo-Arrow Arm consists of one bow, one arrow and one ¾ x 1½-inch machine bolt for fastening the bow and arrow together.

Style No. for Forged Steel Pin		Style No. for Clamp Pin		—Dimensions in Inches—		Each	
Plain	Galvanized	Plain	Galvanized	Wire Spacing	Size Angle	Wt., Lbs.	List Price
214939	214944	214935	214943	24	2½x2½x¼	21	$1 30
252769	252770	252771	252772	30	2½x2½x¼	25	1 50
214940	206606	214936	196342	36	3 x3 x¼	39	1 80
214941	206607	214937	196343	52	3 x3 x¼	52	2 25
214942	206608	214938	196344	72	3 x3 x¼	69	2 90

GROUND WIRE BAYONETS

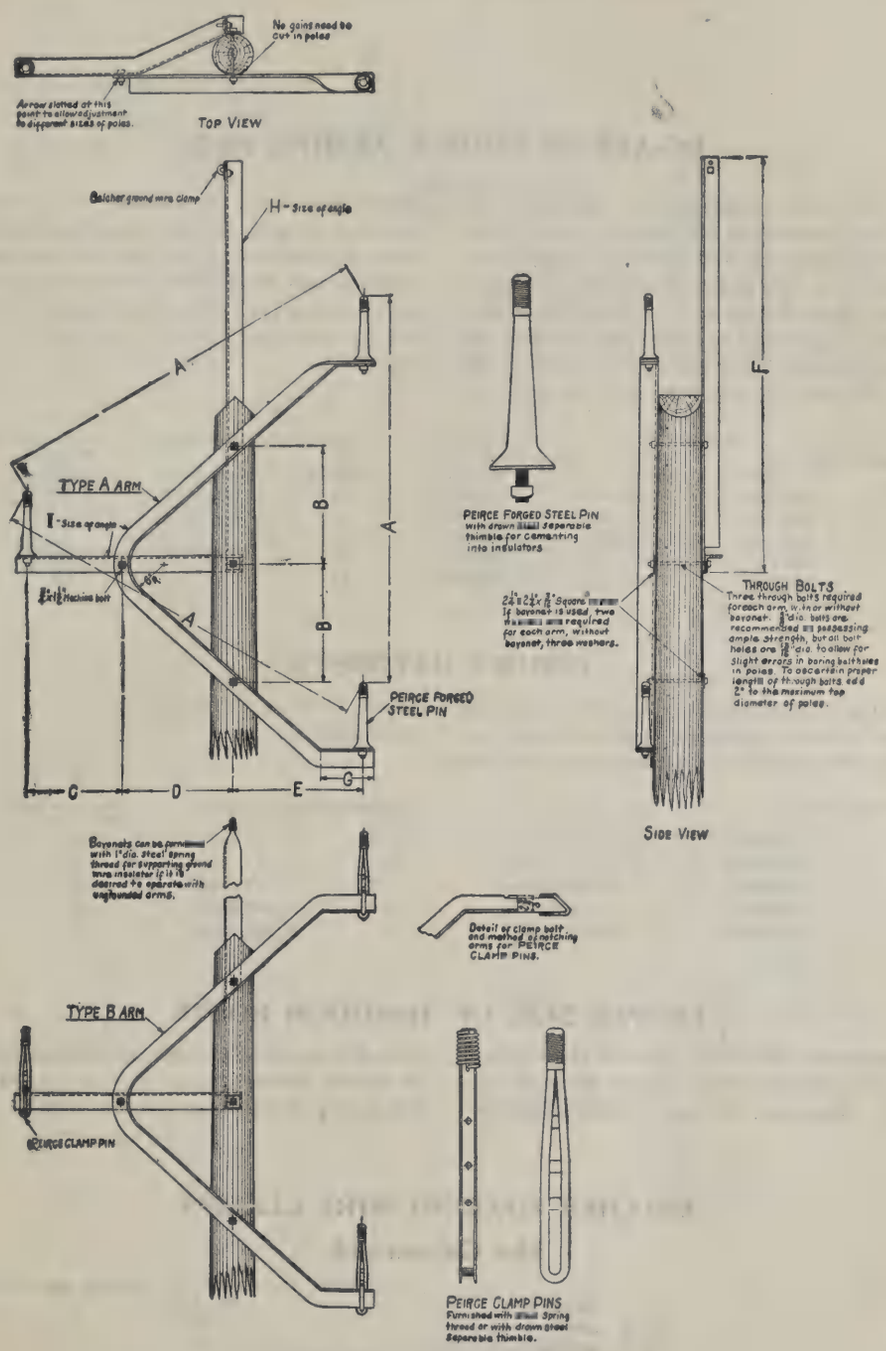
These prices cover bayonets punched for attaching the ground wire clamps. For bayonets with Peirce steel spring insulator threads, 1-inch diameter, in place of clamps, add 20 cents each to list prices. Both straight and corner bayonets have 13/16-inch holes and slots for ⅝-inch through bolts.

Straight Bayonets

No additional bolts are required for attaching the straight bayonet to the pole, the upper and middle cross-arm bolts serving this purpose.

Style No.		For Bo-Arrow	—Dimensions in Inches—		Each	
Plain	Galvanized	Arm	Length	Size Angle	Wt., Lbs.	List Price
214961	214962	24-inch spacing	32	2 x2 x¼	8½	$0 48
252773	252774	30-inch spacing	40	2 x2 x¼	10¾	55
214945	214948	36-inch spacing	50	2½x2½x¼	17	75
214946	214949	52-inch spacing	66	2½x2½x¼	22½	1 00
214947	214950	72-inch spacing	75	3 x3 x¼	31	1 30

DETAILS OF BO-ARROW ARMS


No gains need be cut in poles
Arrow slotted at this point to allow adjustment to different sizes of poles.
TOP VIEW
Belcher ground wire clamp
H - Size of angle
A
TYPE A ARM
I - Size of angle
B
B
A
PEIRCE FORGED STEEL PIN
C
D
E
G
PEIRCE FORGED STEEL PIN with drawn steel separable thimble for cementing into insulators
THROUGH BOLTS
Three through bolts required for each arm, with or without bayonet. ⅝" dia. bolts are recommended as possessing ample strength, but all bolt holes are 11/16" dia. to allow for slight errors in boring bolt holes in poles. To ascertain proper lengths of through bolts add 2" to the maximum top diameter of poles.
F
SIDE VIEW
Bayonets can be furnished with 1" dia. steel spring thread for supporting ground wire insulator if it is desired to operate with unGrounded arms.
Detail of clamp bolt and method of attaching arms for PEIRCE CLAMP PINS.
TYPE B ARM
PEIRCE CLAMP PIN
PEIRCE CLAMP PINS
Furnished with steel spring thread or with drawn steel Separable thimble.

Standard Sizes in Inches

Size	A	B	C	D	E	F	G	H	I
24	24	7⅞	4½	[illegible]	8¼	32	4	2 x2 x¼	2½x2½x¼
30	30	9⅛	7	[illegible]	11	40	5	2 x2 x¼	2½x2½x¼
36	36	12 1/16	6	12	13½	50	[illegible]	2½x2½x¼	3 x3 x¼
52	52	15⅝	10	15	20	66	9	2½x2½x¼	3 x3 x¼
72	72	21 7/16	18	20½	24	75	10½	3 x3 x¼	3 x3 x¼

BO-ARROW DOUBLE ARMING SETS

These sets are adjustable by means of the slots in the cross pieces for poles of from 7 to 11 inches in top diameter, and consist of a right and a left-hand bow, a right and a left-hand straight arrow, three cross pieces of angle or channel steel, depending on whether forged steel or clamp pins are used, two bolts for fastening bows and arrows together and six bolts for clamping the cross pieces to the arms. These cross pieces are necessary to give sufficient clearance between the two large high-voltage insulators required in each line wire, but are not needed on the 24 and 30-inch arms, in which case two bows, two straight arrows and a double arming or spreader bolt for fastening the four parts together are furnished.

Style No.				Dimensions in Inches		Per Set	
Forged Steel Pin		Clamp Pin					
Plain	Galvanized	Plain	Galvanized	Wire Spacing	Size Angle	Weight, Lbs.	List Price
252775	252780	253049	253054	24	2½x2½x¼	43	$2 40
252776	252781	253050	253055	30	2½x2½x¼	51	2 80
252777	252782	253051	253056	36	3 x3 x¼	113	5 55
252778	252783	253052	253057	52	3 x3 x¼	139	6 65
252779	253048	253053	253058	72	3 x3 x¼	173	8 10

CORNER BAYONETS

Two extra through bolts are required for attaching the corner bayonet to the pole. Each corner bayonet consists of one straight piece of angle steel, one bent piece and two ½ x 2-inch machine bolts for fastening them together.

Style No.			Dimensions in Inches		Each	
Plain	Galvanized	For Bo-Arrow Arm	Length	Size Angle	Wt., Lbs.	List Price
214963	214964	24-inch spacing	32	2 x2 x$\frac{3}{16}$	13	$0 85
252784	252785	30-inch spacing	40	2 x2 x$\frac{3}{16}$	16	1 00
214951	214954	36-inch spacing	50	2 x2 x¼	26	1 30
214952	214955	52-inch spacing	66	2½x2½x¼	44	2 00
214953	214956	72-inch spacing	75	2½x2½x¼	50	2 25

PROPER SIZE OF THROUGH BOLTS

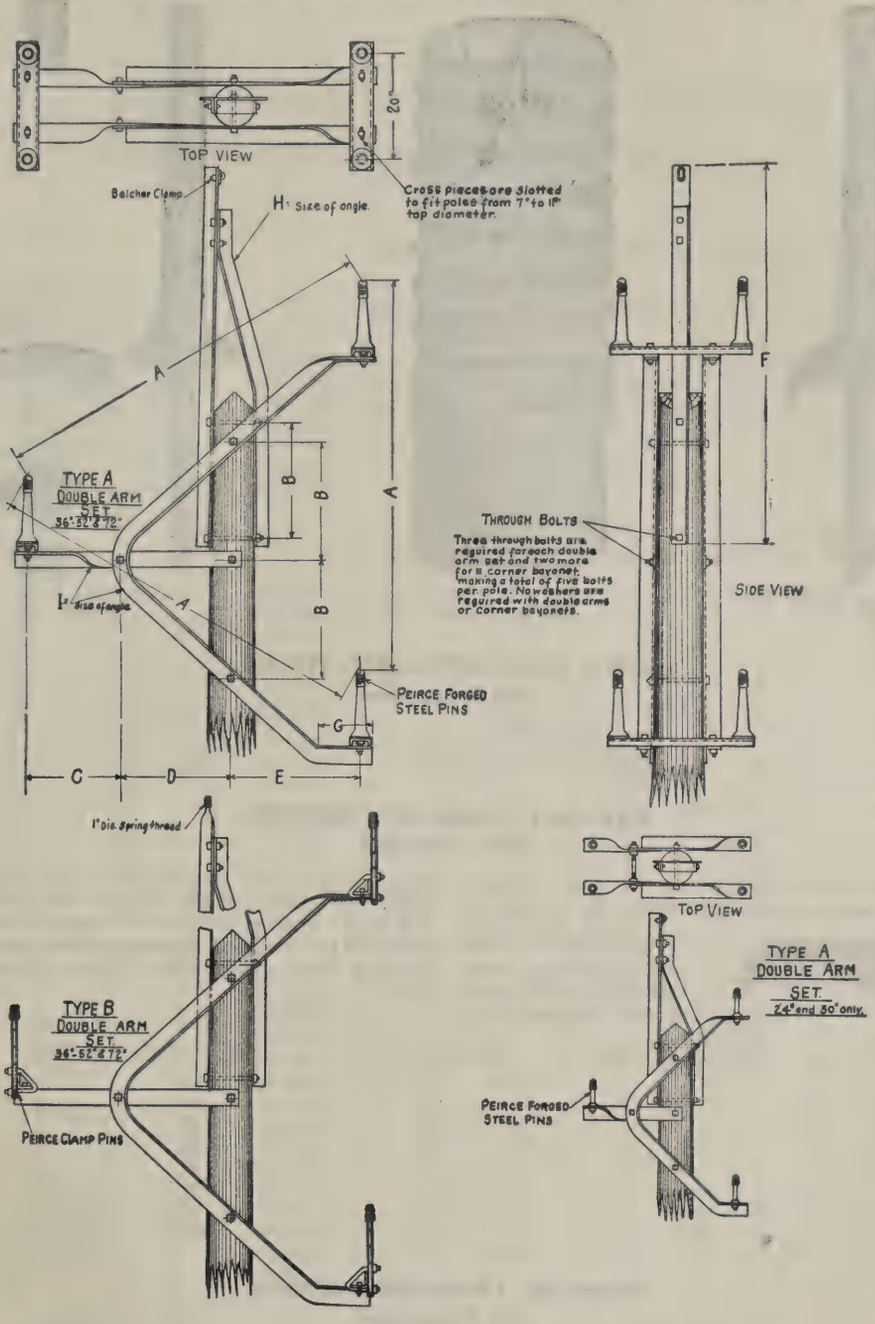
All bolt holes in Bo-Arrow arms are $\frac{13}{16}$-inch diameter, which allows the use of ¾-inch through bolts, if desired. However, the use of bolts larger than ⅝-inch is not recommended, as the breaking strength of ⅝-inch through bolts is over 16,000 pounds, which gives a very high factor of safety.

BELCHER GROUND WIRE CLAMPS

Hot Galvanized

Style No.	Description	Per 100	
		Wt., Lbs.	List Price
214957	Type J —attached with J bolt	44	$15 00
252786	Type U—attached with U bolt	70	24 00

DETAILS OF BO-ARROW DOUBLE ARMING SETS


TOP VIEW
Cross pieces are slotted to fit poles from 7" to 11" top diameter.
Belcher Clamp
H: Size of angle.
TYPE A DOUBLE ARM SET 36"-52"-72"
I" dia. of angle
THROUGH BOLTS
Three through bolts are required for each double arm set and two more for a corner bayonet, making a total of five bolts per pole. No washers are required with double arms or corner bayonets.
SIDE VIEW
PEIRCE FORGED STEEL PINS
I" Dia. Spring thread
TOP VIEW
TYPE A DOUBLE ARM SET 24" and 30" only.
TYPE B DOUBLE ARM SET 36"-52"-72"
PEIRCE CLAMP PINS
PEIRCE FORGED STEEL PINS

Standard Sizes in Inches

Size	A	B	C	D	E	F	G	H	I
24	24	7⅞	4½	8	8¼	32	4	2 x2 x 5/16	2½x2½x¼
30	30	9⅛	7	8	11	40	5	2 x2 x 5/16	2½x2½x¼
36	36	12 1/16	6	12	13½	50	8	2 x2 x¼	3 x3 x¼
52	52	15⅜	10	15	20	66	9	2½x2½x¼	3 x3 x¼
72	72	21 1/16	18	20½	24	75	10½	2½x2½x¼	3 x3 x¼

FITTINGS FOR PEIRCE FORGED STEEL PINS

ASSEMBLY FOR ROUND TOP WOOD ARM

DRAWN STEEL THIMBLE HOT GALVANIZED

LONG BOLT TYPE, UNASSEMBLED

DRAWN STEEL SEPARABLE THIMBLE
Hot Galvanized

Style No.	Description	Per 100 Wt., Lbs.	Per 100 List Price
252798	For insulators with 1 -inch bore	9	$14 00
252799	For insulators with 1⅜-inch bore	10	14 00

PRESTEEL CROSS-ARM SADDLES
Hot Galvanized

The cross-arm saddle is used with Peirce Forged steel pins on round top cross arms. Besides giving a firm seat for the pin, it helps prevent the arm's splitting when subjected to heavy strains. Because of its being pressed from sheet steel it is very strong and stiff. The Peirce forged steel pin with this saddle will hold a greater strain than a curved base malleable iron pin because there are no sharp edges to cut into the wood. The results of its use are surprising. Try it.

Style No.	Width of Cross Arm Inches	Size of Pin Hole Inches	Per 100 Wt., Lbs.	Per 100 List Price
252800	3¼	¾	62	$5 50
252801	3½	¾	68	5 75
252802	3¾	¾	74	6 00
252803	4	¾	80	6 30
252804	5	¾	100	7 70
252805	3¼	1	62	5 50
252806	3½	1	68	5 75
252807	3¾	1	74	6 00
252808	4	1	80	6 30
252809	5	1	100	7 70

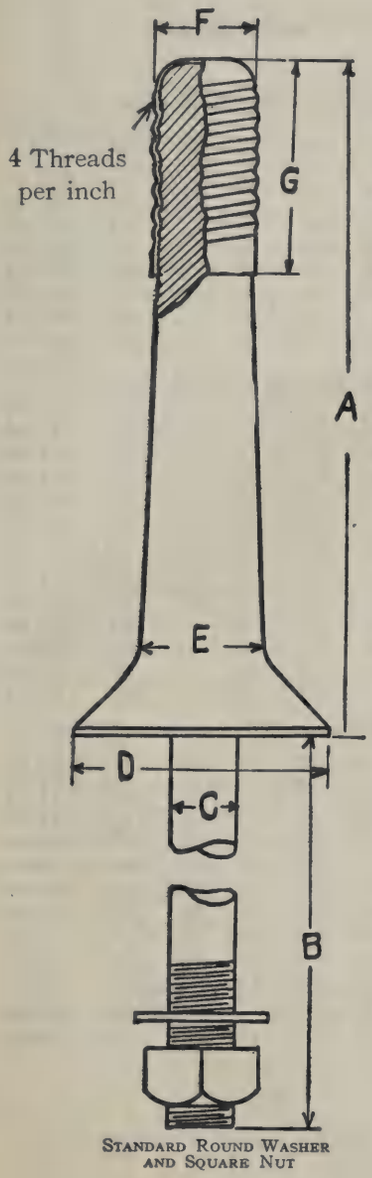
PRESTEEL CENTERING WASHER
Hot Galvanized

The centering washer is used on the lower end of the Peirce forged steel pin to center the pin when the pin is used on an existing cross arm with holes bored for wood pins. See illustration above.

Style No.	To Fit in Hole Diameter Inches	Size of Pin Hole Inches	Per 100 Weight, Lbs.	Per 100 List Price
252810	1¼	¾	12	$1 60
252811	1¼	1	12	1 60
252812	1½	¾	13	1 70
252813	1½	1	13	1 70

PEIRCE FORGED STEEL PINS FOR WOOD ARMS

With Drawn Steel Separable Thimbles—Hot Galvanized



STANDARD ROUND WASHER AND SQUARE NUT

1500-Lb. Series for Insulators with 1-inch Bore

Style No.	Trade No.	Dimensions in Inches A	B	C	D	E	F	G	Per 100 Weight, Lbs.	Per 100 List Price
249137	5102	3½	5½	¾	2¼	.94	1 11/13	2	217	$26 50
249138	5104	4	5½	¾	2¼	.98	1 11/13	2	231	28 00
249139	5106	4½	5½	¾	2¼	1.02	1 11/13	2	246	29 50
249140	5108	5	5½	¾	2¼	1.05	1 11/13	2	261	31 00
249141	5110	5½	5½	¾	2¼	1.08	1 11/13	2	278	32 75
249142	5112	6	5½	¾	2¼	1.12	1 11/13	2	297	34 75
249143	5114	7	5½	¾	3	1.15	1 11/13	2	388	44 35
249144	5116	8	5½	¾	3	1.22	1 11/13	2	435	49 25

1500-Lb. Series for Insulators with 1⅜-inch Bore

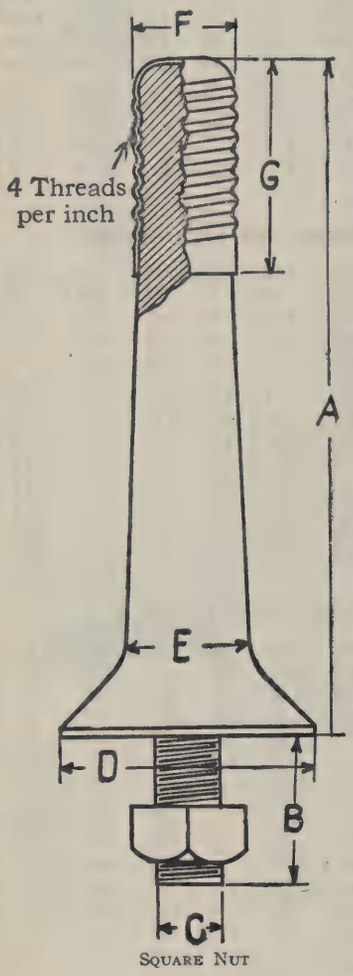
249145	5118	4	6½	¾	2½	1.16	1 7/13	2½	285	32 90
249146	5120	5	6½	¾	2½	1.20	1 7/13	2½	318	36 15
249147	5122	5½	6½	¾	2½	1.22	1 7/13	2½	334	37 05
249148	5124	6	6½	¾	2½	1.23	1 7/13	2½	351	39 05
249149	5126	7	6½	¾	3	1.26	1 7/13	2½	417	48 00
249150	5128	8	6½	¾	3	1.30	1 7/13	2½	445	51 40
252828	5130	9	6½	¾	3	1.33	1 7/13	2½	515	56 05
252829	5132	10	6½	¾	3	1.36	1 7/13	2½	568	60 90
252830	5134	11	6½	¾	3½	1.38	1 7/13	2½	652	67 90
252831	5136	12	6½	¾	3½	1.41	1 7/13	2½	699	71 65
252832	5138	13	6½	¾	3½	1.44	1 7/13	2½	746	74 65
252833	5140	14	6½	¾	3¾	1.48	1 7/13	2½	824	81 00
252834	5142	15	6½	¾	3¾	1.51	1 7/13	2½	877	85 25
252835	5144	16	6½	¾	3¾	1.58	1 7/13	2½	932	89 80

3000-Lb. Series for Insulators with 1⅜-inch Bore

252836	5146	4	8½	1	2½	1.26	1 7/13	2½	425	42 40
252837	5148	5	8½	1	2½	1.30	1 7/13	2½	462	47 00
252838	5150	5½	8½	1	2½	1.35	1 7/13	2½	503	51 25
252839	5152	6	8½	1	2½	1.37	1 7/13	2½	525	53 50
252840	5154	7	8½	1	3	1.41	1 7/13	2½	577	58 75
252841	5156	8	8½	1	3	1.47	1 7/13	2½	626	63 75
252842	5158	9	8½	1	3	1.53	1 7/13	2½	678	69 00
252843	5160	10	8½	1	3	1.57	1 7/13	2½	734	75 50
252844	5162	11	8½	1	3½	1.63	1 7/13	2½	864	85 00
252845	5164	12	8½	1	3½	1.68	1 7/13	2½	927	90 00
252846	5166	13	8½	1	3½	1.74	1 7/13	2½	999	95 75
252847	5168	14	8½	1	3¾	1.80	1 7/13	2½	1102	104 00
252848	5170	15	8½	1	3¾	1.86	1 7/13	2½	1184	110 60
252849	5172	16	8½	1	3¾	1.92	1 7/13	2½	1271	119 75

PEIRCE FORGED STEEL PINS FOR STEEL ARMS

With Drawn Steel Separable Thimbles—Hot Galvanized



1500-Lb. Series for Insulators with 1-inch Bore

Style No.	Trade No.	Dimensions in Inches A	B	C	D	E	F	G	Per 100 Weight, Lbs.	Per 100 List Price
249151	5101	3½	1¾	¾	2¼	.94	27/32	2	158	$22 50
249152	5103	4	1¾	¾	2¼	.98	27/32	2	173	24 00
249153	5105	4½	1¾	¾	2¼	1.02	27/32	2	188	25 50
249154	5107	5	1¾	¾	2¼	1.05	27/32	2	202	27 00
249155	5109	5½	1¾	¾	2¼	1.08	27/32	2	220	28 75
249156	5111	6	1¾	¾	2¼	1.12	27/32	2	239	30 75
249157	5113	7	1¾	¾	3	1.15	27/32	2	330	40 25
249158	5115	8	1¾	¾	3	1.22	27/32	2	376	45 25

1500-Lb. Series for Insulators with 1⅜-inch Bore

249159	5117	4	1¾	¾	2½	1.17	1 7/32	2½	215	28 25
249160	5119	5	1¾	¾	2½	1.20	1 7/32	2½	247	31 50
249161	5121	5½	1¾	¾	2½	1.22	1 7/32	2½	263	32 40
249162	5123	6	1¾	¾	2½	1.23	1 7/32	2½	280	34 40
249163	5125	7	1¾	¾	3	1.26	1 7/32	2½	346	43 35
249164	5127	8	1¾	¾	3	1.30	1 7/32	2½	394	46 75
252864	5129	9	1¾	¾	3	1.33	1 7/32	2½	444	51 40
252865	5131	10	1¾	¾	3	1.36	1 7/32	2½	496	56 25
252866	5133	11	1¾	¾	3½	1.40	1 7/32	2½	582	63 25
252867	5135	12	1¾	¾	3½	1.43	1 7/32	2½	628	67 00
252868	5137	13	1¾	¾	3½	1.46	1 7/32	2½	675	70 00
252869	5139	14	1¾	¾	3¾	1.50	1 7/32	2½	753	76 35
252870	5141	15	1¾	¾	3¾	1.53	1 7/32	2½	805	80 60
252871	5143	16	1¾	¾	3¾	1.56	1 7/32	2½	861	85 15

3000-Lb. Series for Insulators with 1⅜-inch Bore

252872	5145	4	2	1	2½	1.25	1 7/32	2½	263	32 40
252873	5147	5	2	1	2½	1.30	1 7/32	2½	300	37 00
252874	5149	5½	2	1	2½	1.33	1 7/32	2½	340	41 25
252875	5151	6	2	1	2½	1.35	1 7/32	2½	363	43 50
252876	5153	7	2	1	3	1.41	1 7/32	2½	415	48 75
252877	5155	8	2	1	3	1.47	1 7/32	2½	464	53 75
252878	5157	9	2	1	3	1.53	1 7/32	2½	516	59 00
252879	5159	10	2	1	3	1.59	1 7/32	2½	572	65 50
252880	5161	11	2	1	3½	1.65	1 7/32	2½	702	75 00
252881	5163	12	2	1	3½	1.70	1 7/32	2½	765	80 00
252882	5165	13	2	1	3½	1.76	1 7/32	2½	837	85 75
252883	5167	14	2	1	3¾	1.82	1 7/32	2½	940	94 00
252884	5169	15	2	1	3¾	1.88	1 7/32	2½	1022	100 60
252885	5171	16	2	1	3¾	1.94	1 7/32	2½	1110	109 75

PEIRCE CLAMP PINS FOR HIGH-VOLTAGE INSULATORS ON STEEL AND WOOD CROSS-ARMS

Hot Galvanized

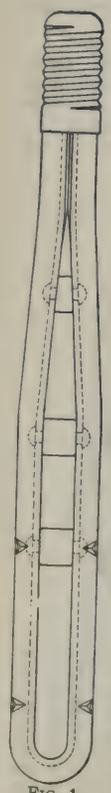


FIG. 1

Peirce clamp pins present a strong, light and inexpensive means of supporting high-voltage insulators on steel or wood arms. They are very useful on terminal structures, built of angle steel or wood, at power houses and substations, since by their use the expense and trouble of boring pin holes is eliminated, and the pins may be spaced as desired and changed later without redrilling the arms.

To reduce the cost of this type of pin, and the number of sizes kept in stock, a combination pin has been developed, which can be used on either a steel or wood arm, having, in either case, a different height above the cross-arm. For instance, Pin No. 252890 is, when used on a Bo-Arrow, 10 inches high, and on a wood arm it is 7¾ inches high, the difference being due, of course, to the fact that the larger arm requires a longer slot or opening for the clamping strap to pass through. Fig. 1 shows the new combination pin; Fig. 3, the pin with No. 252914 angle clamp for Bo-Arrow or 3-inch angle steel arms; and Fig. 2, the pin with No. 252911 cross-arm strap for a 4x5-inch wooden arm.

The clamp pin is made of a single piece of channel steel bent double, and separated by spacers to give the truss construction illustrated, and thus secure the greatest strength with a given amount of steel. It will be noticed that one side of the pin has four sharp prongs, which bite into wooden arms and prevent the pin's deflecting if an unseasoned arm should shrink in service. When the pin is used on a steel arm, the prongs are faced away from the arm and are so located as not to interfere with the nuts of the clamp.

Peirce high-tension clamp pins are furnished with separable thimbles and with the Peirce 1⅜-inch spring threads. The drawn steel thimbles are the same as those described under forged steel pins and pole top pins, and this allows the use of insulators in which these thimbles are cemented on any one of these three pins and considerably simplifies stock-keeping. The Peirce 1⅜-inch steel spring threads do away with cementing, which is an advantage in changing over from wooden pins, and hold the insulators firmly without, however, locking them against removal.

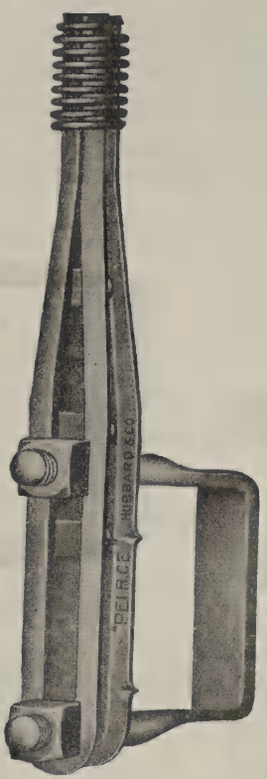


FIG. 2
No. 252901 PIN WITH STRAP FOR WOOD CROSS-ARM

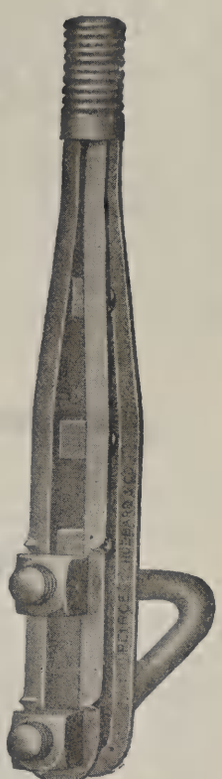


FIG. 3
No. 252890 PIN WITH ANGLE CLAMP FOR BO-ARROW ARM

1 7/32-inch Drawn Steel Separable Thimble—1⅜-inch Spring Thread

Size Channel Inches	Height Above Arm, Inches For Bo-Arrow and 3-inch Angle Arms	For Wood Arms 3¼x4¼-inches to 4x5-inches	Style No.	Per 100 Weight, Lbs.	Per 100 List Price
1 x½	6	3¾	252886	172	$22 00
1 x½	7	4¾	252887	187	23 00
1 x½	8	5¾	252888	203	24 00
1 x½	9	6¾	252889	217	27 00
1 x½	10	7¾	252890	230	30 00
1 x½	11	8¾	252891	244	32 00
1 x½	12	9¾	252892	257	35 00
1 x½	13	10¾	252893	270	37 00
1¼x½	14	11¾	252894	322	40 00
1¼x½	15	12¾	252895	338	43 00
1¼x½	16	13¾	252896	352	46 00

Style No.	Per 100 Weight, Lbs.	Per 100 List Price
252897	185	$20 00
252898	200	21 00
252899	216	22 00
252900	230	25 00
252901	243	28 00
252902	257	30 00
252903	270	33 00
252904	284	35 00
252905	335	38 00
252906	350	41 00
252907	365	44 00

Clamping bolts are not included in pin prices.
Style numbers 252886 to 252896 inclusive have drawn steel thimbles.
Style numbers 252897 to 252907 inclusive have 1⅜-inch spring threads.

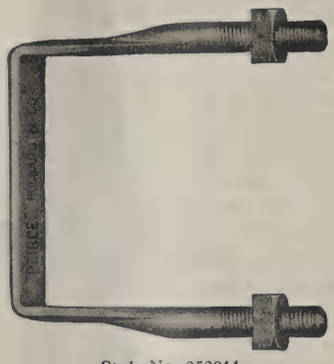
PEIRCE CLAMPS FOR HIGH-VOLTAGE CLAMP PINS
Hot Galvanized

Peirce Angle Clamps are used for supporting clamp pins on cross arms of angle section, such as the Bo-Arrow, Hi-Ten Extensions and Angle Steel Arms. These clamps are made of ⅝-inch round steel, and are formed to fit angles having notches ¼-inch deep in each leg, which holds the pins in a vertical position at all times. On this account, standard pins and clamps will not fit unnotched angles, but special pins and clamps to fit any desired size or shape of angle, channel, beam, pipe or rail section can be supplied promptly.

For mounting Peirce High Tension Clamp Pins on wood cross arms, a new line of drop forged steel cross-arm straps has been developed.

The Peirce Pipe Clamp is designed to grip firmly pipes of from 1¼ to 2-inch nominal diameter, and consists of a cast block and a ⅝-inch U bolt. Peirce clamp pins and pipe clamps are a popular and economical means of supporting high-voltage bus bars on pipe frameworks.

Style No. 252914



Style No. 252911

Style No. 252916

Style No.	Description	Size of Cross Arm, Inches	Per 100 Wt., Lbs.	Per 100 List Price
252908	Heavy cross-arm strap	3¼x4¼ Wood arm	142	$12 00
252909	Heavy cross-arm strap	3½x4½ Wood arm	148	12 75
252910	Heavy cross-arm strap	3¾x4¾ Wood arm	154	13 50
252911	Heavy cross-arm strap	4 x5 Wood arm	160	14 25
252912	Angle clamp	2½x2½ Notched angle	90	5 75
252913	Angle clamp	3 x2 Notched angle	90	5 75
252914	Angle clamp	3 x3 Notched angle	100	6 00
252915	Angle clamp	3½x3½ Notched angle	115	6 50
252916	Pipe clamp	1¼ to 2 Standard pipe	160	10 00

Style No. 249110

WOOD TOP PINS WITH STEEL BOLTS
Bolts Hot Galvanized or Plain

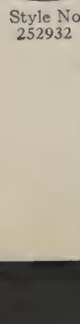
Wood top pins are composed of seasoned locust tops, thoroughly impregnated with paraffin, and stiff steel fin bolts. They are made in a variety of heights with short and long shanks for wood, angle or channel steel arms, and for two sizes of insulator pin holes, 1 and 1⅜ inches in diameter.

Style No.	Size of Wood Top, Inches Diam. Top	Diam. Bottom	Length	Size of Bolt, In. Diameter	Length	Length of Bolt Below Top, In.	Per 100 Wt., Lbs.	Per 100 List Price
249110	1	1⅞	4½	½	5½	1	52	$12 00
249111	1	2¼	5¼	½	6½	1¼	60	12 50
249112	1⅜	2¼	4½	⅝	5½	1	90	14 25
249113	1⅜	2¼	5¼	⅝	6½	1¼	115	15 25
249114	1	1⅞	4½	½	9½	5	72	12 [illegible]
249115	1	2¼	5¼	½	10½	5¼	80	14 00
249116	1	2¼	5¼	½	11½	6¼	88	14 35
249117	1⅜	2¼	4½	⅝	9½	5	135	16 75
249118	1⅜	2¼	4½	⅝	10½	6	160	18 00
249119	1⅜	2¼	5¼	⅝	10½	5¼	165	18 75
249120	1⅜	2¼	6½	⅝	12½	6	190	21 00
249121	1⅜	2½	8	⅝	14	6	225	26 00
249122	1⅜	2¾	9	⅝	16	7	250	28 00

SHORT SHANK WESTERN UNION PINS
Hot Galvanized or Plain

Short shank pins are used with transposition brackets. The bolts are made in ½-inch and ⅝-inch diameters, the cob being 1-inch diameter. These pins are standard with the A. T. & T. Co. and the W. U. T. Co. for use on transposition brackets.

Style No. 252932



Style No. 252933

Style No.	Diameter Bolt Inches	Length, Inches Above Shoulder	Length, Inches Below Shoulder	Per 100 Weight, Lbs.	Per 100 List Price
252932	½	4	1	48	$ 9 00
252933	⅝	4	1	65	11 50

STANDARD WESTERN UNION PINS
Hot Galvanized

Wood cob pins of the Western Union type are made in accordance with the specifications of the Western Union Telegraph Co. and the Railway Signal Association. The cobs are of the best grade of air-dried oak, turned to fit a gauge and boiled in paraffin to exclude all moisture. The pins are made of stiff, high carbon steel with clean threads, square nuts and clipped, round washers, and can be used with standard insulators having 1-inch pin holes. The ½-inch pin stands a load of 1000 pounds, similar to that of a dead ended wire, applied at the wire groove of a standard glass insulator, and the ⅝-inch Pin, 1700 pounds, with deflections of less than 10 degrees.

Style No.	Diameter, Bolt Inches	Length, Inches: Above Shoulder	Length, Inches: Below Shoulder	Per 100: Weight, Lbs.	Per 100: List Price
252930	½	4¼	5	73	$ 9 50
252931	⅝	4¼	5	110	12 50

Regularly furnished Hot Galvanized, but can be furnished plain when so ordered.

Style No. 252930

POLE TOP PINS
Hot Galvanized

The pole top pins illustrated represent current practice in the construction of lines requiring the supporting of a single wire above the pole top.

All pole top pins have $\frac{11}{16}$-inch holes.

Pipe Pins

For the higher voltage lines the pipe pins are in general use, because of their strength and light weight, and are superseding the old types of cast and malleable pins. They are furnished with either the spring thread for 1⅜-inch bore insulators, or the Peirce standard $1\frac{7}{32}$-inch sheet steel separable thimble for cementing into insulators of 1⅜-inch bore, which is the same thimble as is furnished with forged steel and clamp pins.

Style No.	Dimensions in Inches: Size Steel Pipe	Length	Spacing Between Holes	Style of Top	Per 100: Wt., Lbs.	Per 100: List Price
252934	1¼	18	8	1⅜-inch Spring	336	$ 60 00
252935	1¼	24	8	1⅜-inch Spring	448	76 00
252936	1¼	36	10	1⅜-inch Spring	672	107 00
252937	1¼	18	8	$1\frac{7}{32}$-inch Thimble	336	65 00
249108	1¼	24	8	$1\frac{7}{32}$-inch Thimble	448	81 00
252939	1¼	36	10	$1\frac{7}{32}$-inch Thimble	672	112 00

Presteel Pins

The strength, light weight and low cost of the presteel pins have brought about their use on all but the heaviest of high-tension construction. They are pressed from sheet steel, which gives the maximum strength for a given weight, and are furnished with Peirce spring threads, which screw into insulators with 1 and 1⅜-inch pin holes, and with Peirce drawn steel separable thimbles for cementing into insulators of these two sizes.

Style No.	Dimensions in Inches: Gauge Sheet Steel	Length	Spacing Between Holes	Style of Top	Per 100: Wt., Lbs.	Per 100: List Price
252940	10	18	8	1 -inch Spring Thread	227	$45 00
252941	10	18	8	1⅜-inch Spring Thread	230	45 00
252942	10	18	8	⅞-inch Thimble	227	50 00
252943	10	18	8	$1\frac{7}{32}$-inch Thimble	230	50 00
252944	10	24	8	1 -inch Spring Thread	303	61 00
252945	10	24	8	1⅜-inch Spring Thread	305	61 00
252946	10	24	8	⅞-inch Thimble	303	66 00
249109	10	24	8	$1\frac{7}{32}$-inch Thimble	305	66 00

FORGED STEEL PINS FOR RAILWAY FEEDERS

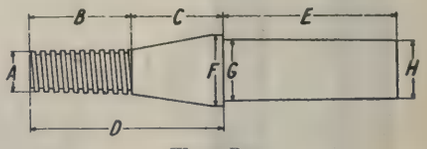
Hot Galvanized

These open hearth steel pins are designed for use with composition feeder insulators at points of excessive load, and are the strongest pins obtainable. They are made in two styles, as illustrated, both of which are 4¼ inches high above the arms, with bases 2½ inches in diameter and have 1-inch die forged insulator threads. No. 253046 has a 1½-inch shank, 4 inches long, and No. 253047 a 1¼-inch shank extending 2⅞ inches from the shoulder, beyond which point it is drawn down to ¾-inch diameter for a length of 1 inch, and is threaded and provided with a nut and a 2-inch round washer. This style of pin is used on malleable iron arms and has the advantage that it cannot be pulled out of the cross-arm.

	Per 100	
Style No.	Wt., Lbs.	List Price
253046	365	$34 00
253047	300	32 00

WOOD PINS

Locust Pins—These locust pins are made from straight grain stock. Standard pins are plain (untreated). They will be furnished paraffined or otherwise treated on special order and at additional price.



Wood Pin

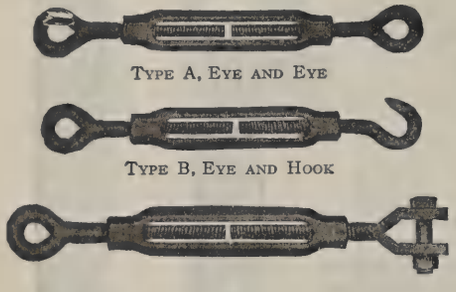
Locust Pins

	Dimensions, Inches								Approx. Net Wt., Lbs. Per 100	List Price Per 100
Style No.	A	B	C	D	E	F	G	H		
102121	1	2½	2¼	4¾	4¼	1⅞	1½	1 1/16	45	$4 00
102125	1⅜	2¼	2½	4¾	4¼	1⅞	1½	1 7/16	45	4 75

DROP FORGED TURNBUCKLES

Hot Galvanized

These turnbuckles are of drop-forged steel, insuring reliability and strength. The list prices are the same for any of the three styles of turnbuckles illustrated.



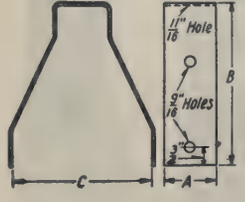
Type A, Eye and Eye

Type B, Eye and Hook

Style No.	Diameter of Bolts Inches	Length of Opening Inches	Per 100 Weight, Lbs.	Per 100 List Price
253035	⅜	4½	95	$100 00
253037	½	6	175	150 00
253038	½	9	190	200 00
253039	½	12	230	250 00
253040	⅝	6	270	215 00
253041	⅝	9	335	250 00
253042	⅝	12	400	300 00
253043	¾	6	400	300 00
253044	¾	9	505	335 00
253045	¾	12	610	375 00

Can be furnished plain. When ordering specify type letter.

POLE-TOP RIDGE IRON



Pole-top ridge irons are made of stiff bar steel, galvanized. They are regularly furnished with four holes 9/16-inch diameter for lag screws and one hole 11/16-inch diameter for bolt. On special order they will be furnished with holes for either ⅜-inch or ½-inch lag screws and for either ½-inch or ⅝-inch bolts.

	Dimensions, Inches				Per 100	
Style No.	A	B	C	Strap Iron	Approx. Net Wt., Lbs.	List Price
196222	2¼	7	6	⅛x2¼	135	$26 25
196223	2¾	7	7	⅛x2¾	285	32 50

RAIL BONDS

As rails of electric railways are bonded so that the return currents may flow to the generating station without excessive loss and so that destructive electrolytic action on adjacent underground metallic structures will be a minimum, a poor bond is not much better than no bond at all. Inasmuch as great amounts of money are invested by railway companies in bonds, the matter of their selection and installation is one of prime importance. Every precaution should be taken to insure that bonds yield a maximum return on the investment.

METHODS OF MANUFACTURE

Essentially, any bond may be considered as being composed of two components—the conductor and the terminals.

The terminals are the portions at the ends of the bond by means of which the bond is mechanically and electrically connected to the rail.

The conductor is the softer flexible portion, which connects together the two terminals.

Attachment of Conductors to Terminals—The feature wherein the processes of bond manufacture differs most is the method of attaching the terminals to the conductor. Obviously, the union between them must be as nearly perfect electrically and mechanically as can be. There are three methods now employed for attaching the terminal to the conductor. They are:

1. Welding the terminal to the conductor by hammer blow or pressure, heat being applied simultaneously.
2. Casting the terminal on the conductor, which has been arranged for the purpose in a flask.
3. Forming the terminal from the material of the conductor itself.

All the bonds having ribbon or stranded conductors listed in this catalogue are made by the process outlined in item 1. Broad patents cover the manufacturing methods involved. While the bonds are being welded, the union between the conductor and terminal is entirely protected fron the oxidizing effect of the air. No cuprous oxide, which if dissolved by the copper makes it brittle, is formed. The process is such that the welding temperature is relatively low. This, coupled with the fact that the terminals are not worked after being annealed by the welding operation, effectively insures against brittleness. This welding process is generally conceded to be the best of the three above indicated.

The electrical conductivity of the welded joint is the same as that of an equal section of copper, as tests will show.

RAIL BOND CONDUCTORS

Conductors of all of the types herein listed are either:

(a) Ribbon,

(b) Stranded, or

(c) Solid.

Ribbon conductors (see Fig. 4) are composed of horizontal laminae, to afford maximum flexibility in the vertical plane. It is in this plane that almost all the movement at the rail joint, due to the passage of rolling stock, occurs. They have ample transverse flexibility to meet the slight horizontal movement at the joint. They offer the further advantage for use under fish-plates, of greater compactness. They are less liable to be pinched when only restricted space is available.

Stranded conductors (see Fig. 3) are of practically the same construction as ordinary stranded cable, but rail bond cable is specially wound and consists of many fine strands. They are ordinarily used for bonding outside of fish-plates and for short distances around special track work, where the length is such that conductor ribbons (laminations) would be liable to separation or to mechanical injury. Stranded conductor bonds are also largely used in elevated railway work and around bridge structures. Where plenty of room under the fish-plate is available, stranded conductor bonds are frequently used.

Solid conductor bonds (see Fig. 8) or as they are commonly known "solid wire bonds" are used for cross bonding and spanning long distances around special work and in structures where there is not so much vibration as to require the flexibility of a stranded conductor.

Tucking or Crimping—To provide a certain amount of flexibility in bond conductors, there is often formed in them, a reverse bend, as shown for instance in Figs. 3 and 4. It has been found that this is advisable to reduce the amount of breakage. Such a bend is called a tuck. Tucks must be so

located that they will not interfere with fish-plate bolts. When the tucking lies exactly in the middle of the bond, as shown in Fig. **4**, it is called middle tucking. When, in order to clear bolts as shown in Fig. 3, the tucking is located off the center, the bond is called offset tucking. Bond type numbers indicate the arrangement of tucking of a bond as explained in Fig. 12.

RAIL BOND TERMINALS

Listed in this catalog are bond terminals of five different types, viz:. the solid-stud-terminal type, the tubular-stud-terminal type, the twin-stud-terminal type, the flame-weld-terminal type, and the soldered-terminal type.

For the solid stud terminal (see Fig. 1) a solid cylinder of copper is expanded by either hydraulic or mechanical pressure (presses for this purpose are shown in Figs. 43 & 43A) into a clean hole drilled entirely through the rail flange or web, as shown in Fig. 1. A portion of the copper is turned over on the outside of the hole, forming a further electrical and mechanical tie between the rail and the copper. Refer to index for a further description of the compressed stud terminal and for directions for its installation.

This type of terminal is recommended wherever its application is feasible. Less skill is required for the installation of stud terminal bonds than for any other type. After the bond is in place there is every assurance that the connection between it and the rail is a good one both mechanically and electrically and that it will stay so.

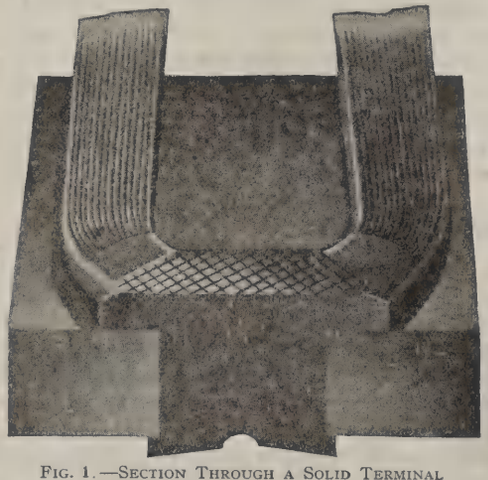


FIG. 1.—SECTION THROUGH A SOLID TERMINAL

Tubular Stud Terminals—These terminals are expanded radially against the walls of holes drilled through the web of rails, by means of tapered expansion punches driven through them. After the terminal is inserted in the hole, a long taper punch (Fig. 35) lubricated with grease or heavy oil is first driven entirely through the terminal, then a short drift pin B is driven home, as shown in cuts D and F. The diameter of the latter is about $\frac{1}{32}$ inch greater than that of the former. Thus the small drift pin supplements the expansion of the taper punch, while the compressed copper lying between the cylindrical surface of drift pin and the larger cylindrical surface of the hole in the rail, maintains sufficient friction on the pin to hold it in place. The diameter of the hole through the terminal is thus enlarged about $\frac{1}{8}$ of an inch, causing a material displacement of copper. As the metal flows against the wall of the hole in the rail it exerts an extremely great pressure, thus making an intimate

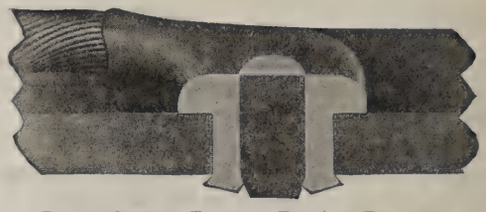


FIG. 2—SECTION THROUGH TUBULAR TERMINAL

molecular bearing which insures a highly efficient and lasting contact.

Rail bonds provided with this style of terminal have several inherent advantages. They can be installed more quickly and economically than the compressed type. No special tools are required for their installation, only a taper punch, a drift pin and a heavy hammer. The simplicity of the operation insures uniformly good results. In the application of this terminal the human element is almost entirely eliminated.

All the work can be done from one side of the rail, which is often of advantage in rebonding rails in paved streets and in bonding frogs or other special track construction. If necessity requires, these bonds if carefully removed may be used a second or even a third time. A taper punch and drift pin somewhat larger than used in the first installation will produce the required extra expansion and a perfect contact.

With every tubular terminal bond we ship two steel drift pins without extra charge, and in large orders we supply an extra number amounting to five per cent. We provide hardened steel taper punches, in sizes correct for the terminals in which they are to be used, at moderate prices, which will be quoted upon application.

One taper punch should install from one hundred to two hundred rail bonds. The table on Fig. 35 shows the dimensions of taper punches and pins regularly made for different sizes of tubular terminals. The sizes of pins designated as "standard" are those which will be supplied with bonds, unless otherwise specified. Standard sizes are adequate when the bond holes are drilled reasonably accurate

RAIL BONDS—Continued

to size. Larger pins will be substituted for those of standard diameters, without additional expense, when specified.

Flame-Weld-Terminal bonds have especially designed terminals suitable for application by the oxy-acetylene welding process. The top surface of the terminal is sloped downward towards the surface which rests against the rail thus forming a recess for building up the weld. We recommend copper coating the surface of the rail before the bond is installed so as to insure a weld at the junction point of the rail bond terminal and the rail surface.

They are attached to the heads of the rails. Bonds thus installed can be quite short. On account of the small amount of material that they contain and of the difficulty of removing them they are practically immune from theft.

Twin-stud Terminals, as indicated in Fig. 37, are used on bonds to be installed on the outer heads of T-rails. The studs have a button of copper on the outside of the terminal. In installing, this button is driven with a hand hammer into a hole in the rail head. The hole has an annular groove (Fig. 37), cut with a hand miller, into which the copper is forced compactly. The stud is thus securely anchored and the entrance of moisture is prevented.

Soldered terminals on bonds (see Fig. 36) are, as the name indicates, soldered to the rails. Their effective installation requires some skill. On account of the small amount of material they contain and of the difficulty of removing them they are practically immune from theft.

HOW TO SELECT BONDS

There are several factors that must be carefully considered when selecting rail bonds for a given application. The cross-sectional area of a bond should depend largely on the traffic. If traffic is heavy, or if there is a likelihood of its shortly becoming heavy, the bond should, if possible, have a conductivity equal to that of the rail.

It is usually best to install bonds under fish-plates, when possible. Sometimes it is not feasible to so arrange bonds and yet have enough sectional area to carry the current without undue heating. In such cases one of the methods of exposed bonding must be adopted.

Another point to be considered when selecting bonds is the grade of labor available for bonding. If only low-grade labor can be secured, a type of bond should be selected that requires a minimum of skill for its installation. All things being equal the stud-terminal bond, arranged under a fish-plate, with the stud hydraulically or mechanically compressed into position is probably best for average conditions and should be used where possible. The following desirable features are characteristic of a stud-terminal bond installed under a fish-plate.

1. Its location on the rail protects it from injury from outside sources and prevents its being stolen.
2. Its construction is such as to make it perfectly adapted to withstand both the vertical and the horizontal movements of the joint.
3. The method of applying compressed-terminal bonds calls for the exercise of only ordinary care in drilling the holes and mounting the compressor for forming the studs into the rail.

It is without question true that much better results can be obtained with ordinary labor with the stud-terminal bond, than with any other type. At the same time there are conditions which the other types of bonds listed best satisfy. Each case must be decided on its own merits.

When selecting bonds results will, as a rule, be most satisfactory if the customer specifies only the form of terminals and conductors and cross-sectional area of the bond required. The system of form designation is explained below, and the different forms of terminals and conductors are illustrated on succeeding pages. The details in regard to the arrangement of laminations and tucking are best determined by the manufacturer. The Westinghouse Company always stands ready to submit drawings and recommendations for specific or unusual problems.

Standard Rail Bonds—It is commercially impossible to anticipate specifications and carry in stock bonds for all possible applications. There is a great variation in the design of rail joints. The space available for bonding under fish-plates, and around the fish-plate bolts, the spacing of the fish-plate bolts, and the over-all lengths of fish-plates, often vary greatly in different installations. They give rise to an enormous number of different types and sizes of bonds.

Deliveries—Any standard bond listed in this table can be delivered promptly, in reasonable quantities. Sizes and types of bonds, not standard, can be furnished on application. Complete dies for a great number of styles and sizes of bonds form a part of the factory equipment. Therefore, any of these can be furnished in any combinations of length and tucking with only the delay incident to their manufacture.

ORDERING BONDS—REQUESTS FOR INFORMATION

In requesting information or ordering bonds, the data in the following items should always be submitted. If all the items cannot be answered, give as many as possible.

1. Capacity of bond.
2. Length of bond.
3. Dimensions of terminals.
4. Design or type number, or the maker's name and section number of rail and joint plate; also the location of bolt holes and diameter of bolts.
5. Blueprint and specification references if any.

Nominal Bond Lengths—Stranded and ribbon bonds containing tucks or crimps and solid wire bonds which are bent to span the splice bar are called "Factory Formed". The nominal length of bonds which contain tucks or crimps is the actual distance between the centers of the studs, in other words, the distance between the bond holes. The price is based upon this length. In the case of bonds made of a single solid wire (solid wire bonds) the nominal length is the distance between the centers of the studs when formed, in other words, the distance between the bond holes. The price is based upon the length measured between terminal stud centers when straight. Unless otherwise specified the straight length is 1½ inches greater than the formed length. The nominal length of all bonds which are given no dimensioned form at the factory is the length when straight, the distance between centers of studs for stud terminal bonds, the overall length for welded and soldered terminal bonds. The price is based upon the straight length.

Terminal Stud Length—If the information requested above accompanies an order for stud-terminal bonds, they will be shipped with terminals of correct length. Obviously, a terminal stud that is long enough to provide a good attachment to a railweb ⅝-inch thick, is too long for a web ⅜-inch thick. Too much copper in a terminal will cause it to form a rivet head over the hole before the hole is filled. When the thickness of the webs into which bonds on a given order will be formed is not known, they will be shipped having the terminal lengths shown in following table. These lengths have been found most suitable for average conditions.

TYPES OF RAIL BONDS

The Westinghouse Electric & Manufacturing Company offers several distinct types of rail bonds, there being many forms and sizes of each, classified as follows:

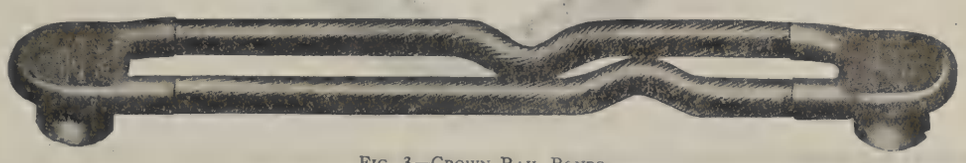


FIG. 3—CROWN RAIL BONDS

Crown Rail Bonds—Having stud terminals either solid for compression or tubular for pin expansion, the conductors joining the terminals being either single solid copper wires, or strands composed of a number of small round wires.

FIG. 4—U. S. RAIL BONDS

United States Rail Bonds—Having single stud terminals either solid for compression or tubular for pin expansion, the conductor being composed of flat copper strips or ribbons laid parallel.

FIG. 5—CROWN TRIPLEX BOND

Crown Triplex Rail Bonds—Having divided lower member adapts itself to limited space beneath angle bars where bonds made of two strand construction could not be applied.

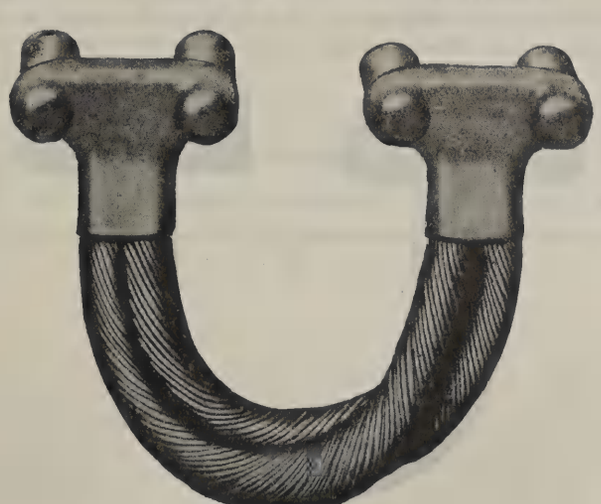


FIG. 6—TWIN TERMINAL RAIL BONDS

Twin Terminal Rail Bonds—Having two small parallel studs on each terminal, the conductor between the terminals being composed of a strand of small round wire.

RAIL BONDS—Continued

FIG. 7—SOLDERED RAIL BONDS

Soldered Rail Bonds—Having flat terminals. The electrical connection with the rails is made with common solder and the conductor between the terminals is composed either of round wire strand or of flat copper ribbons.

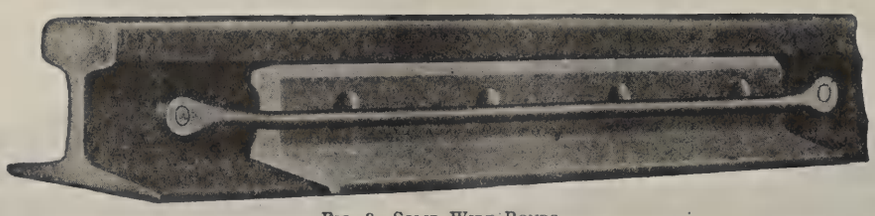


FIG. 8—SOLID WIRE BONDS

Solid Wire Bonds—These are "one-piece" bonds, the terminals being forged from the solid conductor. They are provided in either solid or tubular terminals usually applied around the splice bar or as cross bonds.

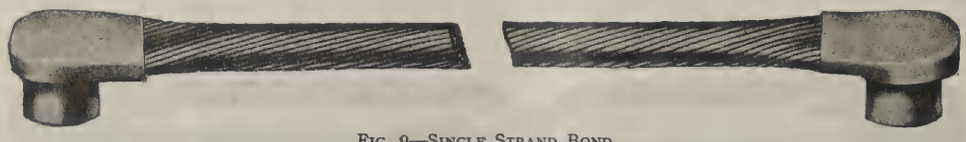


FIG. 9—SINGLE STRAND BOND

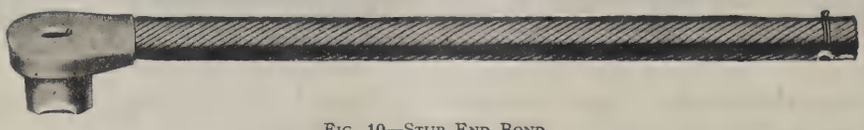


FIG. 10—STUB END BOND

Single Strand Bonds—Used to span the splice bar or as cross bonds; also may be applied beneath the angle bar where space permits. Made either in solid or tubular terminals.

FIG. 11—FLAME WELD BOND

Flame Weld Bonds—Are welded to the rail by oxyacetylene flame. This is accomplished by the use of a specially prepared copper flux wire as the attaching metal, thus making a permanent contact.

CONCEALED RAIL BONDS

Forms of Crown and United States Rail Bonds

Orders Should Specify the Type

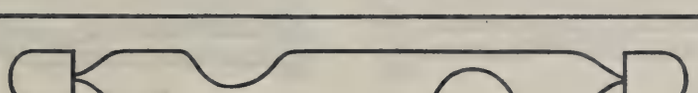
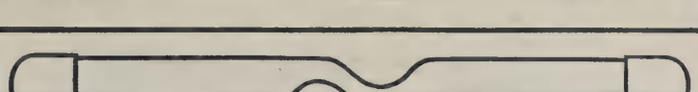
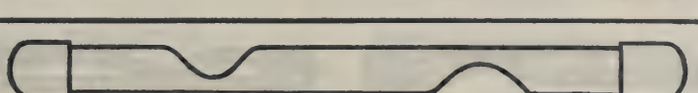
UNEVEN (ODD) STRANDS	FORM OF BODY	EVEN STRANDS
Form C. - 1 " C. S. - 1 " C. P. - 1 " U. S. - 1 " U. P. - 1		Form C. - 2 " C. S. - 2 " C. P. - 2 " U. S. - 2 " U. P. - 2
Form C. - 3 " C. S. - 3 " C. P. - 3 " U. S. - 3 " U. P. - 3		Form C. - 4 " C. S. - 4 " C. P. - 4 " U. S. - 4 " U. P. - 4
Form C. - 5 " C. S. - 5 " C. P. - 5 " U. S. - 5 " U. P. - 5		Form C. - 6 " C. S. - 6 " C. P. - 6 " U. S. - 6 " U. P. - 6
Form C. S.-01 " C. P.-01 " U. S.-01 " U. P.-01		Form C. S.-02 " C. P.-02 " U. S.-02 " U. P.-02
Form C. S.-03 " C. P.-03 " U. S.-03 " U. P.-03		Form C. S.-04 " C. P.-04 " U. S.-04 " U. P.-04
Form C. S.-05 " C. P.-05 " U. S.-05 " U. P.-05		Form C. S.-06 " C. P.-06 " U. S.-06 " U. P.-06

FIG. 12

Concealed Crown Rail Bonds
(Patented)

All single-stud terminal bonds, the conductors of which are composed either of single solid wires or of one or more strands, each strand composed of small round wires, are known as Crown bonds. They are made with both styles of terminals, the tubular terminal, known as type C. P. (C-rown P-in) bonds, and the solid compression stud terminal, known as type C. S. (C-rown S-olid) bonds. The various forms of conductors connecting terminals are given arbitrary numerals or letters to distinguish them. Round wire strands are flexible equally in all planes as distinguished from the flat ribbon type of conductor. Crown bonds are made in any length or capacity desired.

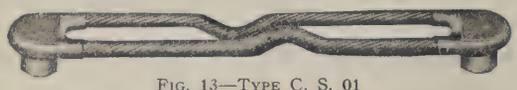


FIG. 13—TYPE C. S. 01
(Unequal Strands)

FIG. 14—TYPE C. S. 02
(Equal Strands)

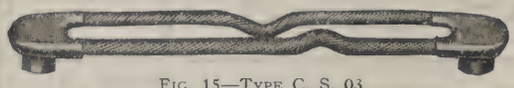


FIG. 15—TYPE C. S. 03
(Unequal Strands)

FIG. 16—TYPE C. S. 04
(Equal Strands)

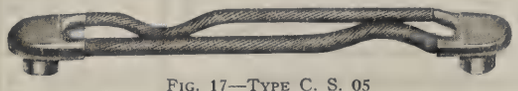


FIG. 17—TYPE C. S. 05
(Unequal Strands)

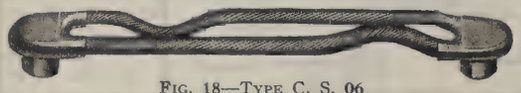


FIG. 18—TYPE C. S. 06
(Equal Strands)

FIG. 19—TYPE C. P. 01
(Unequal Strands)

FIG. 20—TYPE C. P. 02
(Equal Strands)

FIG 21—TYPE C. P. 03
(Unequal Strands)

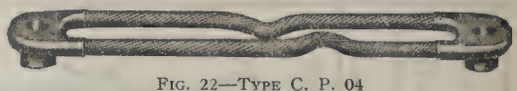


FIG. 22—TYPE C. P. 04
(Equal Strands)

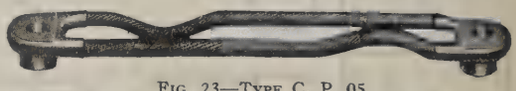


FIG. 23—TYPE C. P. 05
(Unequal Strands)

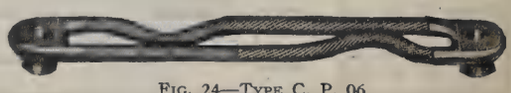


FIG. 24—TYPE C. P. 06
(Equal Strands)

SINGLE-CONDUCTOR BONDS

This single conductor bond is sometimes used under splice bars having a large bonding space beneath the track bolts and little or none above the bolts. It is a good bond to use wherever the joint construction will permit. Some advantage is gained by making this style of bond long enough to allow the terminals to project beyond the ends of the splice bars.

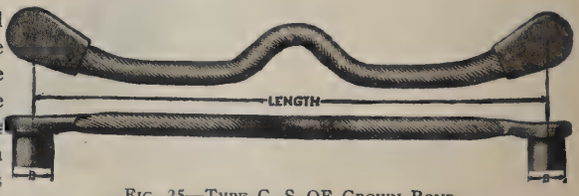


FIG. 25—TYPE C. S.-OF CROWN BOND

Concealed United States Rail Bonds
(Patented)

The United States rail bond has its flexible conductor portion made of flat, parallel laid ribbons of annealed copper. It is designed for use with rail joints having narrow spaces between the joint plates and the rail web. This makes it applicable in some cases when Crown bonds with round wire strands cannot be used advantageously. These bonds are made either with solid compression studs or with tubular terminals. The latter are not shown in cuts. Those having solid terminals will be known as Type U. S. United States bonds, while those with tubular terminals will be designated as Type U. P. United States bonds. In each case arbitrary numerals will be suffixed to distinguish the several forms of crimps in the conductors. These bonds are made in any length or capacity required.

FIG. 26—TYPE U. S. 01
(Unequal Strands)
(Tubular Terminal, Type U. P. 01.)

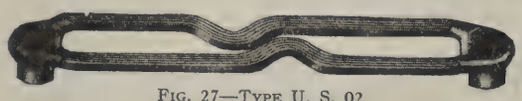


FIG. 27—TYPE U. S. 02
(Equal Strands)
(Tubular Terminal, Type U. P. 02.)

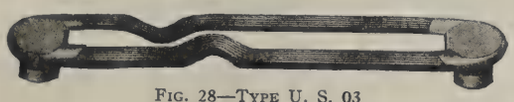


FIG. 28—TYPE U. S. 03
(Unequal Strands)
(Tubular Terminal, Type U. P. 03.)

FIG. 29—TYPE U. S. 04
(Equal Strands)
(Tubular Terminal, Type U. P. 04.)

FIG. 30—TYPE U. S. 05
(Unequal Strands)
(Tubular Terminal, Type U. P. 05.)

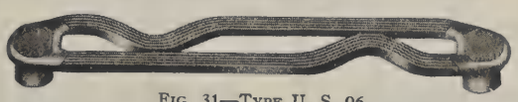


FIG. 31—TYPE U. S. 06
(Equal Strands)
(Tubular Terminal, Type U. P. 06.)

EXPOSED CROWN RAIL BONDS

These are "one piece" bonds, the terminals being forged from the solid conductor. They are provided with either solid or tubular terminals. The extended length of these bonds should be one and one-half inches more than the distance between bond holes, to allow for forming.

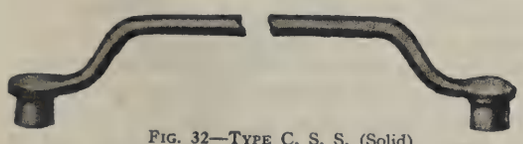


FIG. 32—TYPE C. S. S. (Solid)

(Tubular terminals, Type C. P. S.) A favorite style of bond for application over joint plates.

These are "flexible" bonds with terminals welded to flexible round strand. They are provided with either solid or tubular terminals. The extended length of these bonds should be one and one-half inches more than the distance between bond holes to allow for forming.

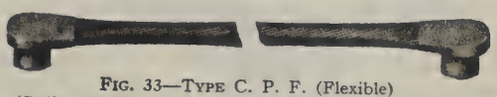


FIG. 33—TYPE C. P. F. (Flexible)

(Solid terminals, Type C. S. F.) Suitable for bonding around joint plates or special work, or for cross bonding.

These are cross bonds made in any length desired provided with either solid or tubular terminals.

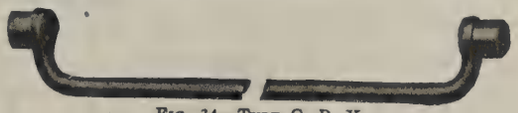
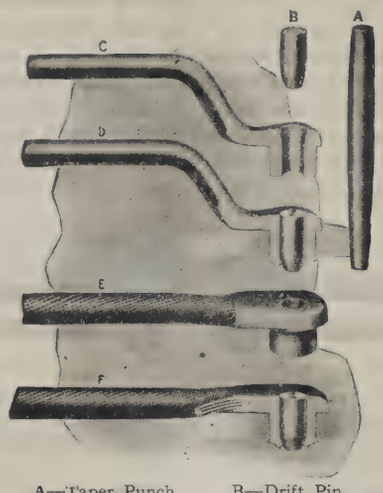


FIG. 34—TYPE C. P. X.
(Solid Terminals, Type C. S. X.)

Method of Application of Tubular Terminals



A—Taper Punch B—Drift Pin

Dimensions of Drift Pins and Taper Punches
Fig. 35—Table I

Terminals			Drift Pins		Taper Punches	
Diameter in Inches		For Size of Bond B. and S. Gauge	Diameter of Pins in Inches		Greatest Diameter in Inches of Standard Taper Punches	Length of Taper Punches in Inches
Outside Stud	Hole Through Terminal		Standard	Special		
1 and over	9/16	...	21/32	43/64 to 22/33	5/8	5
7/8	13/32	4/0	1/2	33/64 to 9/16	15/32	4
3/4	11/32	3/0	17/32	17/32	13/32	4
5/8	9/32	2/0	15/32	..	11/32	3 1/2
1/2	7/32	1/0	1/4	..	19/64	3 1/2

SOLDERED RAIL BONDS

(Patented)

FIG. 36—FORM 1, TYPE S. B., SOLDERED BOND

The Type S. B. (S-oldered B-ond) Form 1 Bond, shown above, has been designed for application to the head of T-rails. In this bond the flexible conductor is composed of a large number of small copper wires, twisted together into a compact strand, which is flexible in all directions. The small, tough wires do not break in the loop, and projecting or loose joint plates will not force the bond from the rail. All 3/0 and 4/0 bonds are made in two sizes each, as shown below. Those having small terminals can be used on any ordinary size of rail; large terminals used only on 70-pound standard T-rails or larger. The extended length of these bonds is measured from end to end of terminals.

Type S. B.-Form 1 Bond

Size of Bond	Length of Bond Formed, in Inches	Dimensions of Contact Surfaces Inches	Length of Bond Extended, in Inches	Number of Wires in Conductors
1/0 B. & S.	7 1/4	9/16 x 2	8 1/4	37
2/0 B. & S.	7 1/4	9/16 x 2	8 1/4	61
3/0 B. & S.	8	5/8 x 2 1/4	9	91
3/0 B. & S.	8 3/4	3/4 x 2 5/8	9 3/4	91
4/0 B. & S.	8	5/8 x 2 1/4	9	127
4/0 B. & S.	8 3/4	3/4 x 2 5/8	9 3/4	127
300,000 C. M.	9	3/4 x 2 5/8	10	127

TWIN TERMINAL BONDS (Patented)

These bonds are applied to the outer side of the heads of T-rails by merely hammering the copper

FIG. 37—FORM-A TWIN STUD TERMINAL BOND INSTALLED

buttons on the bond terminal into holes drilled in the rail. The copper completely fills the holes and affords excellent contact. The following are advantageous points of Twin Terminal bonds.

They are short and yet have ample flexibility.

Efficient and durable.

Installed with the simplest tools.

Their first installation costs are low.

They are applied without disturbing the joint plate.

Their position on the rail renders them easy to inspect.

Each terminal and its two studs are forged from soft pure copper. The studs are ½-inch in diameter and are spaced 1¼ inch between centers. For bonds up to and including 250,000 circular mils, the studs are $\frac{9}{16}$-inch long, and above 250,000 circular mils, $\frac{11}{16}$-inch long. The conductor cable is welded to the terminals at a low temperature and all air is excluded. A perfect union between the terminals and the conductor is assured. Inasmuch as the conductor issues from the lower side of each terminal and in the direction of the vertical movement of the joint, the terminals are relieved of all stress, which is confined to the flexible portion of the bond.

FIG. 38—STANDARD FORM A

The form A can be furnished with single or double conductor as desired. They are made in all standard sizes of conductors up to and including 500,000 circular mils. The standard lengths are 7½ inches for 250,000 circular mils and smaller, and 8 inches above 250,000 circular mils.

Form B bond is similar to Form A except that the conductor emerges at the end of the terminal. This design makes the loop more compact and provides clearance on track joints when the center track bolts would interfere with the standard form A.

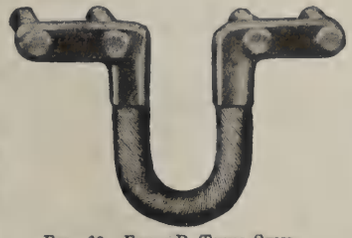


FIG. 39—FORM-B TWIN STUD TERMINAL BOND

BONDS FOR RAIL HEADS

Flame Weld Bonds with Copper Terminals (Patented)

FIG. 40—TYPE FWCA-2 DOUBLE CONDUCTOR

These bonds are designed for application to the ball of the rail by use of the oxy-acetylene flame and special copper flux wire.

The single conductor type is FWCA-1.

Steel Terminal Flame Weld Bonds (Patented)

FIG. 41—TYPE FWSA-2 DOUBLE CONDUCTOR

Single strand FWSA-1 single conductor can be furnished with either single or double conductor.

Flame Weld Rail Bonds are designed for application with oxy-acetylene flame, although they can be put on with an arc by a sufficiently expert welder.

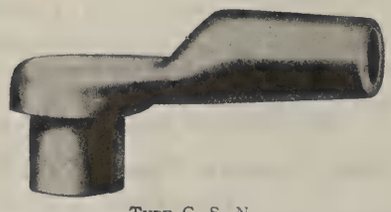
A specially prepared copper flux wire as attaching metal is required for proper results. The use of pure copper should be avoided because it oxidizes excessively and becomes porous and brittle.

They are more strongly attached mechanically than any other types of welded bonds, have large area of contact and make a permanent electrical connection. When welded the contact cannot corrode and deteriorate.

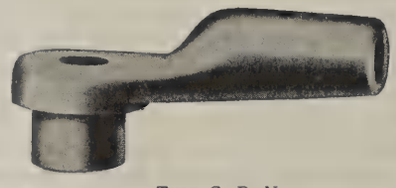
Can be applied to any part of the rail as desired. Can be used on rail heads with Weber type joints.

SOCKET TERMINALS

These terminals can be used in many places where it would be inconvenient to order special lengths of bonds. The various styles of terminal shanks shown are provided with deep sockets into which the conductors, cut to proper length, may be soldered by the purchaser. Standard terminals of these designs are made with studs having diameters of $\frac{5}{8}$, $\frac{3}{4}$, $\frac{7}{8}$ and 1 inch. The sockets in every case are drilled to fit the conductor, as ordered.



TYPE C. S. N.



TYPE C. P. N.

TYPE C. S. O.

TYPE C. P. O.

FIG. 42—SOCKET TERMINALS

BONDING TOOLS AND APPLIANCES

COMPRESSORS

In these screw compressors, the old style outer screw has been replaced by a cylindrical sleeve 2, which in one position is free to slide in or out of the frame with a single thrust or pull of the operator. Turning this sleeve through a quarter revolution brings two shoulders to press against the compressor frame, and these take all the thrust of the inner screw ram. This construction is similar to the breech block of a modern cannon. The speed with which it can be operated gives to this tool a distinct advantage over the large outer screw of the older style compressors. This mechanism also permits the use of a short, stiff, well constructed screw ram, and brings the wrench close to the frame of the tool and near to the rail. These features add to the life and effectiveness of the tool.

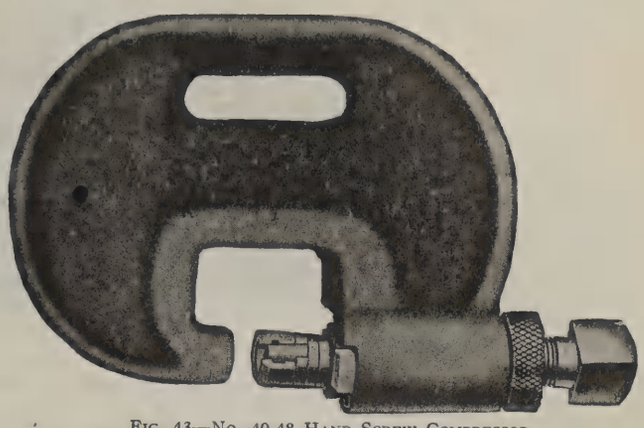


FIG. 43—No. 40-48 HAND SCREW COMPRESSOR

HAND SCREW COMPRESSORS

Number of Compressor	Approximate Weight, Pounds	Style and Size of Rail
40	67	T-rails up to 5¼ inches
42	80	T-rails under 7 inches
44	105	Girder rails under 7 inches
46	140	Girder rails up to 9 inches
48	165	Girder rails 9 inches and over

List of Parts for Types 40-48 Screw Compressors

1 Body casting.
2 Breech block sleeve.
3 Screw ram.
4 Screw in body.
5 Collar on screw ram.
6 $\frac{3}{16}$-inch pin in screw ram.
7 Spring on screw ram.
8 Wrench for machine.

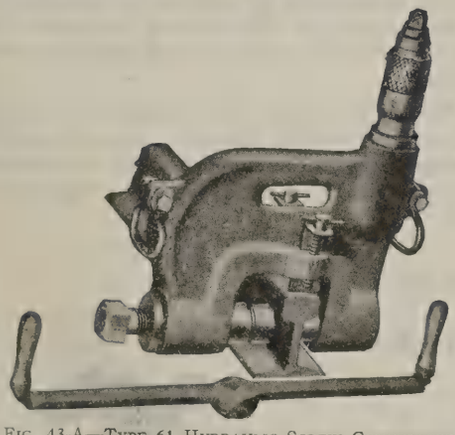


FIG. 43-A—TYPE 61 HYDRAULIC SCREW COMPRESSOR

HYDRAULIC SCREW COMPRESSORS

The hydraulic screw compressor shown above is built upon entirely new principles. It is extremely strong and durable, rapid in action, and contains no valves or intricate parts to get out of order. It has a capacity of 35 tons, which pressure exerted on a terminal stud will produce lasting and effective results. Approximate weight, 115 pounds.

List of Parts for Type 61 Hydraulic Screw Compressor

1 Body or frame.
2 Threaded brass sleeve.
3 Piston screw.
4 $\frac{5}{16}$-inch headless cap screw for outer sleeve.
5 Outer sleeve.
6 ¼-inch pin in piston screw and on small piston.
7 Leather packing for cup in oil chamber.
8 Steel cup for oil chamber.
9 Small piston.
11 Handles on body.
12 Leather cup packing on end of small piston.
13 Packing screw on end of small piston.
14 Leather cup packing on large piston.
15 Brass nut on large piston.
16 Large compressor piston.
17 Leather washer on large piston.
18 Brass washer on large piston.
19 ¼-inch round head screw on large piston.
20 Collar on screw ram.
21 ¼-inch pin in screw ram.
22 Spring on screw ram.
23 Breech block sleeve.
24 Screw ram.
25 Adjusting gauge.
26 Adjusting screw.
27 Wrench for sleeve screw.
28 Spanner wrench for nut on large piston.
29 Wrench handle.
30 ½-inch headless set screw in body.

"LITTLE GIANT" ELECTRIC DRILL

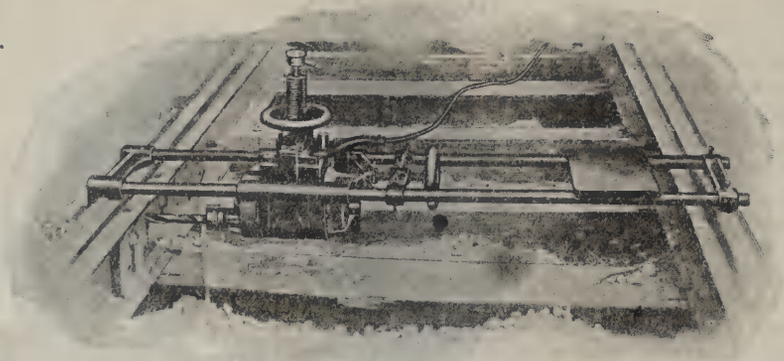


FIG. 44—DUNTLEY ELECTRIC DRILL WITH ADJUSTABLE FRAME

Style 255843 electric drill has been especially designed to operate on 450 to 600 volts direct-current circuit. It is particularly suitable for drilling the rails for bonding, having a drilling capacity of 1-inch diameter hole in steel and 2-inch diameter hole in wood.

Style 255844 drill is designed to operate on a 250-volt direct-current circuit and is specially suitable for use in bonding rails in mines and industrial plants. This drill has a capacity of ¾-inch hole in steel and 1½-inch hole in wood.

These drills are regularly equipped with Morse round taper sockets taking standard round taper shank drills. They are furnished with two cables, one for the trolley connection and the other for the rail or ground. The pipe handle shown at the bottom of the illustration is removable for close side work. The drills are regularly furnished with feed screw as shown, but a ratchet feed or a spade handle can be supplied if desired.

Special precautions have been taken to prevent danger of shocks to workmen, and if directions are followed there is no danger from this source, even though the windings of the tool may become grounded.

The design and construction of these tools have been carefully worked out in accordance with approved principle to overcome the trouble incident to rough handling and high voltage on street railway work.

The side spindle gearing permits close corner work and the hardened and ground steel gears combine long wearing quality and great strength.

The armature is form wound and the brush-holders are similar to those used on large machines. Removable covers at the commutator end afford perfect accessibility to commutator and brushes. A large cast fan provides efficient ventilation. The bearings are of the sleeve type with large oil retaining cavities.

The drill is provided with a magnetic switch with adjustable contacts, magnetic blowout and no-voltage release. The removal of four screws allows the handle and all connections to be taken from the drill.

Style No.	Cat. No.	Description	Morse Round Taper Socket	Net Weight in Lbs.
255843	103468	Duntley electric drill No. 3, 600 volts	No. 3	48
255844	157005	Duntley electric drill No. 2, 250 volts	No. 2	30

NO. 3 BOYER ANGLE GEAR

Where it is necessary to work in very close quarters or drill near to ties, we recommend the use of our No. 3 Boyer Angle Gear in combination with a Duntley Electric Drill. This gear is no larger than an ordinary hand ratchet. Distance from center of spindle to the outside of housing, 1¾ inches. Distance from point of feed screw to the end of socket, 8¼ inches.

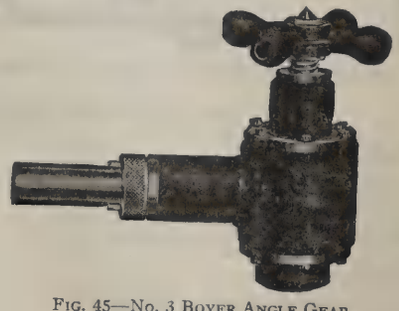


FIG. 45—No. 3 BOYER ANGLE GEAR

Style No.	Description	EACH Weight, Lbs.
148130	No. 3 Boyer angle gear	13

HAND-OPERATED DOUBLE-TWIN-SPINDLE DRILL

Twin-stud-terminal bonds require four holes, two in the head of each of the abutting rails. The double-twin-spindle drill bores all four holes simultaneously, and drills them cheaply, quickly and accurately. It has a positive automatic feeding device which provides a wide range of adjustment. Each stroke of the operating lever rotates all of the drills through equal arcs.

An adjusting sleeve is provided so that each drill point can be initially set in a longitudinal direction independently of the others. This arrangement permits the use of drills of different lengths and renders perfect operation possible where rails are unevenly worn or set or where, for any reason, the surface drilled into is not a perfect plane.

A gauge is furnished with each machine for determining proper hole depth.

Frames can be raised or lowered quickly to bring the drill points in their correct positions. Attachment to the rails is effected without disturbing rail joints.

Drill points are held very firmly in the drill, and breakage and chipping are thereby reduced to a minimum. So rigidly are the points held that holes can be started without first marking the rail with a prick punch.

Portability—When the tool is moved from place to place the operating lever, which is easily detached, is removed. **When traffic,** over tracks being bonded, must not be disturbed the drilling machines can be effectively attached to the splice bars instead of to the head of the rail.

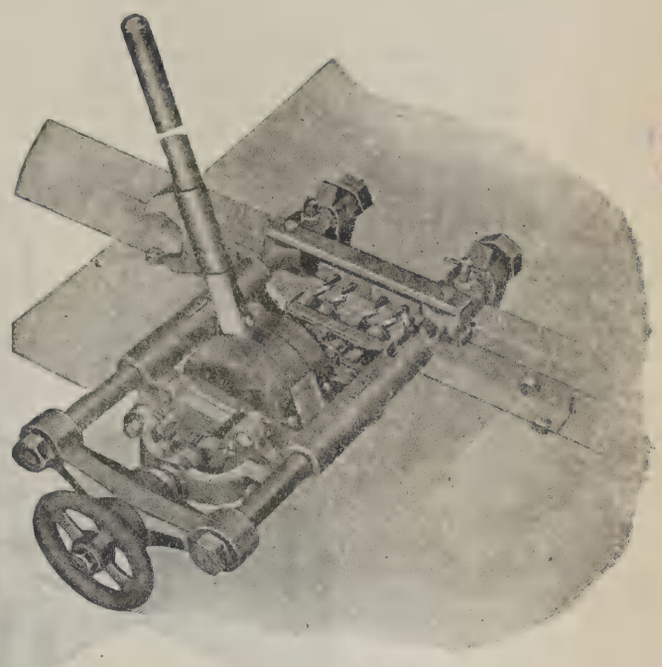


FIG. 46—HAND-OPERATED DOUBLE-TWIN-SPINDLE DRILL TYPE NO. 22

Outfit—Each drilling machine is equipped with one complete set of new drills. Many parts of the machine are interchangeable and can be ordered by mail.

Style No.	Description	EACH Net Wt. Lbs.
187193	Hand-operated double-twin-spindle drill	125

Parts for Type No. 22 Drill

1 Large part of body (back) casting.
2 Small part of body (front) casting.
3 Gear cover, casting.
4 Springs on gear cover.
5 Truss plate on back part of body.
6 Small yoke for feed screw.
7 Large yoke for feed screw.
8 Plate on large yoke (outside of brass nut).
9 Hand wheel.
11 Brass nut on feed screw.
12 Feed screw.
13 Feed ratchet gear.
14 Collar on feed screw.
15 Cam for feed pawls on feed screw.
16 $\frac{3}{8}$-inch plunger for cam in truss plate.
17 Spring for plunger in truss plate.
18 Feed pawls.
19 Spring for feed pawls.
20 $\frac{1}{16}$-inch headless set screw in pawls.
21 Brass friction in feed pawls.
22 Guide and clamping bar for machine.
23 Loose jaw on guide bar (clamp).
24 1-inch nut on guide bar (clamp).
25 $1\frac{1}{16}$-inch nut on guide bar (clamp).
26 Washer on guide bar (clamp).
27 Adjusting screw on guide bar.
28 Tie for guide bar (clamp).
29 Depth gauge for drilling.
30 Thumb nut for depth gauge.
31 Driver lever for driving machine.
32 Pawl for drive lever.
33 Stud for drive lever, pawl stud.
34 Handle and wrench for drive.
35 Single gear spindle.
36 Double gear spindle.
37 Intermediate gear.
38 Intermediate gear staggered teeth.
39 Ratchet driving gears.
40 Shaft for drive gears.
41 Adjusting nuts on spindle.
42 Clamps (dogs) for holding drills.
43 $\frac{1}{4}$-inch headless set screws for dogs on spindle.
44 Ball race in truss plate.
45 Truss block for feed screw.
46 $\frac{3}{8}$-inch balls.
48 Oil hold cover (front body).
49 Oil hold cover (back body).
50 Oil hold cover (back body).
51 Collar on driving shaft.
52 Friction spring on adjusting nut on spindles.
53 Woodruff key for guide bars.
54 $\frac{1}{2}$-inch cap screw in truss plate.
56 Spring for driving pawls.
58 $\frac{3}{16}$-inch pins for collar on feed screw.
62 $\frac{1}{2}$-inch cap screws for small and large part of body truss plate and tie on guide bars.
63 $\frac{5}{8}$-inch cap screw for small yoke.
64 $\frac{1}{16}$-inch Fil. screws for plate on large yoke outside brass nut for feed screw.

DRILLING MACHINES

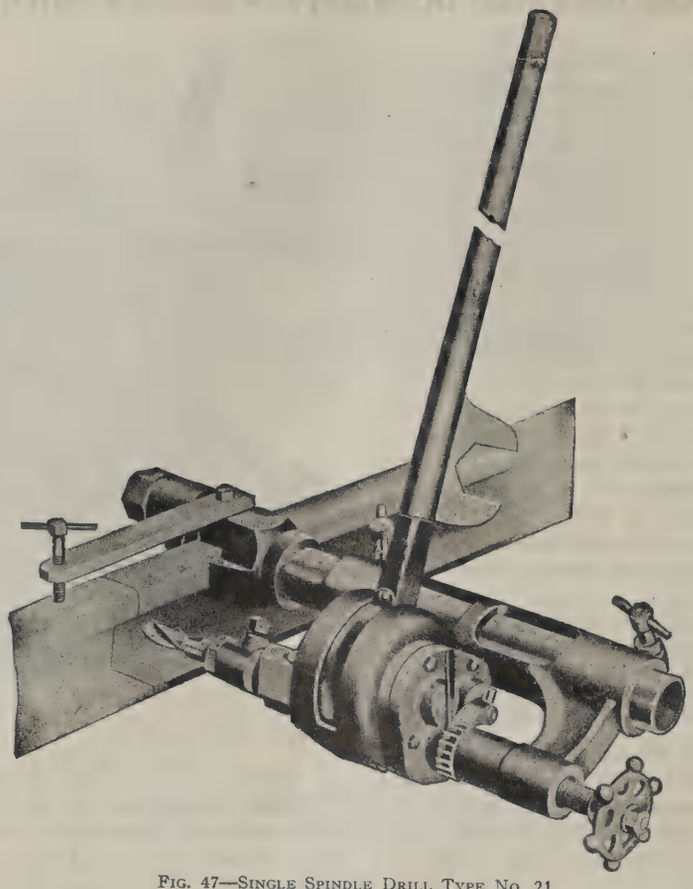


FIG. 47—SINGLE SPINDLE DRILL TYPE NO. 21

The large single spindle drills shown on this and the next page will bore any size hole up to 1⅛ inches, through rail webs for any type of single stud terminal bond. Like the multiple spindle drills already described, they have a double acting lever and an automatic feed. They are adjustable in all respects and are provided with fittings for rigid attachment to the rail. Being held rigidly, the drill points will pass entirely through the rail without breaking, at the same time boring a perfectly smooth and true hole. These drills have many distinct advantages over other track drills.

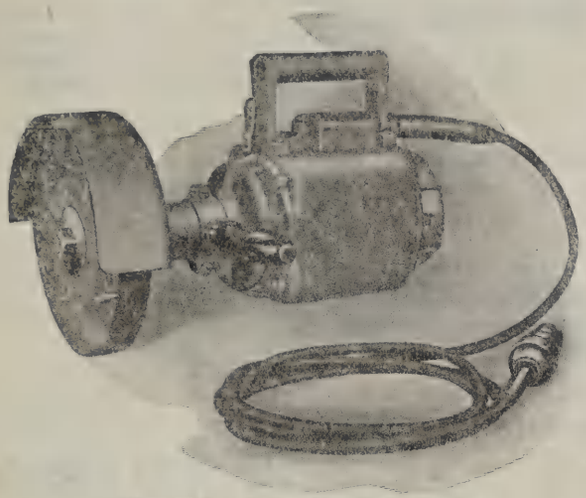
Type No. 21 can be used on all roads where traffic will permit. It has a positive and simple method of attachment to the head of the rail. Approximate weight, 85 pounds.

List of Parts for Type No. 21 Drill

1 Frame.
2 Body.
3 Cover on body.
4 Clamp bar.
5 Loose jaw on clamp bar.
6 Nut on clamp bar.
7 Washer on clamp bar.
8 Feed sleeve.
9 Driving lever.
10 Ratchet driving gear—25 teeth.
11 Ratchet driving gear—27 teeth.
12 Gear sleeve on drill spindle.
13 Adjusting bar on clamp bar.
14 Brass bushing in front end of frame.
15 Brass bushing in rear end of frame.
16 Feed screw.
17 Shaft for driving lever and gears.
18 Ball race on drill spindle.
19 Intermediate gear
20 Drill spindle.
21 Collar on drill spindle.
22 Large nut on drill spindle.
23 Large washer on drill spindle.
24 Stud for driving pawls.
25 Stud for connecting body to frame.
26 Feed pawl.
27 Cam for feed pawls.
28 Clamp screws on frame.
29 Catch pawl for feed ratchet.
30 Crank handle on feed screw.
31 Adjusting screw.
32 Driving pawls.
33 Washers on rear end of drill spindle.
34 Key in drill spindle.
35 Stud for catch pawl.
36 Key in clamp bar.
38 Small nut on drill spindle.
39 Cap screw for adjusting bar.
40 Key in feed screw.
41 Spring for catch pawl.
42 Cap screws for body.
43 Round head screw for driving lever.
46 Set screw for clamping drill in spindle.
47 Spring for driving pawls.
49 Friction plunger in feed pawl.
50 Headless set screw in feed pawl.
51 Spring in feed pawl.
52 ⅜-inch steel balls (ball bearing).
53 Shield (gear cover).
54 Driving handle and wrench.

"LITTLE GIANT" PORTABLE ELECTRIC GRINDER

For 460 to 600-Volt D. C. Circuits



"Little Giant" Portable Electric Grinder

For grinding rails for bonds, either soldered or otherwise fastened, we are offering a portable electric grinder that will accomplish a very large amount of work at a rapid rate. This tool is light, absolutely portable, and can be handled by a comparatively inexperienced operator.

The grinder carries an emery wheel 6 x 1¼ x ⅝ inches, which has a speed of 2400 r.p.m. and ample power to do rapid work. It has a magnet switch with adjustable contacts, magnetic blowout and no-voltage release.

The removal of four screws allows the handle and all connections to be taken from the grinder, and removable covers at the commutator end afford ready means of inspection.

Suitable cable is furnished with each grinder.

Style No.	Description	Each—Net Wt., Lbs.
148169	Duntley portable electric grinder	28
187115	Extra wheels, 6 in. dia., 1¼ in. face, ⅝-in. hole	6

HAND TOOLS FOR INSTALLING TWIN-STUD TERMINAL BONDS

Milling Cutters—It is necessary to mill an annular groove, as shown in Fig. 37, in holes in which the studs of twin-stud-terminal bonds are to be driven. Such grooves are milled with this cutter. A groove is cut by rotating the cutter, with a swinging motion, keeping the teeth meanwhile pressed against the sides, several times within the hole. The cutter can be detached from the handle and can be renewed when dull.

Fig. 50 Style No. 255845

Style No.	Description	Net Weight in Lbs.
255845	Milling cutter with handle	½

Dulling punches are used for rounding off and dulling the sharp edges of holes drilled in rail heads for twin-stud-terminal bonds. This one is especially designed for the work and will do it well.

Fig. 51—Dulling Punch. Style No. 148137

Fig. 52—Riveting Hammer. Style No. 148138

Riveting hammers are used for driving and expanding in their holes the studs of twin-stud-terminal bonds. The hammer listed here has been found to be especially adapted for the work. It is a practical man's hammer.

Style No.	Description	Weight
148137	Dulling punch	3 oz.
148138	Riveting hammer	2½ lbs.

CHANNEL PINS

These channel pins are made of soft steel, copper plated, and are tapered on one end so that they may be easily started in the rail, and are slightly larger than the hole in the rail so that when seated they compress tightly on the wire and make a firm and solid joint. Style No. 135073 is used largely by steam roads for signal bonding.

For temporary bonding, as in the case of new electric roads under construction, they afford a quick and efficient means of obtaining a good electrical circuit in temporary tracks and sidings.

In mines using electric haulage, where it is often necessary to shift some section of track, and where it is impossible to install other bonds, the channel pin affords a cheap and efficient form of bonding.

Style No.	Size Bonding Wire B. & S. Gauge	Outside Diam. Pin, Inches	Diam. Hole in Rail, Inches	Per 1000 Approx. Wt., Lbs.	Per 1000 List Price
135073	6	5/16	9/32	14	
102247	4	3/8	11/32	15	
135074	2	15/32	7/16	30	
102248	0	19/32	9/16	32	
181860	00	19/32	9/16	30	
102249	00	21/32	5/8	50	
186317	00	3/4	23/32	87	
127101	000	3/4	23/32	85	
102250	0000	25/32	3/4	80	
186318	0000	29/32	7/8	110	

COPPER BONDING SLEEVES

These sleeves are made of a special copper alloy of great ductility and low resistance. They consist of a hollow slotted sleeve having a flange at one end, and the other end so shaped that when the sleeve is driven into place in the rail it may be upset to form a head or shoulder. The hole in the rail is drilled 1/32-inch smaller than the outside diameter of the sleeve so that when the sleeve is driven into the rail it compresses over the wire, binding it firmly in place. In addition to regular bonding, these sleeves are equally well adapted to cross-connecting and special bonding as the bond wire extends entirely through the sleeve.

To properly install these sleeves a drift punch driving and upsetting tools are required. The drift punch removes any burrs around the edge of the hole in the rail left by the drill. It is driven lightly into the hole from the same side that the bonding sleeve is to enter. The sleeve is then inserted in the rail and driven home by means of the driving tools. One end of the tool is slotted to allow it to clear the bond wire. After the sleeve is in position the upsetting tool is applied to the tapered end to form a head or shoulder against the rail. A hole is provided in the end of this tool to give clearance to the projecting end of the bond wire.

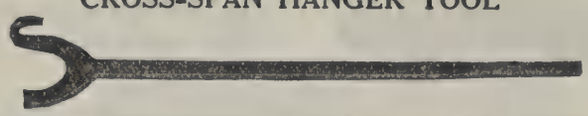
Style No.	Size Bonding Wire B. & S. Gauge	Outside Diam. Cap Inches	Diam. Hole in Rail Inches	List Price Per 1000
135082	0	19/32	9/16	
135083	0	21/32	5/8	
135084	00	19/32	9/16	
135085	00	21/32	5/8	
135086	0000	25/32	3/4	

TOOLS FOR INSTALLING BONDING SLEEVES

Style No.	Description
137366	Drift punch
137367	Driving tool
137368	Upsetting tool

LINEMEN'S TOOLS

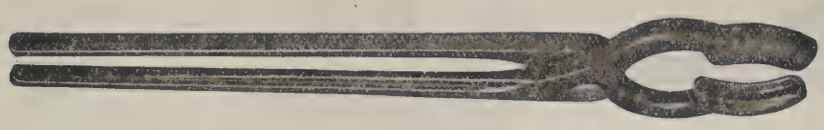
CROSS-SPAN HANGER TOOL



The cross-span hanger tool can be economically used in installing straight-line hangers, frogs, crossings, etc., and is one of the most useful tools for the tower wagon equipment. It is made of forged steel. Over-all length, 30½ inches.

Style No.	Each: Approx. Net Wt., Lbs.	Each: List Price
128426	4½	$7 50

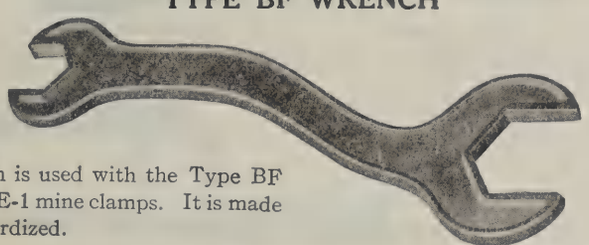
TYPE A TONGS



Type A tongs are essential for the installation of cap and cone insulators. They are made of malleable iron. Over-all length, 20 inches.

Style No.	Each: Approx. Net Wt., Lbs.	Each: List Price
119357	4	$2 50

TYPE BF WRENCH



The type BF wrench is used with the Type BF suspensions, RE and RE-1 mine clamps. It is made of malleable iron sherardized.

Style No.	Each: Approx. Net Wt., Lbs.	Each: List Price
112740 For BF, LH & JW Suspensions and RE Clamps	1¼	$0 50
281996 For BF, LH & JW Suspensions and RE-1 Clamps	1¼	0 50

TYPE HB WRENCH

The type HB wrench is used with the type HB mine trolley clamps. Made of drop-forged steel. Length, 7¾ inches.

Style No.	Each: Approx. Net Wt., Lbs.	Each: List Price
126629	⅜	$0 50

STEEL LAG-SCREW WRENCH

These wrenches are forged from select bar steel, polished. For use with ½ to ⅝-inch lag screws. Length, 11½ inches.

Style No.	Per Dozen: Approx. Net Wt., Lbs.	Per Dozen: List Price
137378	20	$20 00

STEEL COMBINATION LAG-SCREW WRENCH

These wrenches are forged from selected bar steel, polished. Can be used with ⅜, ½ and ⅝-inch lag screws and bolts. Length, 13½ inches.

Style No.	Per Dozen: Approx. Net Wt., Lbs.	Per Dozen: List Price
137379	20	$24 00

MONKEY WRENCHES

The entire bar of these wrenches is one solid steel forging, making them the strongest wrench made.

Style No.	Total Length, Inches	Will Open, Inches	Approx. Net Wt. Each, Lbs.	List Price Per Dozen
137380	6	$\frac{7}{8}$	$\frac{3}{4}$	$10 00
137381	8	$1\frac{1}{4}$	$1\frac{3}{4}$	12 00
137382	10	$1\frac{3}{4}$	$2\frac{3}{8}$	14 00
137383	12	$2\frac{1}{8}$	$3\frac{3}{8}$	18 00

STILSON WRENCHES

Style No.	Total Length, Inches	For Pipes, Max. Diam., Inches	Each — Approx. Net Wt. Lbs.	Each — List Price
137384	6	$\frac{1}{2}$	$\frac{3}{4}$	$2 00
137385	8	$\frac{3}{4}$	$\frac{5}{8}$	2 00
137386	10	1	$1\frac{3}{8}$	2 25
137387	14	$1\frac{1}{2}$	$2\frac{3}{4}$	3 00

CHAMPION SCREW-DRIVERS

Machinists' Style—For Heavy Work

Style No.	Length of Blade, Inches	Approx. Net Wt. Each, Lbs.	List Price Per Dozen
137389	4	$\frac{1}{4}$	$ 4 25
137390	5	$\frac{5}{16}$	5 00
137391	6	$\frac{3}{8}$	6 00
137392	7	$\frac{7}{16}$	7 00
137393	8	$\frac{1}{2}$	8 00
137394	9	$\frac{9}{16}$	9 00
137395	10	$\frac{5}{8}$	10 00
137396	12	$\frac{3}{4}$	12 00

STRIPPING CHISEL

These chisels are made from drop-forged octagon tool steel. They will remove trolley ears and approaches from the trolley wire without injuring either the wire, the ear or the approach. Over-all length is 23 inches.

Style No.	Each — Approx. Wt. Net Lbs.	Each — List Price
128476	3	$3 00

SOCKET FRAMING CHISELS

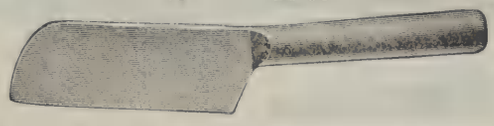
Style No.	Width of Blade, Inches	Approx. Net Wt. Each, Lbs.	List Price Per Dozen
137397	1	$1\frac{7}{16}$	$11 00
137398	$1\frac{1}{2}$	$2\frac{3}{16}$	13 00
137399	2	$2\frac{3}{4}$	16 00

CABLE STRIPPING KNIFE

Style No.	Description	Approx. Net Wt. Each, Lbs.	List Price Per Dozen
137400	Polished	$\frac{3}{8}$	$21 25

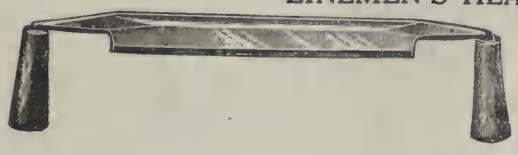
LINEMEN'S TOOLS—Continued

CABLE SPLITTING KNIVES



Style No.	Description	Per Dozen Approx. Net Wt., Lbs.	Per Dozen List Price
137401	With Wood Handle	6⅜	$16 00
137402	Solid Steel, Polished	5½	12 00

LINEMEN'S HEAVY DRAW-KNIVES



Style No.	Length of Blade, Inches	Approx. Net Wt. Each, Lbs.	List Price Per Dozen
137403	12	2	$18 00
137404	14	2 3/16	20 00
137405	16	2½	22 00

LINEMEN'S HAND AXES

Single Bevel

Style No.	Width of Blade, Inches	Approx. Net Wt. Each, Lbs.	List Price Per Dozen
137630	4¼	2⅜	$10 50
137631	4¾	2 11/16	11 50
137632	5¼	3⅛	13 00
137633	5¾	3½	14 50

ADJUSTABLE HACK-SAW FRAME AND BLADES

The frames have an extra strong back. They are made of solid steel, nickel-plated, and are adjustable to take blades from 8 to 12 inches long. Packed one in a box. Style number includes frame but does not include any blades. Blades are packed 12 to a package. Orders for broken packages will not be accepted.

Style No.	Length of Blade, Inches	Approx. Net Wt. Each, Lbs.	List Price Per Dozen
	Hack-Saw Frame Adjustable for 6 to 12 **Hack-Saw Blades**		
137637		1 3/16	$25 00
		Per Dozen	Per Gross
137638	8	⅜	$ 8 00
137639	9	7/16	9 00
137640	10	½	10 00
137641	11	9/16	11 00
137642	12	⅝	12 00

KLEIN'S SIDE CUTTING PLIERS

Polished Head, Black Handles

DIAMOND SPECIAL, WITHOUT TWISTER

DIAMOND SPECIAL, WITH TWISTER

WORLD SPECIAL, WITHOUT TWISTER

WORLD SPECIAL, WITH TWISTER

Style No. "Diamond Special"	Style No. "World Special"	Size, Inches	Approx. Net Wt. Each, Lbs.	List Price Per Dozen
		Without Sleeve Twister		
206582	206591	5	3	$16 75
206583	206592	6	5	20 85
206584	206593	7	7½	25 00
206585	206594	8	12	30 00
206586	206595	9	12½	33 35
206587	206596	10	18	36 75
		With Sleeve Twister		
206588	206597	7	7½	28 00
206589	206598	8	12	32 00
206590	206599	9	13	36 00

The 7-inch size twister is fitted for No. 12 (B. & S.) sleeves and the 8 and 9-inch for No. 10 (B. & S.) sleeves.

LINEMEN'S TOOLS—Continued

GAS PLIERS
Forged Steel, Polished

Style No.	Size, Inches	Per Dozen Approx. Net Wt.	Per Dozen List Price
137649	8	7½	$11 00
137650	10	10	15 00
137651	12	17½	17 00

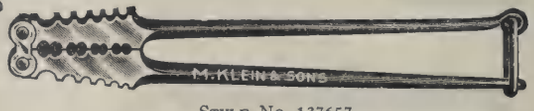
"VICTOR" BOLT CLIPPERS

Style No.	Mfrs. No.	For Bolts Max. Diam., Inches	For Bolts Length, Inches	Each Approx. Net Wt., Lbs.	Each List Price
129806	0	5/16	18	3	$3 75
129807	1	3/8	24	4½	5 00
129808	2	½	30	7½	7 00
129809	3	5/8	36	12½	9 00

SPLICING CLAMPS

Style No. 137653

Style No. 137654



Style No. 137657

Style No. 137659 Style No. 137660

Style No.	Size of Wire Copper B. & S.	Size of Wire Iron B. W. G.	Size of Sleeve Copper B. & S.	Size of Sleeve Iron B. W. G.	Length, Inches	Per Dozen Approx. Net Wt., Lbs.	Per Dozen List Price
			Single Clamps				
137653	2, 4, 6 and 12	4, 6, 8 and 14	.....	.....	10½	14½	$25 50
137654	0, 2 and 4	2, 4 and 6	.....	.....	10¾	14¾	25 50
			Combination Clamps				
137657	4 to 12	6 to 14	6 to 12	8 to 14	11¼	17¾	32 00
137659	4 to 14	6 to 16	6 to 12	8 to 16	11¼	17¾	32 00
137660	2 to 12	4 to 14	6 to 14	8 to 16	11¼	17¾	32 00

CLINCHING IRONS

The clinching iron is a malleable-iron anvil shaped to fit over the boss of the trolley ear and provides a solid backing for the ear while the lips are clinched over. When cut in half, each half is ideal for clinching approaches of Detroit frogs, crossings, section insulators, etc.

Style No.	Each: Approx. Net Wt., Lbs.	Each: List Price
186294	9½	$1 50

TROLLEY-WIRE CLAMPS

The trolley-wire clamp secures a very powerful grip and does not injure the wire, irrespective of the strain imposed. Its action is positive. It is quicker to attach or detach than the ordinary trolley clamp.

Style No.	Size, Wire	Each: Approx. Net Wt., Lbs.	Each: List Price
185906	0 and 00	4½	$5 00
185907	000 and 0000	4½	5 00

HAVEN'S ECCENTRIC WIRE CLAMPS
Polished Steel

HAVEN'S ECCENTRIC CLAMP

Style No.	Maximum Size Wire	Per Dozen: Approx. Net Wt., Lbs.	Per Dozen: List Price
102113	No. 8 wire and smaller	12	$24 75
102114	½-inch wire and smaller	30	35 00

"CHICAGO" WIRE GRIPS

"CHICAGO" GRIP, BARE WIRE

"CHICAGO" GRIP, INSULATED WIRE

Style No.	Maximum Size Wire	Each: Approx. Net Wt. Lbs.	Each: List Price
	For Bare Wire		
137661	0 wire and smaller	2⅝	$ 8 00
137662	0000 wire and smaller	7½	12 00
	For Insulated Wire		
137663	00 wire and smaller	3¾	9 00
137664	0000 wire and smaller	7¼	12 00

"QUICK SAMSON" WIRE GRIPS

"QUICK SAMSON" GRIP

Style No.	Size, Wire	Each: Approx. Net Wt. Lbs.	Each: List Price
	For Bessemer Strand		
137665	1/16 to ⅜-inch	9½	$10 00
137666	¼ to ½-inch	12	11 00
137667	1/16 to ⅝-inch	18	12 00
	For Bare Copper		
137668	No. 6 to 00	9½	10 00
137669	No. 2 to 0000	12	11 00

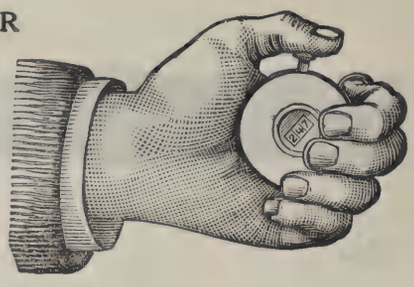
PARALLEL SCREW CLAMPS

PARALLEL SCREW CLAMP

Style No.	Size, Wire	Approx. Net Wt. Each, Lbs.	List Price Per Dozen
102115	0 and 00 rd.	7	$28 00
102116	00 rd. or gr. and 000 rd.	7½	32 00
102117	000 rd. or gr. and 0000 rd.	7¾	40 00
137671	00 Fig. 8	7	35 00
137672	000 Fig. 8	7½	38 00
137673	0000 Fig. 8	7¾	40 00

POCKET COUNTER

A handy device for inspector's use, counting of material, poles, etc. It registers to 999 and can be reset to zero at any time. Furnished nickel-plated. 2 inches diameter.



Style No.	Each: Approx. Net Wt., Lb.	Each: List Price
137406	¼	$7 00

TOOL BELT AND SAFETY STRAPS

Style No.	Description	Per Dozen: Approx. Net Wt. Lbs.	Per Dozen: List Price
137674	Tool belt, 2¼ inches, with rings for attaching safety strap	27	$20 00
137675	Safety strap 1¾ inches, 6 feet long, with strong snaps and buckle to reduce length	30	23 20

POLE CLIMBERS AND LEG STRAPS

Style number of climbers does not include straps.

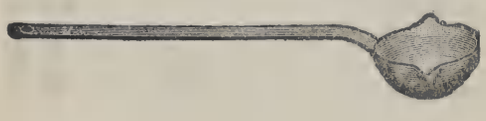
Style No.	Description	Length, Inches	Approx. Net Wt. Each, Lbs.	List Price Per Dozen
137678	Climbers	15	3⅝	32 00
137679	Climbers	15½	3⅝	32 00
137680	Climbers	16	3⅝	32 00
137681	Climbers	16½	3⅝	32 00
137682	Climbers	17	3⅝	32 00
137683	Climbers	17½	3⅝	32 00
137684	Climbers	18	3⅝	32 00
137685	Climber straps*	22	1¼	19 00

* Two upper straps with 4 x 4 pads.
Two lower straps without pads.

MELTING POTS

Style No.	Diameter, Inches	Each: Approx. Net Wt., Lbs.	Each: List Price
137686	4	2	$1 00
137687	4½	3	1 10
137688	5	4¼	1 20
137689	6	8½	1 30

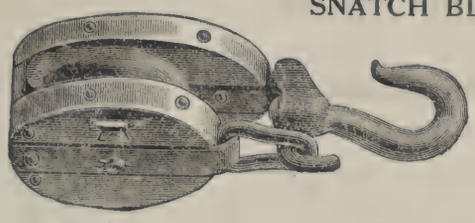
POURING LADLES

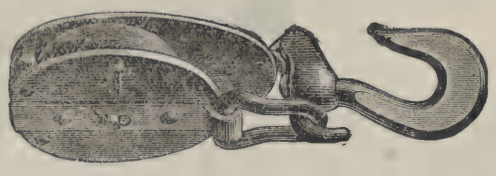


Style No.	Diameter, Inches	Approx. Net Wt. Each, Lbs.	List Price Per Dozen
137690	2½	9	$2 75
137691	3	11	3 50
137692	3½	13	4 00
137693	4	16	4 75

LINEMEN'S TOOLS—Continued

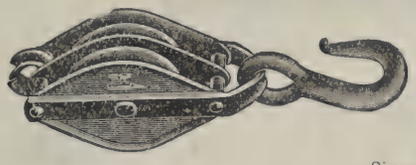
SNATCH BLOCKS—Iron Bushed





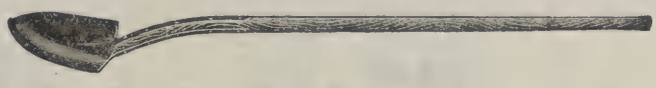
Style No. Wood Shell	Style No. Steel Shell	Size Sheave, Inches	Diameter Rope, Inches	Length Shell, Inches	Each Approx. Net Wt. Wood Shell	Each Approx. Net Wt. Steel Shell	List Price Wood Shell	List Price Steel Shell
137723	137726	3 x1⅛x½	⅞	6	5⅞	6¾	$4 00	$4 00
137724	137727	3½x1¼x½	⅞	7	7⅜	8¾	4 75	4 75
137725	137728	4½x1⅜x⅝	1	8	10¾	12	5 75	5 75

STEEL TACKLE BLOCKS—Iron Bushed



Style No. Single	Style No. Double	Style No. Triple	Size Sheave, Inches	Diam. Rope, Inches	Length Shell, Inches	Approx. Net Wt. Single	Approx. Net Wt. Double	Approx. Net Wt. Triple	List Price Single	List Price Double	List Price Triple
138214	138219	138224	2¼x ⅝x⅜	½	4	1¼	1¾	2¼	$0 85	$1 60	$2 15
138215	138220	138225	3 x ¾x⅜	⅝	5	2	3	4	90	1 75	2 25
138216	138221	138226	3½x1 x½	¾	6	3¾	5	6¾	1 10	2 00	2 90
138217	138222	138227	4¼x1 x½	⅞	7	6	9	12	1 30	2 40	3 50
138218	138223	138228	4¾x1⅛x⅝	1	8	7	12	17	1 65	2 85	4 25

SHOVELS—Hickory or Ash Handles



Round Point, Crooked Handle, Front and Back Straps Polished

Style No.	Length Handle, Feet	Length Strap, Inches	Per Dozen Approx. Net Wt.	Per Dozen List Price
138235	6	22	90	$33 75
138236	7	22	100	36 95
138237	8	22	110	39 75
138238	9	22	120	44 25

Round Point, Straight Handle, Front and Back Straps Polished

Style No.	Length Handle, Feet	Length Strap, Inches	Per Dozen Approx. Net Wt.	Per Dozen List Price
138239	6	22	90	$33 75
138240	7	22	100	36 95
138241	8	22	110	39 75
138242	9	22	120	44 25

With "D" Handle, 9-inch Black Blade, Polished Straps

Style No.	Grade	Approx. Net Wt. Each, Lbs.	List Price Per Dozen
		With Round Point	
138243	A	5½	$21 75
138244	B	5	19 60
		With Square Point	
138245	A	5	21 75
138246	B	4½	19 60

LINEMEN'S TOOLS—Continued

POST HOLE SPOONS—Maple Handles

W. U. Pattern

Flat Toe, Straight Handle, Front and Back Straps Polished

Style No.	Length, Handle, Feet	Length Straps, Inches	Per Dozen Approx. Net Wt.	Per Dozen List Price
138229	7	9	105	$17 50
138230	8	9	115	19 25
138231	9	9	125	21 50
138232	8	22	125	22 00
138233	9	22	135	24 50
138234	10	22	145	26 00

TAMPING AND DIGGING BARS

Made of 1-inch Octagon Steel

Style No.	Length, Feet	Each Approx. Net Wt. Lbs.	Each List Price
138253	6	17	$3 30
138254	7	20	3 60
138255	8	23	3 80

Made of 1⅛-inch Octagon Steel

Style No.	Length, Feet	Each Approx. Net Wt. Lbs.	Each List Price
138256	6	22	$3 70
138257	7	26	4 00
138258	8	30	4 50

CROW AND DIGGING BARS

Made of 1-inch Octagon Steel

Style No.	Length, Feet	Each Approx. Net Wt. Lbs.	Each List Price
138247	6	17	$2 70
138248	7	20	3 00
138249	8	23	3 30

Made of 1⅛-inch Octagon Steel

Style No.	Length, Feet	Each Approx. Net Wt. Lbs.	Each List Price
138250	6	22	$3 60
138251	7	26	3 90
138252	8	30	4 25

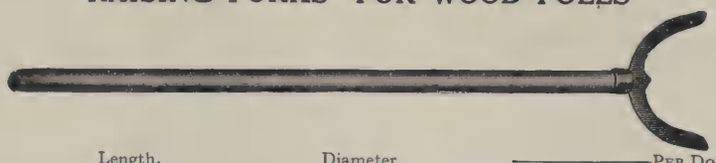
HARDWOOD TAMPING BARS
With Extra Heavy Steel Shoe

Style No.	Length, Feet	Per Dozen Approx. Net Wt.	Per Dozen List Price
102192	7	160	$21 00
102193	8	180	24 00

PIKE POLES

Style No.	Length, Feet	Diameter, Inches	Per Dozen Approx. Net Wt.	Per Dozen List Price
137694	10	1¾	70	$13 50
137695	12	1¾	90	15 00
137696	14	1¾	110	17 00
137697	16	1¾	130	20 00
137698	12	2¼	100	20 50
137699	14	2¼	120	23 50
137700	16	2¼	140	26 50
137701	18	2¼	170	30 00

RAISING FORKS—FOR WOOD POLES

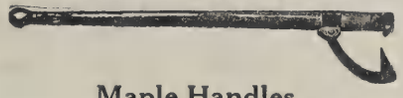


Style No.	Length, Feet	Diameter, Inches	Per Dozen — Approx. Net Wt.	Per Dozen — List Price
137702	10	1¾	100	$24 00
137703	12	1¾	120	25 50
137704	14	1¾	140	27 00
137705	16	1¾	160	30 00
137706	14	2¼	180	32 00
137707	16	2¼	195	34 00
137708	18	2¼	210	36 00
137709	20	2¼	235	39 00

SWIVEL CARRYING HOOKS

Style No.	Length Handle, Feet	Per Dozen — Approx. Net Wt.	Per Dozen — List Price
137712	4	85	$25 00
137713	5	95	26 20

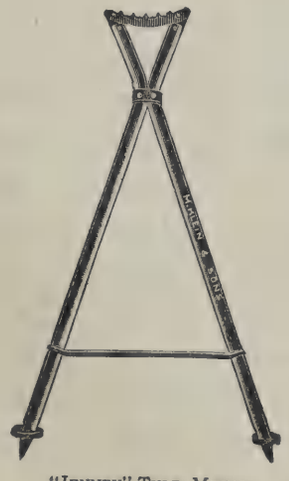
CANT HOOKS



Maple Handles

Style No.	Description	Approx. Net Wt.	List Price
137710	Cant Hook, 4½-foot handle	115	$19 00
137711	Extra handles for above	90	10 00

POLE SUPPORTS



"Jenney" Type, Metal

"Jenney" Type, Wood

"Mule" Type, Metal

Style No.	Length, Feet	Each — Approx. Net Wt.	Each — List Price
	"Jenney" Type, Metal		
137714	6	32	$13 50
137715	7	34	14 50
137716	8	53	15 50
	"Jenney" Type, Wood		
137717	6	39	7 50
137718	7	57	8 25
137719	8	62	9 00
	"Mule" Type, Metal		
137720	6	32	12 50
137721	7	35	13 50
137722	8	39	14 50

GENERAL INFORMATION

COPPER AND ALUMINUM COMPARED AS TO WEIGHT AND RESISTANCE

Size B. & S. G.	Diameter, Mils.	Area, C. M.	Pounds Per 1000 Feet		Pounds Per Mile		Resistance at 70° F. Ohms Per 1000 Feet	
			Copper	Aluminum	Copper	Aluminum	Copper	Aluminum
0000	460.000	211600.0	642.68	192.86	3393.07	1018.30	.049286	.07904
000	409.640	167805.0	509.32	152.94	2690.75	807.52	.062148	.09966
00	364.800	133079.4	404.20	121.28	2133.74	640.36	.078363	.12569
0	324.860	105534.0	320.50	96.18	1692.14	507.83	.098816	.15849
1	289.300	83694.2	254.20	76.29	1342.21	402.81	.12459	.19982
2	257.630	66373.0	201.60	60.50	1064.39	319.44	.15712	.25200
3	229.420	52634.0	159.86	47.97	843.96	253.55	.19824	.31778
4	204.310	41742.0	126.78	38.05	669.44	200.90	.24982	.40067
5	181.940	33102.0	100.54	30.17	530.79	159.30	.31504	.50526
6	162.020	26250.5	79.72	23.93	421.02	126.35	.39725	.63720
7	144.280	20816.0	63.23	18.98	333.93	100.21	.50099	.80350
8	128.490	16509.0	50.14	15.05	264.78	79.46	.63176	1.0131
9	114.430	13094.0	39.77	11.93	209.90	62.99	.79643	1.2773
10	101.890	10381.0	31.53	9.462	166.49	49.95	1.0047	1.6111
11	90.742	8234.0	25.01	7.505	132.04	39.63	1.2666	2.0312
12	80.808	6529.9	19.83	5.952	104.71	31.43	1.5971	2.5615
13	71.961	5178.4	15.73	4.720	83.02	24.92	2.0139	3.2300
14	64.084	4106.8	12.47	3.743	65.83	19.76	2.5396	4.0724
15	57.068	3256.7	9.890	2.968	52.22	15.67	3.1939	5.1354
16	50.820	2582.9	7.843	2.354	41.42	12.43	4.0378	6.4755
17	45.257	2048.2	6.220	1.867	32.85	9.857	5.0918	8.1670
18	40.303	1624.3	4.933	1.480	26.04	7.814	6.4201	10.300
19	35.890	1288.1	3.912	1.174	20.65	6.199	8.0860	12.985
20	31.961	1021.5	3.102	.931	16.38	4.916	10.209	16.381

DATA RELATING TO BARE AND WEATHERPROOF WIRES AND CABLES

Size B. & S. Gauge	Circ. Mils.	Wires in Strand	Diam. Each Wire	Diam. of Strand	Weight per 1000 Ft., Strand	Area Square Inches	Outside Diam., Inches		Weight Per 1000 Ft., Pounds		Resistance Per 1000 Ft., at 60° F.
							3 Braid	2 Braid	3 Braid	2 Braid	
STRANDED											
	2000000	91	0.1482	1.6302	6204.8	1.56874	2.000	1.875	7008	6690	0.00530
	1750000	91	.1387	1.5257	5429.3	1.36494	1.906	1.781	6193	5894	.00607
	1500000	91	.1284	1.4124	4653.6	1.17831	1.781	1.656	5380	5098	.00707
	1250000	91	.1172	1.2892	3878.0	.98170	1.656	1.531	4508	4264	.00852
	1000000	61	.1280	1.1520	3100.3	.78494	1.531	1.406	3674	3456	.01060
	950000	61	.1248	1.1232	2945.3	.74618	1.468	1.343	3503	3292	.01115
	900000	61	.1215	1.0935	2790.3	.70724	1.437	1.312	3332	3127	.01179
	850000	61	.1181	1.0629	2635.3	.66852	1.406	1.281	3162	2963	.01247
	800000	61	.1145	1.0305	2480.2	.62810	1.375	1.250	2992	2799	.01325
	750000	61	.1109	.9981	2325.2	.58922	1.343	1.218	2822	2635	.01413
	700000	61	.1071	.9639	2170.2	.54954	1.312	1.187	2650	2471	.01514
	650000	61	.1032	.9288	2015.2	.51020	1.250	1.125	2443	2282	.01630
	600000	61	.0992	.8928	1860.2	.47146	1.234	1.109	2235	2093	.01767
	550000	37	.1219	.8533	1703.0	.43181	1.156	1.031	2064	1925	.01925
	500000	37	.1162	.8134	1548.2	.39237	1.109	1.000	1894	1765	.02116
	450000	37	.1103	.7721	1393.4	.35234	1.062	.937	1724	1601	.02349
	400000	37	.1040	.7280	1238.5	.31431	1.031	.906	1553	1436	.02648
	350000	19	.1357	.6785	1083.34	.27511	.968	.843	1345	1248	.03026
	300000	19	.1256	.6285	926.01	.23591	.921	.796	1174	1083	.03531
	250000	19	.1147	.5738	771.67	.19635	.875	.750	985	907	.04233
0000	211600	19	.1055	.5275	653.14	.16609	.812	.687	800	745	.04997
000	167772	7	.1549	.4644	512.07	.13185	.734	.671	653	604	.06293
00	133079	7	.1380	.4134	406.98	.10429	.687	.625	522	482	.07935
0	105625	7	.1228	.3684	322.39	.08303	.640	.578	424	388	.10007
1	83694	7	.1093	.3279	255.45	.06559	.593	.531	328	303	.12617
2	66358	7	.0973	.2919	202.5	.05205	.531	.468	270	246	.15725
3	52624	7	.0867	.2601	160.6	.04132	.468	.421	206	190	.19827
4	41738	7	.0772	.2316	127.4	.03276	.437	.390	170	155	.25000
6	26244	7	.0612	.1836	80.1	.02059	.406	.359	115	103	.39767
8	16512	7	.0486	.1458	50.4	.01298	.296	.250	78	68	.62686
10	10384	7	.0385	.1155	31.7	.00815	.250	.203	54	45	1.00848
12	6528	7	.0305	.0915	19.9	.00511	.218	.187	37	29	1.59716
14	4108	7	.0242	.0726	12.5	.00322	.....	.....	28	21	2.54192
SOLID											
0000	211600	1	.....	.4600	640.5	.16619	.640	.609	767	723	.04893
000	167772	1	.....	.4096	507.8	.13177	.593	.562	629	587	.06170
00	133079	1	.....	.3648	402.8	.10452	.515	.500	502	467	.07780
0	105625	1	.....	.3250	319.7	.08295	.500	.468	407	377	.09811
1	83694	1	.....	.2893	253.3	.06573	.453	.422	316	294	.12370
2	66358	1	.....	.2576	200.8	.05211	.437	.390	260	239	.15600
3	52624	1	.....	.2294	159.3	.04133	.406	.359	199	185	.19670
4	41738	1	.....	.2043	126.3	.03278	.359	.328	164	151	.24800
6	26244	1	.....	.1620	80.6	.02061	.328	.296	112	100	.39440
8	16512	1	.....	.1285	49.9	.01297	.296	.250	75	66	.62710
10	10384	1	.....	.1019	31.4	.00815	.234	.203	53	46	.99720
12	6528	1	.....	.0808	19.7	.00512	.203	.172	35	30	1.58600
14	4108	1	.....	.0641	12.4	.00322	.187	.156	25	20	2.52100
16	2580	1	.....	.0508	7.8	.00202	.172	.125	20	16	4.00900
18	1624	1	.....	.0403	4.9	.00127	.156	.109	16	12	6.37400
20	1024	1	.....	.0320	3.1	.00080	.....	.....	12	9	10.14000

GENERAL INFORMATION—Continued

COMPARATIVE COSTS OF COPPER, COPPER-CLAD AND STEEL TROLLEY WIRE

TABLE I—Price per Mile of Copper and Bronze Wire

Cts. per Lb.	No. 0	No. 00	No. 000	No. 0000
13	$219.31	$276.51	$348.66	$439.66
13½	227.74	287.14	362.07	456.57
14	236.18	297.78	375.48	473.48
14½	244.61	308.41	388.89	490.39
15	253.05	319.05	402.30	507.30
15½	261.48	329.68	415.71	524.21
16	269.92	340.32	429.12	541.12
16½	278.35	350.95	442.53	558.03
17	286.79	361.59	455.94	591.85
17½	295.22	372.22	469.35	591.85
18	343.66	382.86	482.76	608.76
18½	312.09	393.49	496.17	625.67
19	320.53	404.13	509.58	642.58
19½	328.97	414.76	522.99	659.49
20	337.40	425.40	536.40	676.40
20½	345.84	436.03	549.81	693.31
21	354.27	446.67	563.22	710.22
21½	362.71	457.30	576.63	727.13
22	371.14	467.94	590.04	744.04
22½	379.58	478.57	603.45	616.86
23	388.01	489.84	616.86	777.86
23½	396.45	499.84	630.27	794.77
24	404.88	510.48	643.68	811.68
24½	413.32	521.11	657.09	828.59
25	421.75	531.75	670.50	845.50
Weight per mile, lbs.	1607	2127	2682	3382

TABLE II—Price per Mile of Copper-Clad Wire

Cts. per Lb.	No. 0	No. 00	No. 000	No. 0000
13	$204.49	$257.40	$323.96	$408.46
13½	212.35	367.30	336.42	424.17
14	220.22	277.20	348.88	439.88
14½	228.08	287.10	361.34	455.59
15	235.95	297.00	373.80	471.30
15½	243.81	306.90	386.26	487.01
16	251.68	316.80	398.72	502.72
16½	259.54	326.70	411.18	518.43
17	267.41	336.60	423.64	534.14
17½	275.27	346.50	436.10	549.85
18	283.14	356.40	448.56	565.56
18½	291.00	366.30	461.02	581.27
19	298.87	376.20	473.48	596.98
19½	306.73	386.10	485.94	612.69
20	314.60	396.00	498.40	628.40
20½	322.46	405.90	510.86	644.11
21	330.33	415.80	523.32	659.82
21½	338.19	425.70	535.78	675.53
22	346.06	435.60	548.24	691.24
Weight per mile, lbs.	1573	1980	2492	3142

TABLE III—Price per Mile of Steel Trolley Wire

Cts. per Lb.	No. 0	No. 00	No. 000	No. 0000
4	$ 59.12	$ 74.80	$ 93.92	$118.24
4¼	62.81	79.47	99.79	125.63
4½	66.51	84.15	105.66	133.02
4¾	70.20	88.82	111.53	140.41
5	73.90	93.50	117.40	147.80
5¼	77.59	98.17	123.27	155.19
5½	81.29	102.85	129.14	162.58
5¾	84.98	107.52	135.01	169.97
6	88.68	112.20	140.88	177.36
6¼	92.37	116.87	146.75	184.75
6½	96.07	121.55	152.62	192.14
6¾	99.76	126.22	158.49	199.53
7	103.46	130.90	164.36	206.92
7¼	107.15	135.57	170.23	214.31
7½	110.85	140.25	176.10	221.70
7¾	114.54	144.92	181.97	229.09
8	118.24	149.60	187.84	236.48
8¼	121.93	154.27	193.71	243.87
8½	125.63	158.95	199.58	251.26
8¾	129.32	163.62	205.45	258.65
9	133.02	168.30	211.32	266.04
Weight per mile, lbs.	1478	1870	2348	2956

GENERAL INFORMATION—Continued

MESSENGER CABLE

Galvanized Steel Wire Strand

Diameter, Inches	Approximate Tensile Strength—Pounds				Net Weight Per 1000 Feet Pounds
	Bessemer	Siemans-Martin	High Strength	Ex. High Strength	
1/8	375	900	1500	2250	23
3/16	1000	2000	3300	4900	65
1/4	1750	3050	5100	7600	115
9/32	2600	4380	7300	10900	180
5/16	3300	4860	8100	12100	210
3/8	4700	6800	11500	17250	300
7/16	6000	9000	15000	22500	370
1/2	8320	11000	18000	27000	510
5/8	13000	19000	25000	42000	930

SPECIFICATIONS

The cable shall consist of a strand of seven wires. Each wire shall be double galvanized by the hot process and shall withstand a test of four one-minute immersions in a saturate solution of copper sulphate, being wiped dry between immersions.

Shipped on reels of 1000, 2000, and 5000 feet.

STEEL TROLLEY WIRE

Steel trolley wire, bare or galvanized, is made in the standard grooved and round sections, sizes 1-0 to 4-0 B. & S. Gauge; put up on reels of continuous length to any weight not exceeding 10,000 pounds.

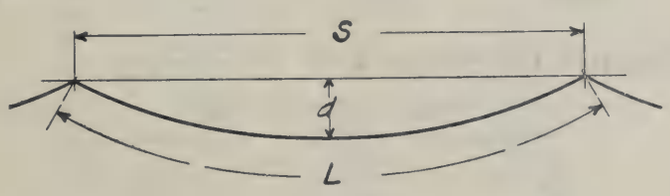
Bare steel trolley wire has the following characteristics:

Size B. & S.	Weight Per 1000 Feet	Weight Per Mile	Resistance Per 1000 Feet at 60° F.	Resistance Per Mile at 60° F.	Tensile Strength	Elastic Limit
0	281	1481	0.7161	3.781	6600	4980
00	354	1870	0.5678	2.998	8300	6225
000	446	2357	0.4500	2.376	9900	7425
0000	562	2966	0.3574	1.888	12500	9350

SAG IN TROLLEY WIRE

The following formulas may be used to find the tension, sag and actual length in a span of trolley wire.

For very close work the calculation is much more complicated and involves the use of the temperature coefficient of expansion and the modulus of elasticity of the metal used, which are given below for both copper and steel.



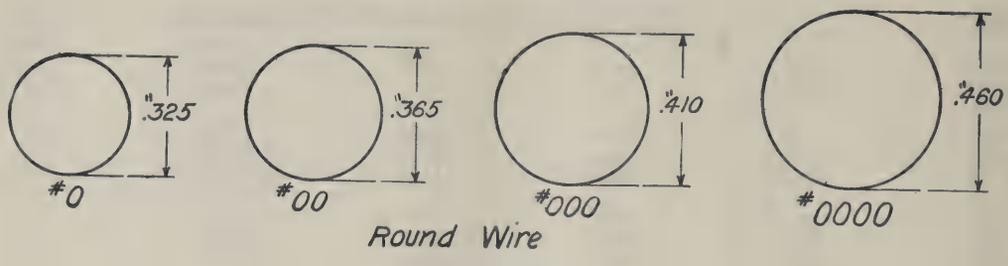
$$T = \frac{S^2W}{8d}$$

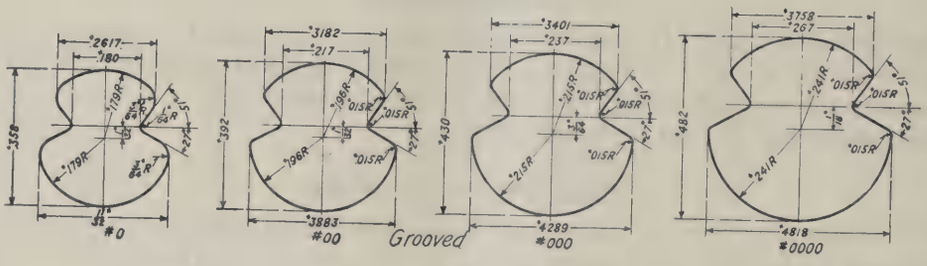
$$d = \frac{S^2W}{8T}$$

$$L = S + \frac{8d^2}{3S}$$

T = Total tension in the wire in pounds.
W = Load per linear foot including weight of wire.
S = Length of span in feet.
d = Deflection or sag at center of the span in feet.
L = Actual Length of wire in feet.
Coefficient of expansion for copper, per degree Fahrenheit = 0.0000096.
Coefficient of expansion for steel, per degree Fahrenheit = 0.0000064.
Modulus of elasticity for copper = 16,000,000.
Modulus of elasticity for steel = 29,000,000.

TROLLEY WIRE
Hard Drawn Copper





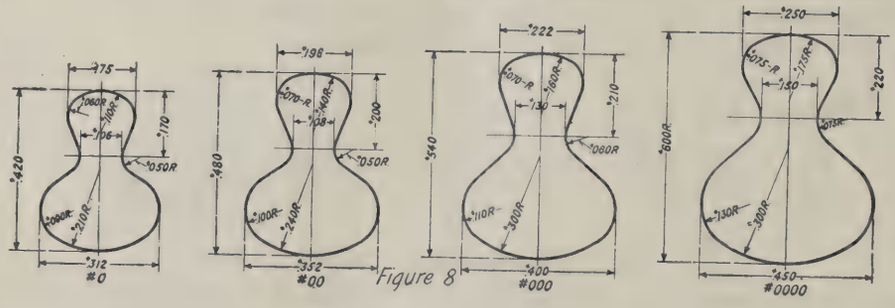


Figure 8

Size B. & S.	Circular Mils.	Ohms Per 1000 Ft. at 25° C.	Weight, Pounds — Per 1000 Feet	Weight, Pounds — Per Mile	Ultimate Tensile Strength, Lbs.
0	105500	.1000	319.35	1686.17	4516
00	133100	.07929	402.89	2127.26	5520
000	167800	.06289	507.93	2681.87	6721
0000	211600	.04988	640.51	3381.89	8143

SUPERELEVATION OF OUTER RAIL ON CURVES

Degrees of Curvature	Speed in Miles Per Hour — Superelevation of Outer Rail in Inches — 20	30	40	50	60
1	1/4	1/2	1	1 3/4	2 1/2
2	1/2	1 1/4	2 1/4	3 1/2	5
3	3/4	1 3/4	3 1/4	5	7 1/4
4	1	2 1/2	4 1/2	6 3/4	...
5	1 1/4	3	5 1/2	...	...
6	1 3/4	3 3/4	6 1/2	...	...
7	2	4 1/4	7 1/2	...	...
8	2 1/4	5	8 3/4	...	...
9	2 1/2	5 1/2	...	...	...
10	2 3/4	6 1/4	...	...	...
11	3	6 3/4	...	...	...
12	3 1/4	7 1/4	...	...	...
13	3 1/2	8	...	...	...
14	3 3/4	...	...	...	...
15	4 1/4	...	...	...	...
16	4 1/2	...	...	...	...

SPECIFICATIONS FOR WOOD POLES

NORTHERN CEDAR POLES

1. All poles shall be cut from live trees during the winter when the sap is down.
2. No poles shall be accepted which have been rafted.
3. The top and butt of all poles shall be sawed square.
4. All poles shall be cut to exact specified lengths.
5. No poles shall be accepted which possess wind-shakes, cat faces, or which have 25 per cent or more of butt-rot.
6. All poles shall be peeled and all knots trimmed close.
7. No poles shall have a sweep in two planes nor a sweep in one plane of more than 1 inch to 5 feet.
8. All poles shall taper at least 1 inch to 5 feet in length.

WESTERN CEDAR POLES

Same specifications as for Northern Cedar Poles, except the top diameter shall be 1 inch greater (in order to secure the necessary butt measurement) and omit paragraph 8.

CHESTNUT POLES

All poles shall be cut from live trees regardless of season. They shall be reasonably straight, free from butt-rot, wind shakes, long checks and splits. They shall be sawed square to exact specified lengths. All knots to be trimmed close; the top diameter shall be 1 inch greater than for Northern Cedar (in order to secure the necessary butt measurement).

JUNIPER (SOUTHERN WHITE CEDAR) POLES

Same specifications as for Northern Cedar, except rafted poles may be accepted occasionally, but no rafted poles should be accepted with holes bored for rafting purposes. (Rafted Juniper Poles will shrink about 1 inch in top diameter after being thoroughly seasoned).

WEIGHTS OF WOOD POLES

Length of Pole	Cedar—Weight in Pounds				Chestnut—Weight in Pounds		
	5-inch Top	6-inch Top	7-inch Top	8-inch Top	6-inch Top	7-inch Top	8-inch Top
20	125	180	240	....	...	....	....
25	200	260	340	430	500	600	720
30	290	360	450	580	660	800	940
35	400	480	600	760	...	1030	1200
40	...	640	780	980	...	1310	1520
45	...	830	1020	1270	...	1660	1940
50	...	1050	1300	1600	...	2080	2480
55	...	1310	1640	2000	...	2600	....
60	...	....	2080	....	...	....	....

The figures given above represent the average of shipping weights used by a large number of dealers in poles. Although poles are usually designated by the diameter of the top, as "5-inch," "6-inch," etc., this may be misleading, because a correct pole may not be exactly round. The circumference of the top should be measured with a tape line and for seasoned poles should be approximately as follows:

5-inch poles, 15 inches circumference at top.
6-inch poles, 18½ inches circumference at top.
7-inch poles, 22 inches circumference at top.
8-inch poles, 25 inches circumference at top.

DATA BLANK FOR OVERHEAD CONSTRUCTION

FOR PURPOSES OF ESTIMATING COST

General:

(1) Name of Railroad.....

(2) Location from.....to.....

Track:

(3) If possible, give engineer's map of road showing alignment and profile on a scale of 400 feet to 1 inch or larger. If map is not available, give following data:

(4) Number of main line tracks.....

(5) Gauge of track and weight of rail.....

(6) Length of track requiring bracket arm construction.....

(7) Length of track requiring cross-span construction.....

(8) List of curves giving degree and length of each with bracket arm or with cross-span construction.....

(9) Number and length of turn outs.....

(10) Are turn outs single or double end?.....

(11) Minimum clearance allowable for poles.....

(12) Minimum clearance allowable for overhead bridges, etc.....

Line:

(13) Line voltage.....

(14) Size of trolley wire.....

(15) Grooved, round or Fig. 8 wire.....

(16) Height of wire above rail.....

(17) Do trolley poles carry feeders?.....

(18) Do trolley poles carry transmission line?.....

(19) Voltage of transmission line.....

(20) Size of transmission line.....

Equipments:

(21) State if locomotives, single cars or multiple unit trains will be used.....

.....

(22) Give maximum speed.....

(23) Give schedule speed.....

(24) Will standard freight cars be hauled on tracks?.....

City Streets:

(25) Give width of city streets between curbs.....

Wood Poles:

(26) What is market price of wood poles delivered on right of way?.....

.....

(27) Nature of soil.....

(28) Cost of labor.....

Special Requirements:

(29) .....

.....

PORCELAIN INSULATORS

There are three methods of producing electrical porcelain. They are known as **dry process, wet process** and **casting process.** The materials used are essentially the same for all three methods. The greater part of the product is manufactured by the wet process and this process is the only one used for high voltage line insulators. For all processes the clay, spar and flint are intimately mixed into a fluid state in what is called a blunger. It is then filtered, after which it is stored in a plastic state.

Dry Process—The clay is afterwards dried out and pulverized to a crumbly condition, in which the granules are of the size of rice grains, or smaller, and in which there is just enough moisture, so that a handful of the material will cling together when squeezed. The material is then pressed in steel moulds of the shape required for the pieces desired. After drying thoroughly and glazing where required, the pieces are fired in kilns in the same way that any other porcelain is fired. Dry process porcelain can be moulded to quite accurate shapes and many pieces can only be made by the dry process for that reason. The dry process is commonly used for knobs and all the small snap-switch parts, for terminal boards of transformers, fuses, etc., and also for ball strain insulators and similar apparatus.

Dry process porcelain is more or less porous, as the particles of clay have not been squeezed intimately together. In general, ½-inch thickness of dry process porcelain will have a puncture voltage of from 20,000 to 30,000 volts against 60,000 to 90,000 volts for wet process work.

Wet Process—As above indicated, the bulk of high-voltage porcelain is made by the wet process, in which the clay is taken in the plastic state, about the consistency of putty, and molded into the required shape in plaster-paris moulds, which rotate on a table. The material is swept out into the mould by a former, called a shoe, and this process is called jiggering. The work is allowed to dry slightly in this mould and part of the moisture is absorbed by the plaster paris. It is then removed from the mould and dried further to what is called a "leatherhard" condition. In this condition the work is firm enough to be turned to more accurate dimensions. It is then dried still further and given a glazing bath before firing in a kiln. Another method of making wet process porcelain is to extrude or squirt the clay into tubes or bars, which are then allowed to dry to the "leatherhard" condition, and turned to shape, in the same manner as jiggered work. From then on the process is the same.

Wet process porcelain is much more dense and homogeneous in structure than dry ware, since the moisture permits the particles of clay to flow tightly together, so that the finished product is practically solid. The term "practically solid" is a comparative one, however, as even wet process porcelain will absorb a small amount of moisture. A low moisture absorption is desirable; but it must not be assumed that any satisfactory porcelain can be made which will have zero absorption.

Casting Process—A modification of the wet process is known as casting. This method is not used very extensively for electrical work, and consequently will not be described here.

The glaze on porcelain is a mixture of clays that fuses into a glass at the firing temperature of the porcelain. This serves to cover the porcelain with a glassy surface that is impervious to moisture and that cleans more readily than the natural unglazed porcelain surface. A great variety of glaze colors can be made by use of inorganic or metallic pigments. The common ones, however, are white and brown. The essential thing about the glaze, if the color is correct, is to have it fit the porcelain; that is, in cooling down, the contraction of the glaze must be the same as that of the porcelain. If the contraction is greater, the glaze cracks with many fine crisscross fissures, called crazing. If the contraction is not so great as that of the porcelain, cracks will occur with chipping off of small pieces of the glaze This is called shivering. Ordinarily neither of these troubles occur if the glaze is so proportioned as to have a thermal expansion the same as that of the porcelain body.

A great deal has been said about the virtues of different manufacturers' products of porcelain; but, in general, there is no great difference as to the materials used. The chief differences result more from the quality of workmanship and methods of handling clay. Much progress has been made in the last few years in turning out fine appearing porcelain of uniform texture, and active development is still being done in this direction. At present the greatest efforts at improvement are being directed toward obtaining a uniform product in which the average will closely approach the best rather than to find some radically new method of manufacturing porcelain.

The Research Division of the Engineering Department of the W. E. & M. Co., has charge of all advance work in connection with the development of materials, processes, and designs in addition to keeping in daily touch with the materials and manufacturing processes at the pottery. On the staff of our Research Division are men of international reputation along these lines and in addition to the research facilities at the main works of the Company, a ceramic laboratory is maintained at the pottery in charge of experts who are working constantly to secure every possible advance in the art.

KILN SHED

FIRING

Since the plant is located where natural gas is available, it is used instead of coal. This fuel is easily controlled and permits of maintaining a more uniform temperature in the kiln. The rate of rise in temperature is more easily controlled which allows the temperature at all parts of the kiln to be kept uniform while rising to the maximum. The variation which takes place when doors have to be opened to introduce fuel is also eliminated. There is also freedom from discoloration of the glaze from the presence of smoke and gases which are a necessary evil where coal is used.

INSPECTION

After firing, the pieces are carefully inspected as they are drawn from the kiln. They are then tested electrically and in the case of multipart insulators they are again tested after cementing.

INSULATOR TESTING

The routine test of porcelain insulators is to invert the insulator in about one inch of water in a broad pan which is connected to one side of the circuit. A small amount of water is poured into the pin hole of the insulator and a light chain hangs into it from the other side of the circuit. The insulators are then tested for five minutes to just about flash over point. If any insulator punctures it is removed from the series, as there are often fifty to one hundred insulators being tested at once. The test is continued and lasts at least one minute after the last insulator has failed. The rain test is performed by mounting the insulator on a metal pin similar to the one on which it is to be used and a line wire is tied to the top of the insulator. The insulator is then subjected to a spray of water directed at an angle of about 45 degrees. This spray is adjusted so that about two-tenths inches of water falls in a minute of time. The voltage is then gradually raised until the insulator flashes over.

LINE VOLTAGE RATING

In determining the insulator for any given installation, local conditions of climate, extent of lines, nature of country traversed, etc., should be carefully considered. An insulator that would afford adequate protection in the dry interior of California where electrical storms are unknown, would be entirely unsuitable for service along the coast where it would be subjected to salt fogs, or in districts where electrical storms are frequent.

Requests for recommendations should be accompanied by complete information relative to the above factors.

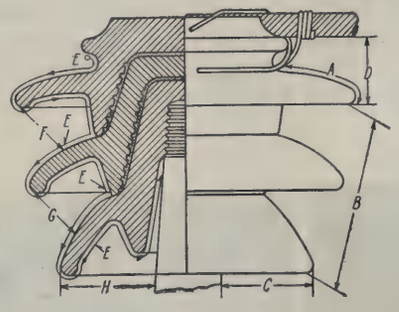
METHODS OF TESTING PORCELAIN INSULATORS

The Westinghouse Company has available for testing insulators a number of testing transformers capable of developing any required test voltage up to and including 500,000 volts to ground. The statements in this catalogue with regard to the arc-over voltage of the individual insulators are based on tests made with the insulator cemented to a round forged steel pin mounted on a grounded steel cross-arm with the line wire tied to the insulator as in service. Under these conditions the arc-over voltage is lower than obtained by the usual method of inverting the insulator in a pan of water and testing from a transformer having the middle point grounded. Much higher arc-over voltages can be obtained when a wood cross-arm is used in place of a steel cross-arm—in other words, the porcelain insulators listed in this catalogue have been rated on tests obtained under the most severe conditions, resembling those of actual service as closely as can be done in a laboratory.

PUG MILLS IN CLAY CELLAR

Arcing and Leakage Distances of Insulator

The sum of distances A+B+C or D+B+C in the accompanying illustration gives the dry arcing distance depending on whether A or D is the shorter distance. The sum of F+G+H gives the arcing distance when wet under a driving rain at 45 degrees from the vertical. When the surfaces are wet the arc will tend to travel along the shortest path from the edge of one shell to the outer surface of the next. The exact path of the arc will depend somewhat on the shape of the parts and will tend to lie between 45 degrees and a normal from the edge of one shell to the outer surface of the next lower shell. The leakage distance is illustrated by the line E.



JIGGER DEPARTMENT

MOISTURE ABSORPTION OF PORCELAIN INSULATORS

The red ink test is a rather unreliable indication due to the fact that practically any porcelain will permit ink to spread on a fresh break, while comparatively porous porcelain will not if the fracture is a few hours old. The comparative ease with which a colored ink can be washed off a fracture is of some value as an indication, providing the same ink is used in each case.

The so-called "Tongue Test" is about as reliable as the "Colored Ink" test, that is, if a newly fractured surface or piece of rather porous material is touched with the tip of the tongue the tongue will tend to adhere to the porcelain surface. Of course as in the case of the red ink test, several pieces should be tried at the same time as the test is a comparative one.

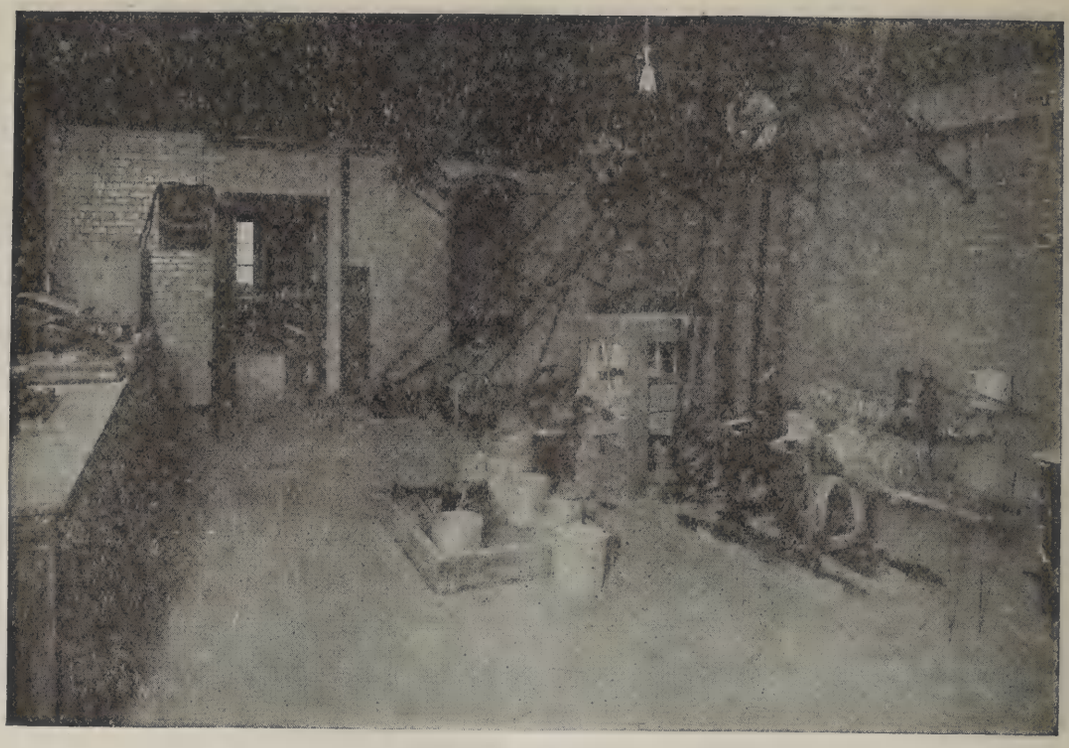
In general, engineers who have carefully investigated the properties of various porcelain bodies agree that the most satisfactory and really only test of value is the measurement of per cent moisture absorption. The customary procedure is as follows:

Pieces of porcelain weighing from 30 to 50 grams each are broken from various parts of the insulator. Care should be taken to have at least 50% of newly fractured surface; otherwise unreliable results will be obtained due to the rapid collection of dust and dirt on the fractured surface. Any moisture in the pores of the samples is then dried out by heating them at a temperature of 110° to 120° C. until constant weights are attained. Twenty-four hours time is usually sufficient.

The samples are then partially submerged in distilled water for a period of 24 hours. The exposed surface is of assistance in permitting the escape of occluded gases. After 24 hours soaking the samples are completely submerged and left submerged until the end of 100 hours.

At the end of the 100 hour period the surface moisture of the samples is quickly dried off with a clean, dry cloth or paper and the samples are weighed.

The per cent moisture absorption is then equal to the weight after the end of 100 hours soaking minus the dry weight divided by the dry weight. The average of several samples should be taken if a reliable value is to be obtained.



EXPERIMENTAL LABORATORY

CEMENTING PORCELAIN INSULATORS

For cementing porcelain a good grade of neat Portland cement is used mixed with water by weight in proportions found by thorough investigations to give most satisfactory results. The cement, after being mixed with the water, is not allowed to stand over thirty minutes before using, and any that is left over is thrown away. After the work is poured it is covered with water and kept moist for forty-eight hours without being disturbed. The above method is being followed in cementing practically all insulators sold by the Westinghouse Electric & Manufacturing Company except in cases where it is better practice to allow the cement to set under steam.

OVERHEAD GROUND WIRES

The phenomenon of insulator puncture from lightning is an old one but first began to be manifest when insulators were first installed on metal pins.

An overhead line becomes charged during the storm with a bound charge which is held in place by the clouds overhead regardless of the fact that currents may be passing back and forth over the line. When a lightning discharge occurs from a cloud these bound charges existing on the line underneath the particular cloud which has discharged are suddenly released. So long as the charges were bound their potential was neutralized by the cloud charge and consequently their presence could not be detected by any means. As soon, however, as these charges are released and no longer neutralized by a charge of opposite potential in the clouds they attempt to pass lengthwise on the line and also over the insulators to ground. If the operating potentials are moderate and the insulators rugged and the poles of wood, the charges may pass over harmlessly on several poles and do no more than slightly mar the surface of the pole.

TRANSMISSION LINE SHOWING OVERHEAD GROUND WIRE

It frequently occurs that ribbons about ¾ inches wide are cut from the surface of cedar poles by discharges over a 6600-volt insulator where they go over high hills. The resistance of each individual pole takes most of the energy and, as is usually the case, the puncture value of the lower voltage insulator is sufficiently high to insure the discharge passing over the surface of the insulator. As the voltages go up, however, there is more possibility of the discharge being concentrated on one pole. Further, the insulators do not as a rule have as high a margin of puncture voltage over flash-over voltage. The result is that on voltages of 44,000 volts and above, insulators are sometimes punctured on wood poles and wood pins.

The whole tendency, however, to puncture insulators is very much increased if there is metal inside the pin or if the pin is metal, and particularly is much increased if this pin is grounded. The puncturing of insulators on metal pins is then liable to occur on voltages as low as 6600 volts, although it becomes more manifest at about 25,000 volts and upward.

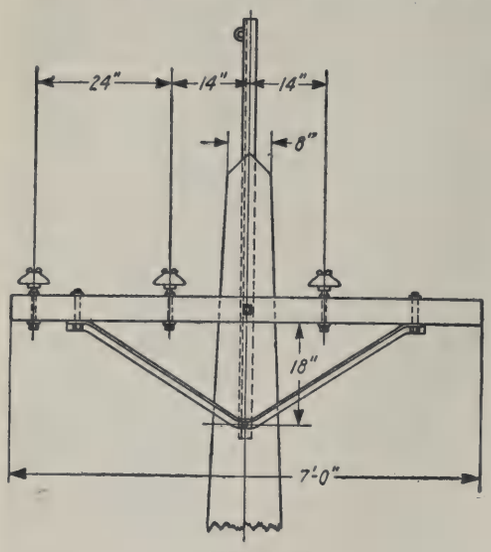
An effort has sometimes been made by operating people to relieve this condition by placing lightning arresters along the line. Unless there is a lightning arrester at every insulator, however, this is of little value. It has been found that the disturbances caused by the release of such bound discharges above described are more of a local nature. It is quite analogous to the explosion of dynamite inside of a pipe that may be open at both ends. The dynamite will burst the pipe in spite of the apparently free passage at each end. It has been found for example that an insulator may be punctured by lightning on a line that is solidly grounded less than a mile away.

The only radical remedy for this condition is to prevent these bound charges from existing on the line by carrying sufficient ground potential over the top of the line to prevent it. This cannot be accomplished entirely without covering the line with a roof of grounded material, but it can be very nearly accomplished by the use of grounded overhead conductors. These conductors should, however, be grounded at every pole.

We recommend where practicable that a high voltage overhead line be put up with protection of overhead ground wires. There are other ways of mitigating the evil to some extent without overhead wires and the satisfactory operation depends somewhat on the amount of power back of the line and on the degree of continuity which is essential to satisfactory operation. The use of a gap around the insulator to permit the discharge to pass around the insulator without puncture will in many cases save the insulator at the expense of a short circuit on the line. If the circuit-breaker equipment is complete and if there is not too much synchronous apparatus which will be thrown out of step involving inconvenience to customers this scheme may be quite successful. There are other schemes involving momentary grounding at the power house of the wire in trouble. This momentary grounding suppresses the arc around the insulator and the ground may then be pulled off by a circuit-breaker or fuse in the grounding device and operation be resumed without serious disturbance, providing only one phase has been affected. This method cannot be recommended generally without knowledge of the specific operating conditions, as there are some circuits on which it would cause more trouble than it would cure, while on other circuits it has proven quite effective.

In general the use of insulators having a high puncture value as compared to an arc-over value will reduce the danger of puncture, but if there is much power behind the line the arc following an arc-over may destroy the insulator just as completely as a puncture would. In this case a gap around the insulator may be a help providing it does not increase the number of arc-overs by a troublesome amount due to the fact that the gap must have a less sparking value than the insulator itself to do any good.

WOOD POLE CONSTRUCTION TRANSMISSION LINES



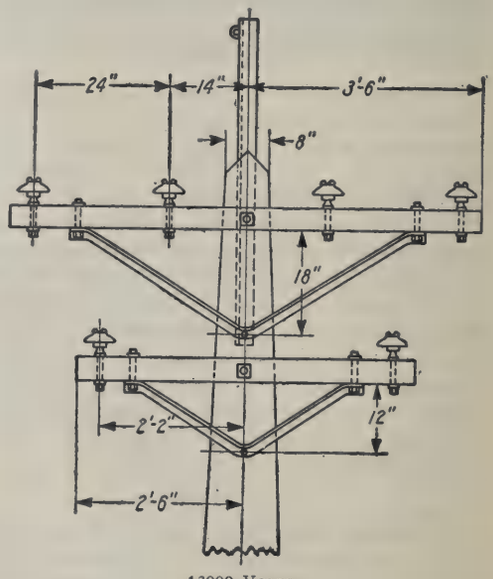
13000 VOLTS

List of Material

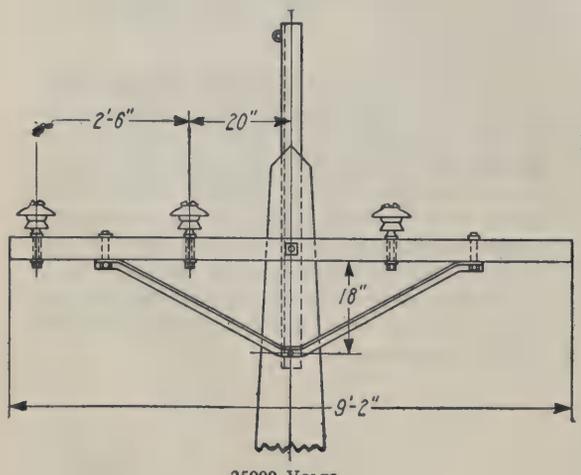
- 1 3½ x 4½ x 7-foot cross arm.
- 1 Cross arm brace, 60-inch spread, 18-inch drop.
- 3 Porcelain insulators.
- 3 1⅜-inch insulator pins.
- 1 Angle iron ground wire bayonet.
- 1 Ground wire clamp.
- 2 ⅝-inch thru bolts.
- 1⅝-inch square washer.
- 2 ½ x 5½-inch machine bolts.
- 2 ½-inch washers.

List of Material

- 1 3½ x 4½-inch x 7-foot cross arm.
- 1 3½ x 4½-inch x 5-foot cross arm.
- 1 Cross arm brace, 60-inch spread, 18-inch drop.
- 1 Cross arm brace, 37-inch spread, 12-inch drop.
- 6 Porcelain insulators.
- 6 1⅜-inch insulator pins.
- 1 Angle iron ground wire bayonet.
- 1 Ground wire clamp.
- 3 ⅝-inch thru bolts.
- 3 ⅝-inch square washers.
- 4 ½ x 5½-inch machine bolts.
- 4 ½-inch washers.
- 1 ½ x 4-inch lag screw.



13000 VOLTS

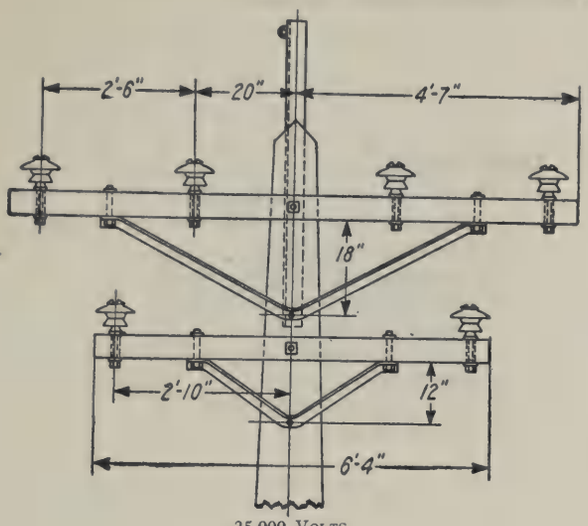


25000 VOLTS

List of Material

- 1 3½ x 4½-inch x 9-foot 2-inch cross arm.
- 1 Cross arm brace, 72-inch spread, 18-inch drop.
- 3 Porcelain insulators.
- 3 1⅜-inch insulator pins.
- 1 Angle iron ground wire bayonet.
- 1 Ground wire clamp.
- 2 ⅝-inch thru bolts.
- 2 ⅝-inch square washers.
- 2 ½ x 5½-inch machine bolts.
- 2 ½-inch washers.

WOOD POLE CONSTRUCTION TRANSMISSION LINES—Continued



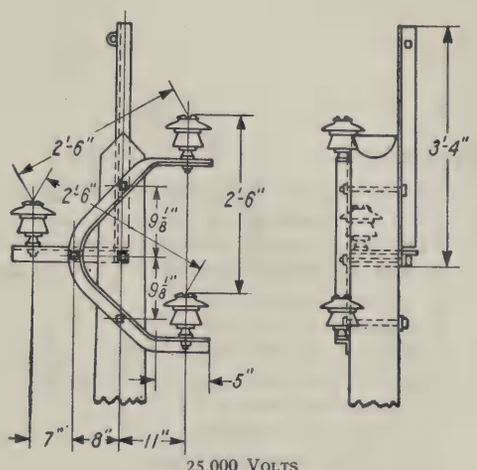
25,000 VOLTS

List of Material

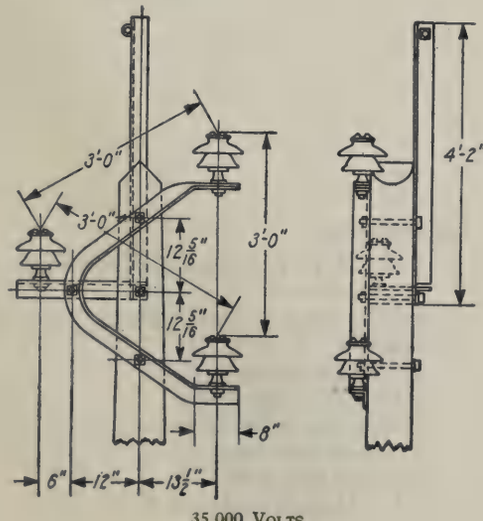
1 3½ x 4½-inch x 9-foot 2-inch cross arm.
1 3½ x 4½-inch x 6-foot 4-inch cross arm.
1 Cross arm brace, 72-inch spread, 18-inch drop.
1 Cross arm brace, 37-inch spread, 12-inch drop.
6 Porcelain insulators.
6 1⅜-inch insulator pins.
1 Angle iron ground wire bayonet.
1 Ground wire clamp.
3 ⅝-inch thru bolts.
3 ⅝-inch square washers.
4 ½ x 5½-inch machine bolts.
4 ½-inch washers.
1 ½ x 4-inch lag screw.

List of Material

1 2½ x 2½ x ¼-inch, 30-inch spacing bo-arrow arm.
3 Porcelain insulators.
3 1⅜-inch insulator pins.
1 2 x 2 x ¼-inch x 3-foot 4-inch angle iron ground wire bayonet.
1 Ground wire clamp.
3 ⅝-inch thru bolts.
2 ⅝-inch square washers.



25,000 VOLTS

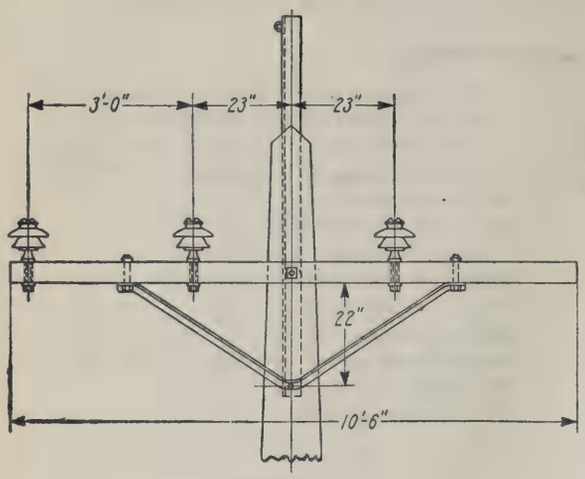


35,000 VOLTS

List of Material

1 3 x 3 x ¼-inch, 36-inch spacing bo-arrow arm.
3 Porcelain insulators.
3 1⅜-inch insulator pins.
1 2½ x 2½ x ¼-inch x 4-foot 2-inch angle iron ground wire bayonet.
1 Ground wire clamp.
3 ⅝-inch thru bolts.
2 ⅝-inch square washers.

WOOD POLE CONSTRUCTION TRANSMISSION LINES—Continued



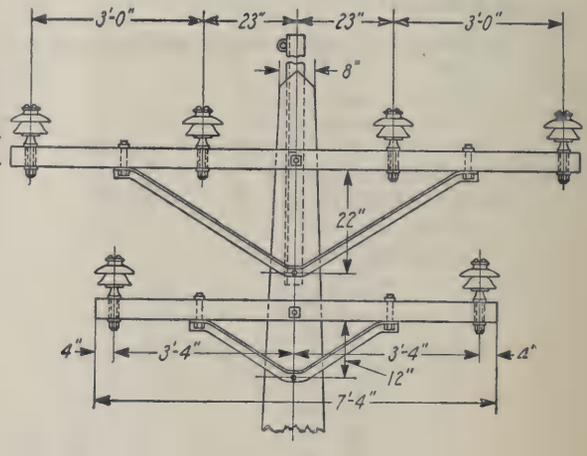
35,000 VOLTS

List of Material

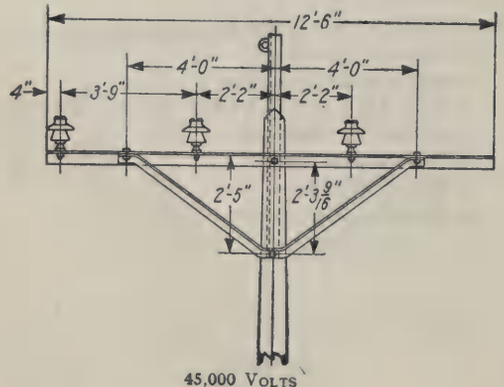
1 3½ x 4½-inch x 10½-foot cross arm.
1 Cross arm brace, 72-inch spread, 22-inch drop.
3 Porcelain insulators.
3 1⅜-inch insulator pins.
1 Angle iron ground wire bayonet.
1 Ground wire clamp.
2 ⅝-inch thru bolts.
1 ⅝-inch square washer.
2 ½ x 5½-inch machine bolts.
2 ½-inch washers.

List of Material

1 3½ x 4½-inch x 10½-foot cross arm.
1 3½ x 4½-inch x 7-foot 4-inch cross arm.
1 Cross arm brace, 72-inch spread, 22-inch drop.
1 Cross arm brace, 42-inch spread, 12-inch drop.
6 Porcelain insulators.
6 1⅜-inch insulator pins.
1 Angle iron ground wire bayonet.
1 Ground wire clamp.
3 ⅝-inch thru bolts.
3 ⅝-inch square washers.
4 ½ x 5½-inch machine bolts.
4 ½-inch washers.
1 ½ x 4-inch lag screw.



35,000 VOLTS

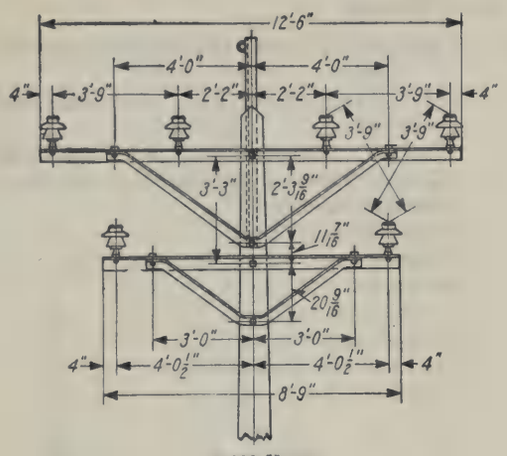


45,000 VOLTS

List of Material

1 3½ x 3½ x 5/16-inch x 12-foot 6-inch angle iron cross arm.
1 Cross arm brace, 8-foot spread, 2-foot 5-inch drop.
3 Porcelain insulators.
3 1⅜-inch insulator pins.
1 Angle iron ground wire bayonet.
1 Ground wire clamp.
2 ⅝-inch thru bolts.
2 ½ x 1½-inch machine bolts.

WOOD POLE CONSTRUCTION TRANSMISSION LINES—Continued



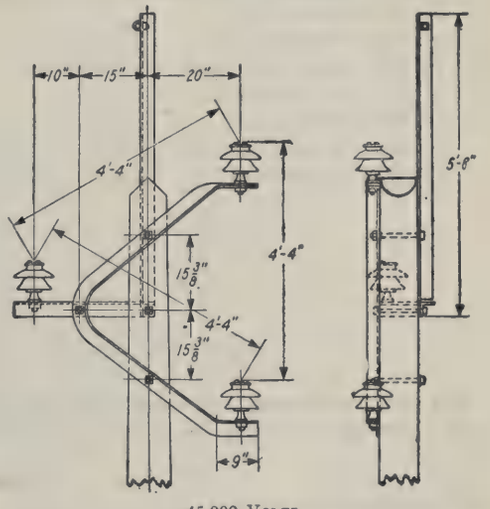
45,000 VOLTS

List of Material

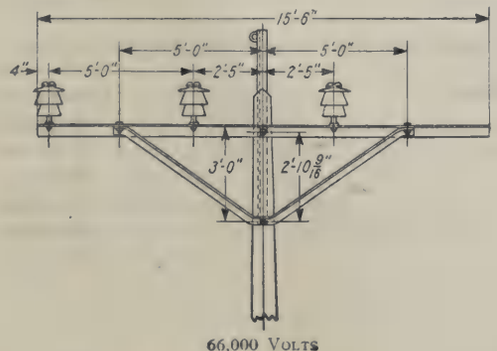
1 3½ x 3½ x $\frac{5}{16}$-inch x 12-foot 6-inch angle iron cross arm.
1 3½ x 3½ x $\frac{5}{16}$-inch x 8-foot 9-inch angle iron cross arm.
1 Cross arm brace, 8-foot spread, 2-foot 5-inch drop.
1 Cross arm brace, 6-inch spread, 22-inch drop.
6 Porcelain insulators.
6 1⅜-inch insulator pins.
1 Angle iron ground wire bayonet.
1 Ground wire clamp.
3 ⅝-inch thru bolts.
1 ⅝-inch square washer.
4 ½ x 1½-inch machine bolts.
1 ½ x 4-inch lag screw.

List of Material

1 3 x 3 x ¼-inch, 52-inch spacing bo-arrow arm.
3 Porcelain insulators.
3 1⅜-inch insulator pins.
1 2½ x 2½ x ¼-inch x 5-foot 6-inch iron ground wire bayonet.
1 Ground wire clamp.
3 ⅝-inch thru bolts.
2 ⅝-inch square washers.



45,000 VOLTS

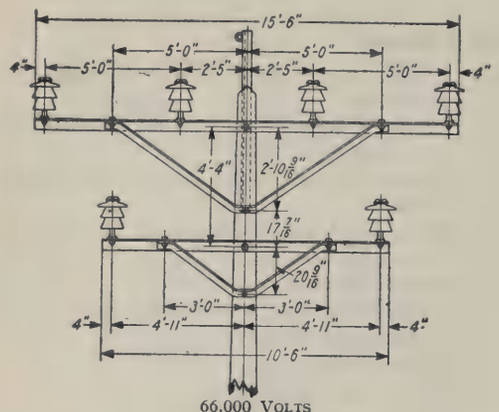


66,000 VOLTS

List of Material

1 3½ x 3½ x $\frac{5}{16}$-inch x 15-foot 6-inch angle iron cross arm.
1 Cross arm brace, 10-foot spread, 3-foot drop.
3 Porcelain Insulators.
3 1⅜-inch insulator pins.
1 Angle iron ground wire bayonet.
1 Ground wire clamp.
2 ⅝-inch thru bolts.
2 ½ x 1½-inch machine bolts.

WOOD POLE CONSTRUCTION TRANSMISSION LINES—Continued



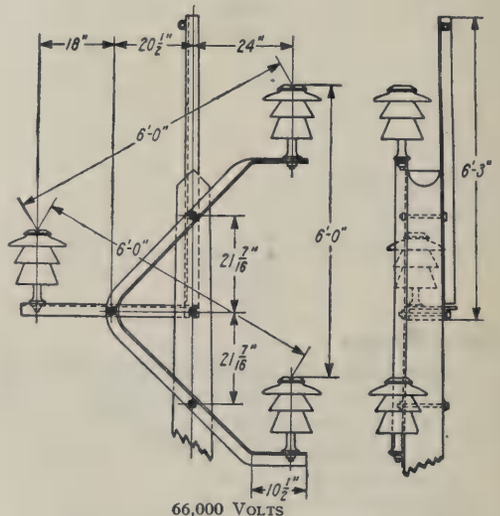
66,000 VOLTS

List of Material

1 3½ x 3½ x $\frac{5}{16}$-inch x 15-foot 6-inch angle iron cross arm.
1 3½ x 3½ x $\frac{5}{16}$-inch x 10-foot 6-inch angle iron cross arm.
1 Cross arm brace, 10-foot spread, 3-foot drop.
1 Cross arm brace, 6-foot spread, 22-inch drop.
6 Porcelain insulators.
6 1⅜-inch insulator pins.
1 Angle Iron ground wire bayonet.
1 Ground wire clamp.
3 ⅝-inch thru bolts.
1 ⅝-inch square washer.
4 ½ x 1½-inch machine bolts.
1 ½ x 4-inch lag screw.

List of Material

1 3 x 3 x ¼-inch, 72-inch-spacing bo-arrow arm.
3 Porcelain insulators.
3 1⅜-inch insulator pins.
1 3 x 3 x ¼-inch x 6-foot 3-inch angle iron ground wire bayonet.
1 Ground wire clamp.
3 ⅝-inch thru bolts.
2 ⅝-inch square washers.



66,000 VOLTS

The distance between conductors on a transmission line is variable depending to a certain extent on local conditions. However, the distance should never be less than the following for spans not exceeding 150 feet.

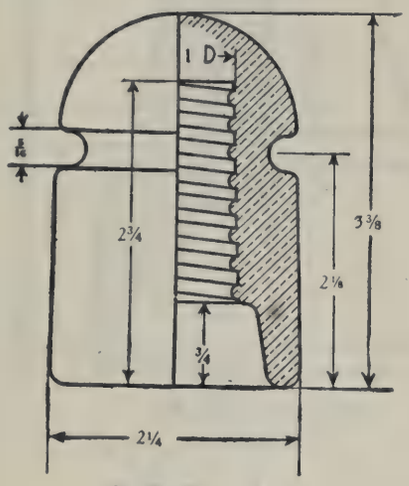
Line Voltage	Separation
Not exceeding 6600 volts	14½ inches
Exceeding 6600 but not exceeding 14,000	24 inches
Exceeding 14,000 but not exceeding 27,000	30 inches
Exceeding 27,000 but not exceeding 35,000	36 inches
Exceeding 35,000 but not exceeding 47,000	45 inches
Exceeding 47,000 but not exceeding 70,000	60 inches

The clearance in any direction between the conductors nearest the pole or tower, and the pole, or tower, shall be not less than:

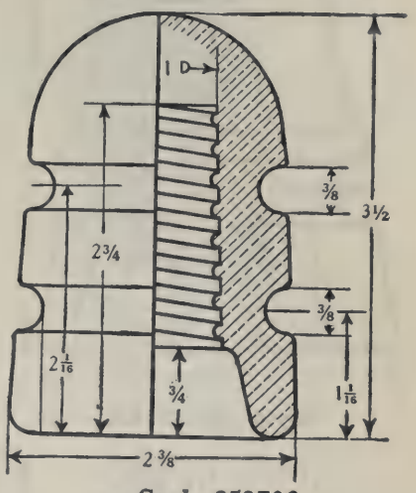
Line Voltage	Clearances
Not exceeding 14,000 volts	9 inches
Exceeding 14,000 but not exceeding 27,000	15 inches
Exceeding 27,000 but not exceeding 35,000	18 inches
Exceeding 35,000 but not exceeding 47,000	21 inches
Exceeding 47,000 but not exceeding 70,000	24 inches

PORCELAIN PIN-TYPE INSULATORS

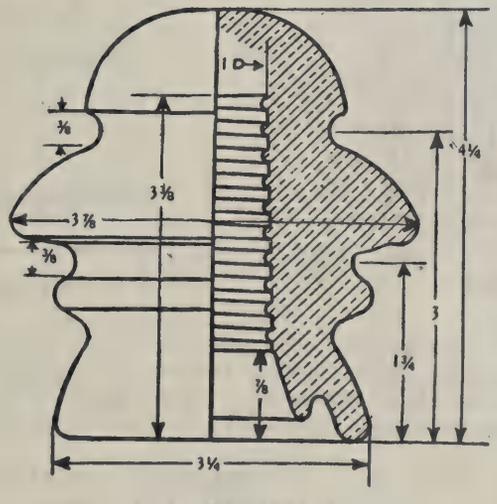
TELEPHONE, TELEGRAPH AND ELECTRIC LIGHT SERVICE



Style No. 195138



Style 253706

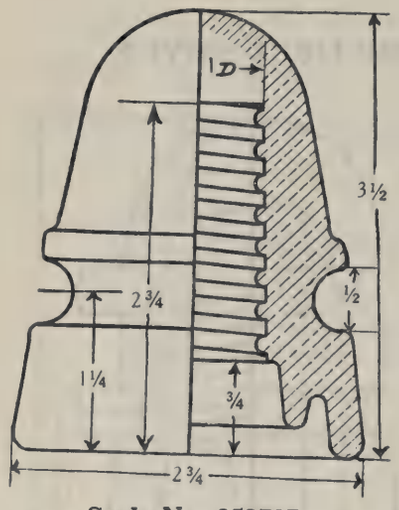


Style No. 195141

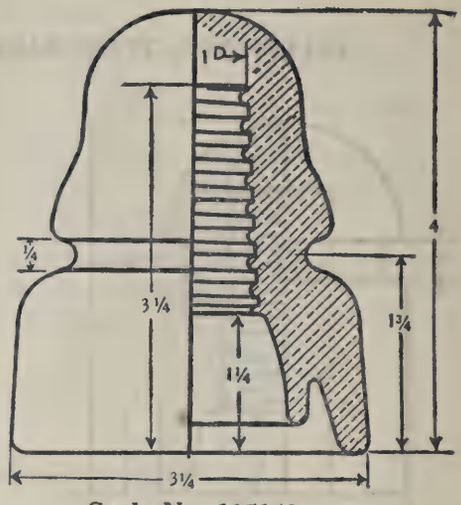
Style No.	195138	253706	195141
Diameter of insulator, inches	2¼	2⅜	3⅜
Height of insulator, inches	3⅜	3½	4¼
Diameter of wire groove, inches	5/16	⅜	⅜
Size of pin hole, inches	1	1	1
Approximate net weight per 100 in pounds	75	82	176
Approximate weight packed per 100 in pounds	87	96	245
Number per barrel	425	425	125
List price per 100	$9 15	$9 15	$36 75

845-92A

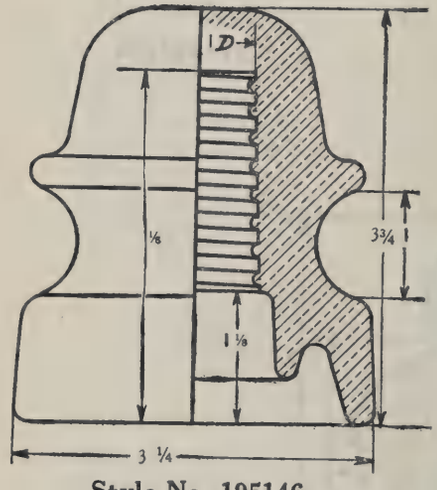
PORCELAIN PIN-TYPE INSULATORS—Continued



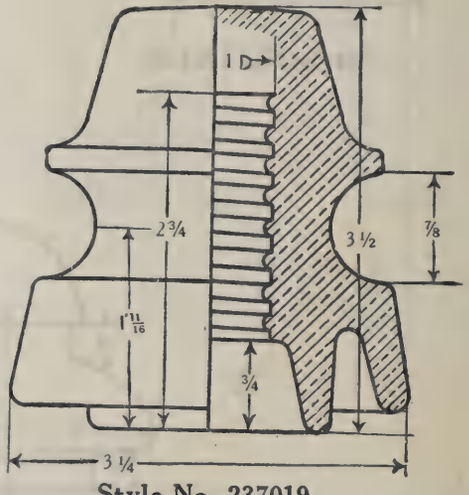
Style No. 253707



Style No. 195143



Style No. 195146



Style No. 237019

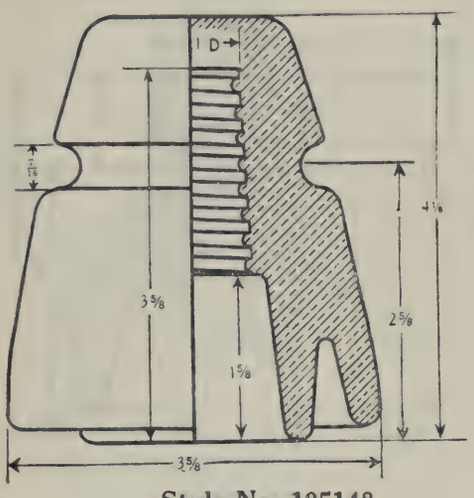
Style No. 195146 will be shipped 200 insulators per box packed in paper cartons, when so ordered. (Weight packed, 125 pounds per 100). Otherwise they will be shipped 200 insulators per barrel.

Style No. 237019 will be shipped 200 insulators per box packed in paper cartons, when so ordered. (Weight packed, 150 pounds per 100). Otherwise they will be shipped 250 insulators per barrel.

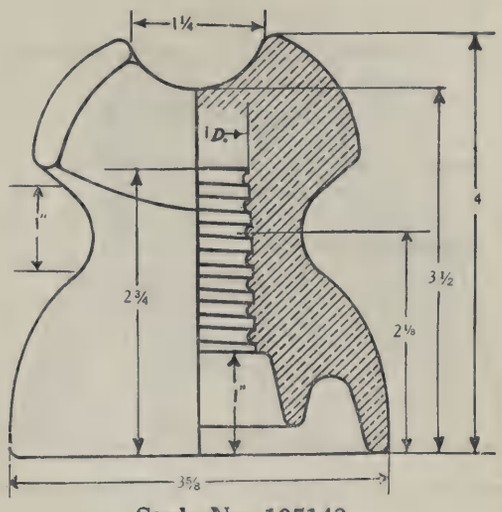
Style No.	253707	195143	195146	237019
Trade voltage rating	**4400**	**4400**	**4400**	**4400**
Dry arc-over voltage	35000	40000	43000	43000
Wet arc-over voltage	13000	13000	14000	14000
Leakage distance, inches	4	4¼	4	4
Wet arcing distance, inches	1¼	1¼	1¼	1½
Diameter of insulator, inches	2¾	3¼	3¼	3¼
Height of insulator, inches	3½	4	3¾	3½
Diameter of wire groove, inches	½	¼	1	⅞
Size of pin hole, inches	1	1	1	1
Approximate net weight per 100 in pounds	85	125	125	105
Approximate weight packed per 100 in pounds	110	150	170	140
Number per barrel	325	240	200	250
Use 1-inch pin with length above arm	4½ inches.	5 inches.	5 inches.	5 inches.
List price per 100	**$16 50**	**$19 25**	**$16 50**	**$16 50**

845-93A

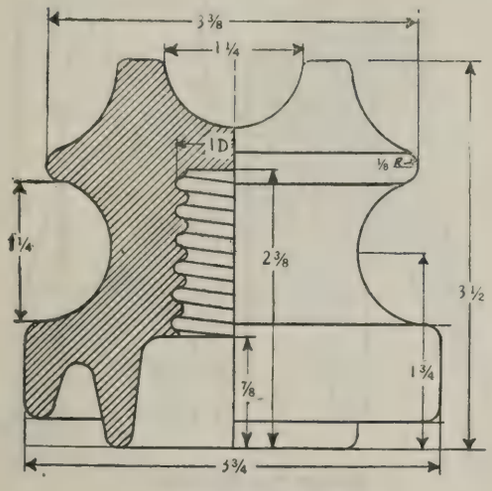
PORCELAIN PIN-TYPE INSULATORS—Continued



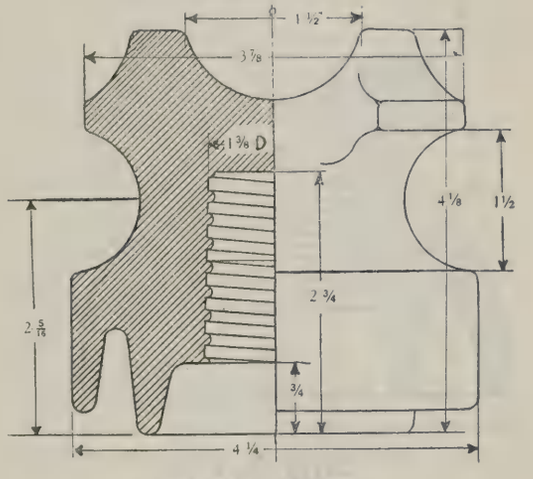
Style No. 195148



Style No. 195149



Style No. 195153

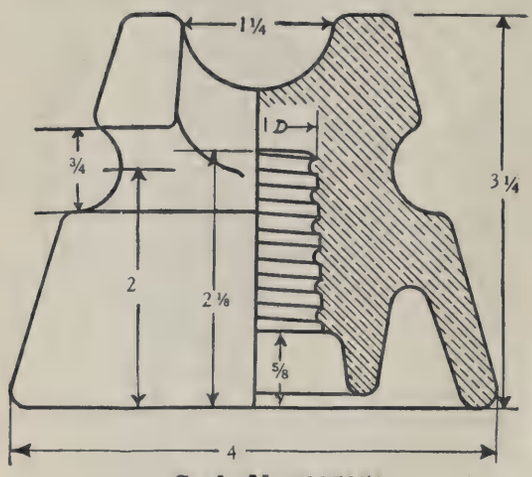


Style No. 195162

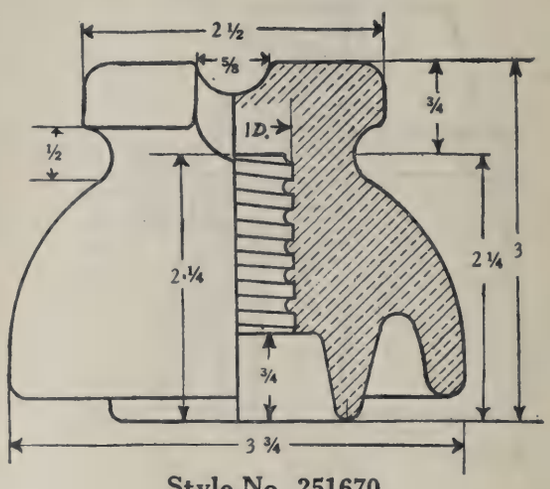
Style No.	195148	195149	195153	195162
Trade voltage rating	**6600**	**6600**	**6600**	**6600**
Dry arc-over voltage	50000	53000	50000	55000
Wet arc-over voltage	20000	22000	20000	20000
Leakage distance, inches	6 3/8	5	4	5 1/4
Wet arcing distance, inches	1 1/2	1 5/8	1 1/2	1 1/2
Diameter of insulator, inches	3 5/8	3 5/8	3 3/4	4 1/4
Height of insulator, inches	4 1/8	4	3 1/2	4 1/8
Diameter of wire groove, inches	7/16	1 1/4	1 1/4	1 1/2
Size of pin hole, inches	1	1	1	1 3/8
Approximate net weight per 100 in pounds	175	190	125	350
Approximate weight packed per 100 in pounds	220	225	185	390
Number per barrel	175	150	175	100
Use 1-inch pin with length above arm	5 inches.	5 inches	4 1/2 inches	5 inches
List price per 100	**$22 00**	**$29 25**	**$32 00**	**$58 50**

845-94A

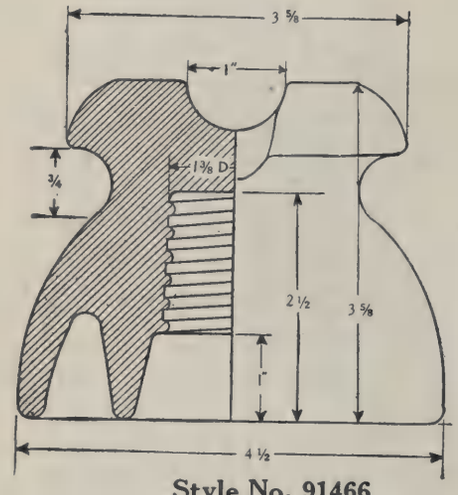
PORCELAIN PIN-TYPE INSULATORS—Continued



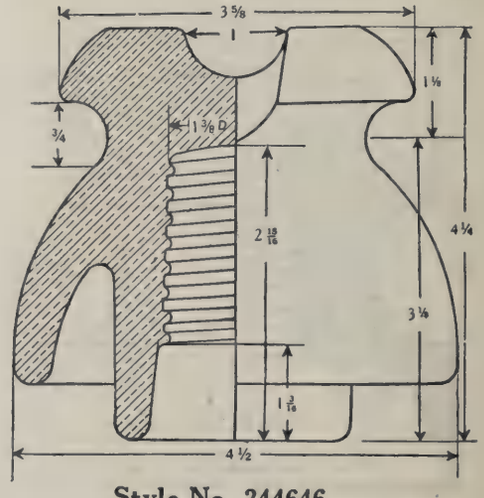
Style No. 195150



Style No. 251670



Style No. 91466

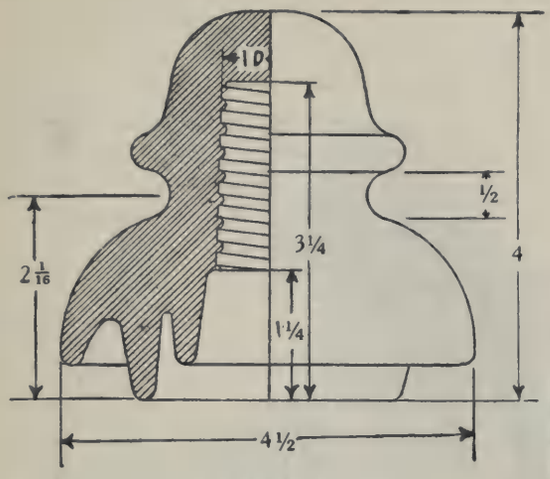


Style No. 244646

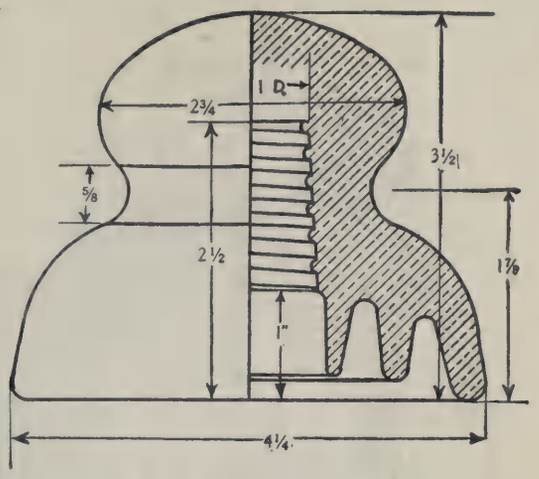
Style No.	195150	251670	91466	244646
Trade voltage rating	**6600**	**7500**	**7500**	**7500**
Dry arc-over voltage	55000	55000	60000	60000
Wet arc-over voltage	23000	24000	25000	25000
Leakage distance, inches	4½	5½	6½	7¼
Wet arcing distance, inches	1¾	1½	1⅝	1¾
Diameter of insulator, inches	4	3¾	4½	4½
Height of insulator, inches	3¼	3	3⅝	4¼
Diameter of top groove, inches	1¼	⅝	1	1
Size of pin hole, inches	1	1	1⅜	1⅜
Approximate net weight per 100 in pounds	158	165	275	275
Approximate weight packed per 100 in pounds	185	185	335	340
Number per barrel	190	200	100	100
Use 1-inch pin with length above arm	4¾ inches	4½ inches	4¾ inches	5 inches.
List price per 100	$22 00	$22 00	$38 50	$62 50

845-95A

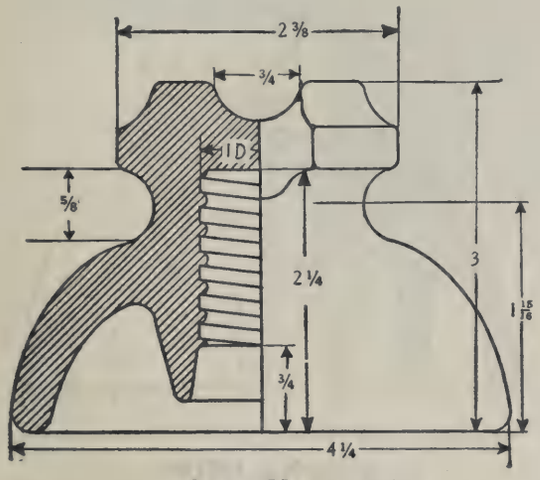
PORCELAIN PIN-TYPE INSULATORS—Continued



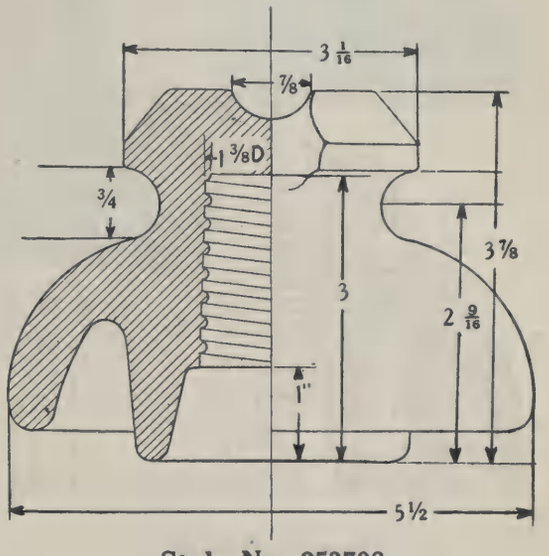
Style No. 195161



Style No. 195156



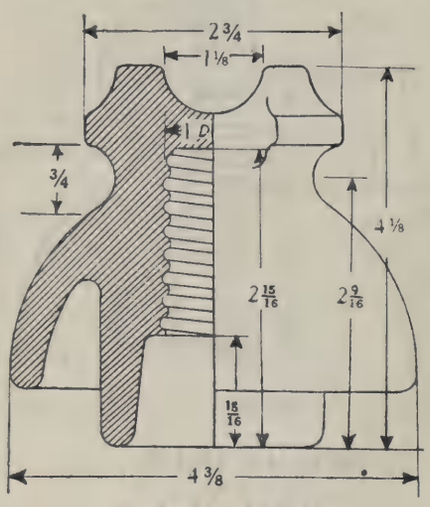
Style No. 195159



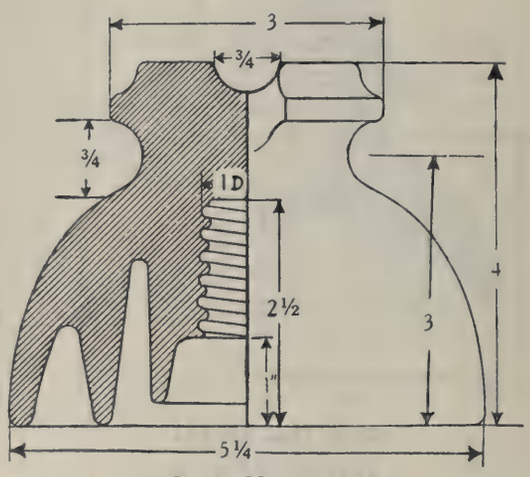
Style No. 253708

Style No.	195161	195156	195159	253708
Trade voltage rating	**7500**	**7500**	**11000**	**11000**
Dry arc-over voltage	50000	50000	54000	65000
Wet arc-over voltage	22000	22000	22000	23000
Leakage distance, inches	6¾	6	5½	7¼
Wet arcing distance, inches	2¼	1¾	1½	2¼
Diameter of insulator, inches	4½	4¼	4¼	5½
Height of insulator, inches	4	3½	3	3⅞
Diameter of wire groove, inches	½	⅝	¾	⅞
Size of pin hole, inches	1	1	1	1⅜
Approximate net weight per 100 in pounds	200	175	165	300
Approximate weight packed per 100 in pounds	250	225	185	510
Number per barrel	125	125	165	65
Use 1-inch pin with height above arm	5½ inches	4½ inches	4½ inches	6 inches.
List price per 100	$47 75	$47 75	$38 50	$60 00

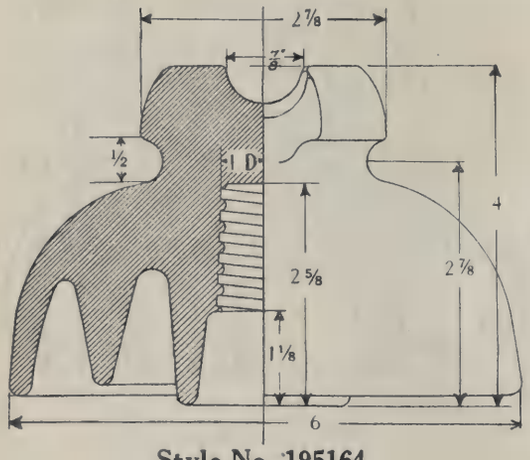
PORCELAIN PIN-TYPE INSULATORS—Continued



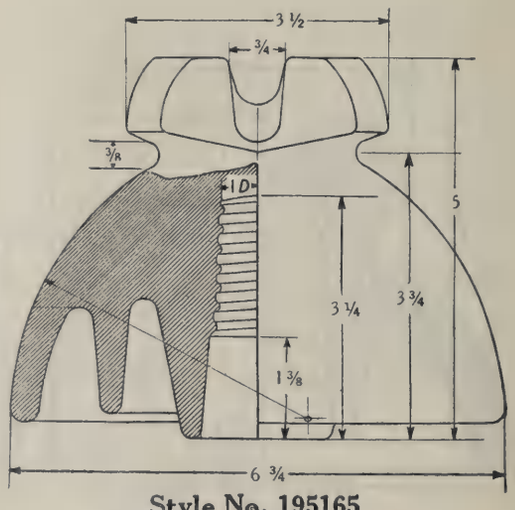
Style No. 195160



Style No. 253709



Style No. 195164

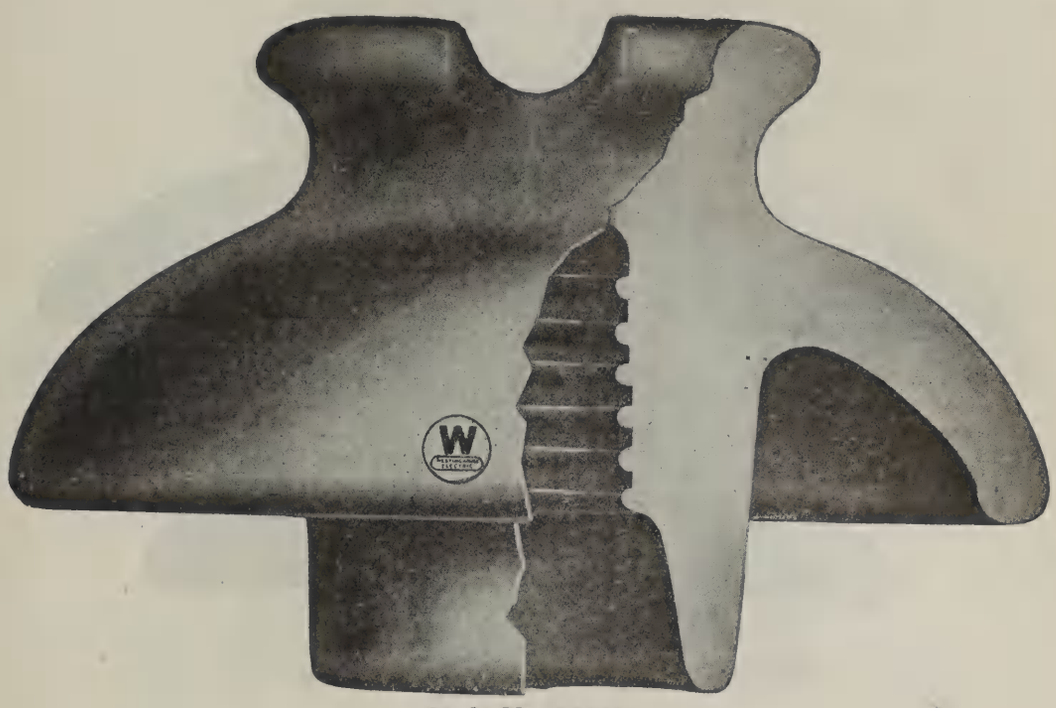


Style No. 195165

Style No.	195160	253709	195164	195165
Trade voltage rating	**13000**	**17000**	**17000**	**23000**
Dry arc-over voltage	64000	69000	75000	80000
Wet arc-over voltage	26000	27000	32000	37000
Leakage distance, inches	7½	11	11¼	13½
Wet arcing distance, inches	2	2¼	2⅝	3
Diameter of insulator, inches	4⅜	5¼	6	6¾
Height of insulator, inches	4⅛	4	4	5
Diameter of top groove, inches	1⅛	¾	⅞	¾
Size of pin hole, inches	1	1	1	1
Approximate net weight per 100 in pounds	225	325	400	500
Approximate weight packed per 100 in pounds	300	395	455	700
Number per barrel	100	65	45	30
Use 1-inch pin with height above arm	5½ inches	5½ inches	5½ inches	5½ inches
List price per 100	**$44 00**	**$81 00**	**$114 00**	**$135 00**

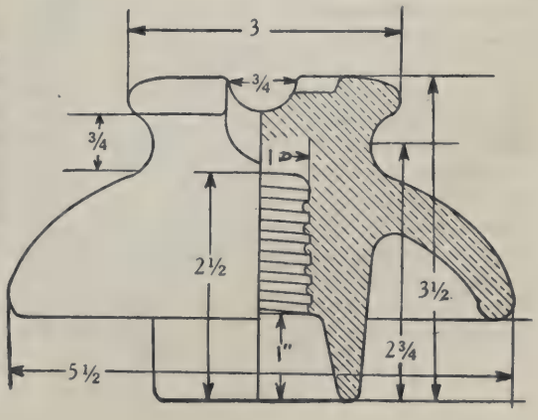
845-97A

PORCELAIN PIN TYPE INSULATORS—Continued

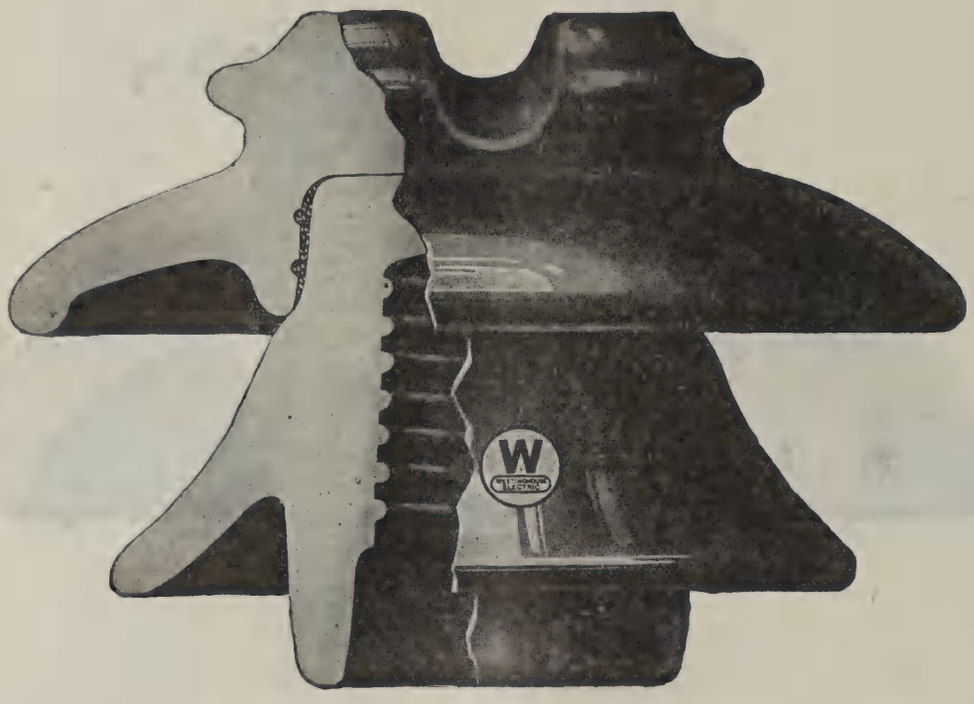


Style No. 195163

Trade voltage rating	13500
Dry arc-over voltage	65000
Wet arc-over voltage	28000
Leakage distance, inches	7¼
Wet arcing distance, inches	2⅝
Diameter of insulator, inches	5½
Height of insulator, inches	3½
Diameter of wire grooves, inches	¾
Size of pin hole, inches	1
Approximate net weight per 100 in pounds	320
Approximate weight packed per 100 in pounds	355
Number per barrel	75
Use 1-inch pin with height above arm 4 inches.	
List price per 100	$45 75

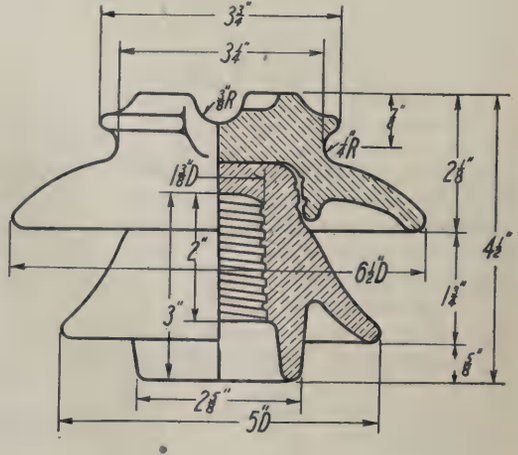


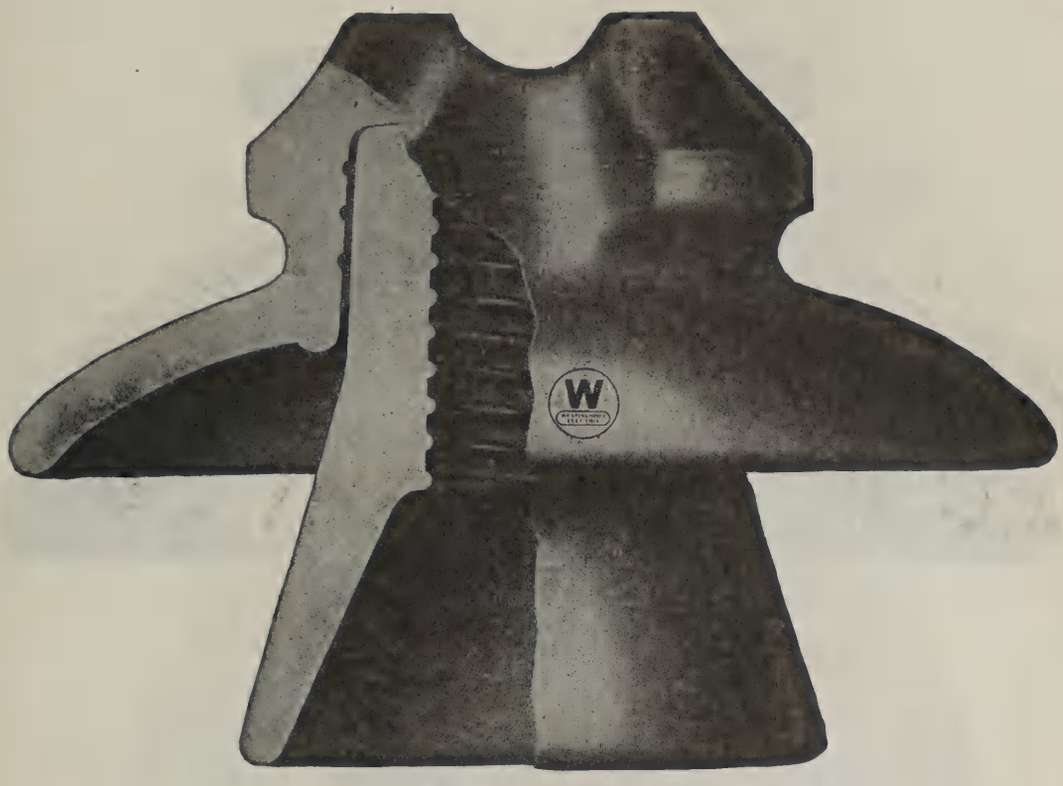
PORCELAIN PIN-TYPE INSULATORS—Continued



Style No. 237023

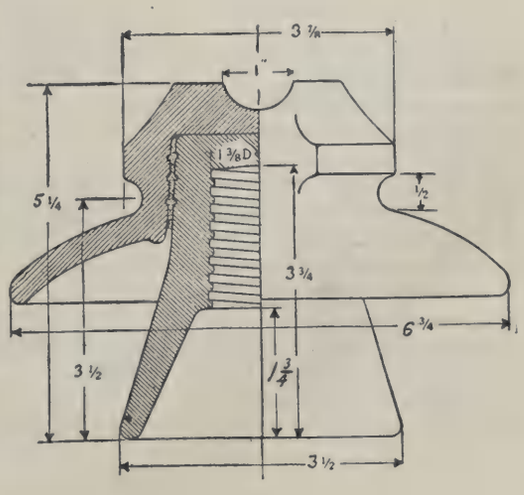
Trade voltage rating	20000
Dry arc-over voltage	75000
Wet arc-over voltage	45000
Leakage distance, inches	11
Wet arcing distance, inches	4¼
Diameter of insulator, inches	6½
Height of insulator, inches	4½
Diameter of top groove, inches	¾
Size of pin hole, inches	1⅜
Approximate net weight per 100 in pounds	480
Approximate weight packed per 100 in pounds	580
Number per crate	100
Use 1⅜-inch pin with height above arm 4½ inches.	
List price per 100	**$138 00**





Style No. 195168

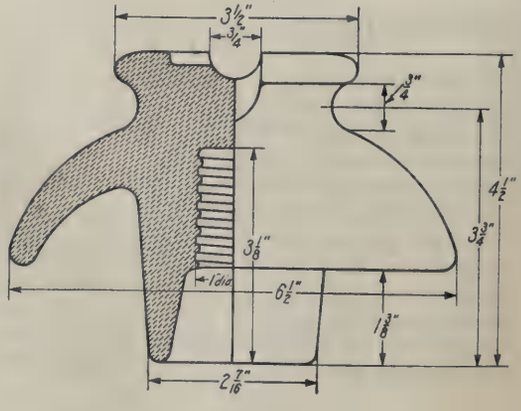
Trade voltage rating	17000
Dry arc-over voltage	73000
Wet arc-over voltage	34000
Leakage distance, inches	10¼
Wet arcing distance, inches	3½
Diameter of insulator, inches	6¾
Height of insulator, inches	5¼
Diameter of top groove, inches	1
Size of pin hole, inches	1⅜
Approximate net weight per 100 in pounds	400
Approximate weight packed per 100 in pounds.	495
Number per crate	80
Use 1⅜-inch pin with height above arm 6 inches.	
List price per 100	$108 00



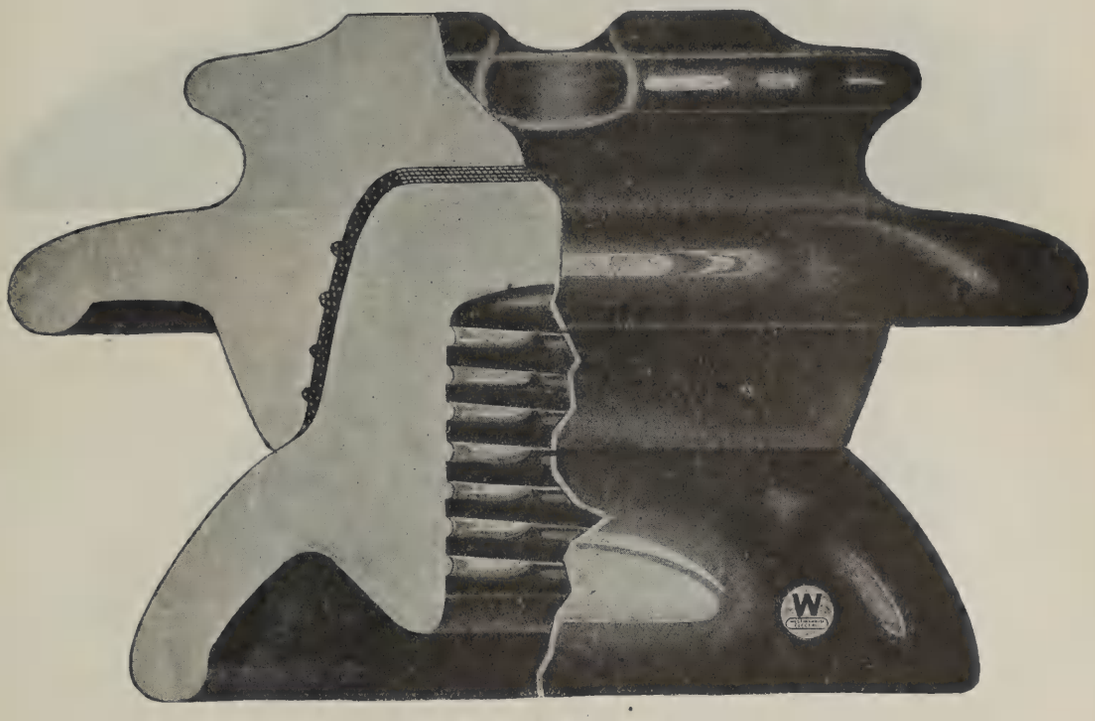
PORCELAIN PIN TYPE INSULATORS—Continued

Style No. 26637

Trade voltage rating	**18000**
Dry arc-over voltage	76000
Wet arc-over voltage	37000
Leakage distance, inches	9
Wet arcing distance, inches	3
Diameter of insulator, inches	6½
Height of insulator, inches	4½
Diameter of wire grooves, inches	¾
Size of pin hole, inches	1
Approximate net weight per 100 in pounds	400
Approximate weight packed per 100 in pounds	625
Number per barrel	45
Use 1-inch pin with height above arm 4½ inches.	
List price, per 100	$109 00



PORCELAIN PIN-TYPE INSULATORS—Continued

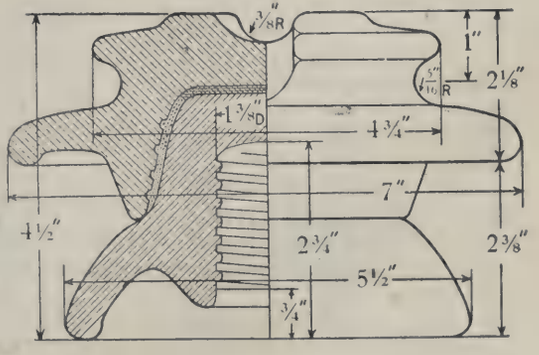


TRADE **FARADOID** MARK

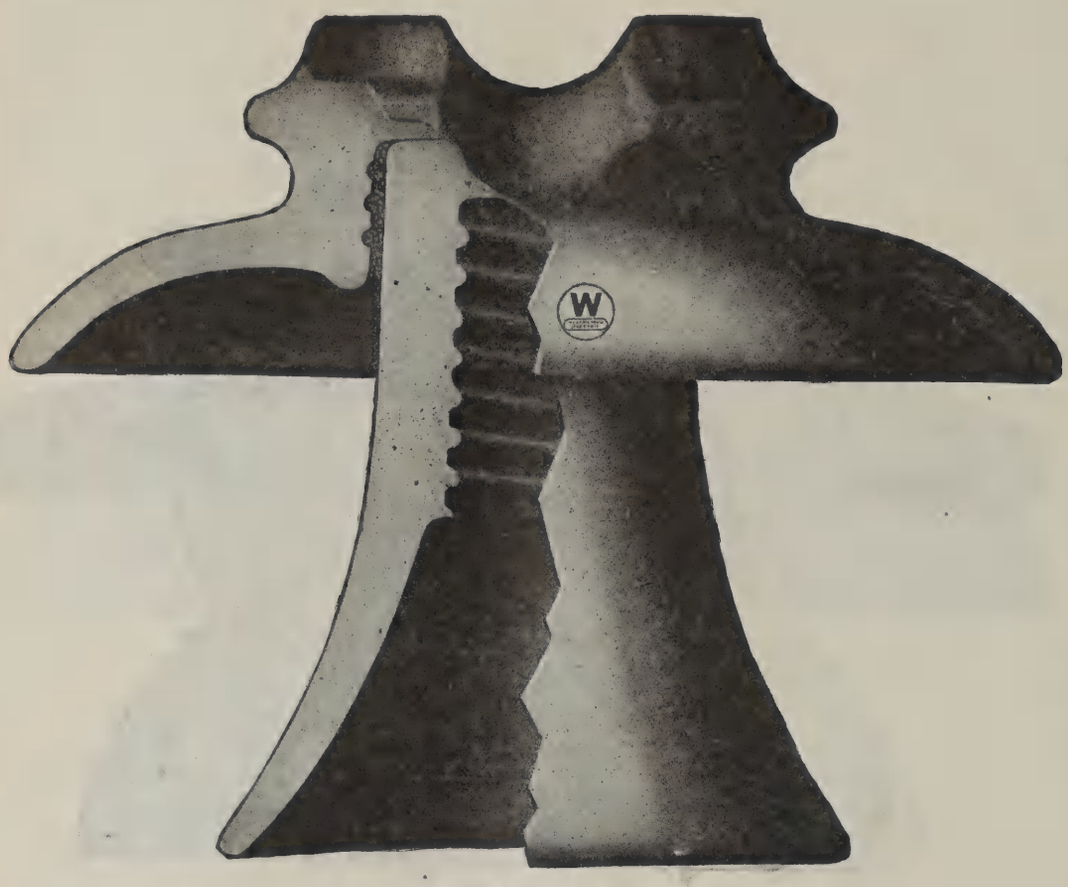
PATENTED

No. 2-15

Trade voltage rating	25000
Dry arc over-voltage	80000
Wet arc-over voltage	50000
Leakage distance, inches	8½
Wet arcing distance, inches	4
Diameter of insulator, inches	7
Height of insulator, inches	4 9/16
Diameter of top groove, inches	¾
Size of pin hole, inches	1⅜
Approximate net weight per 100 in pounds	600
Approximate weight packed per 100 in pounds	709
Number per crate	35
Use 1¾-inch pin with height above arm	6 inches
List price per 100	$177 00



PORCELAIN PIN-TYPE INSULATORS—Continued

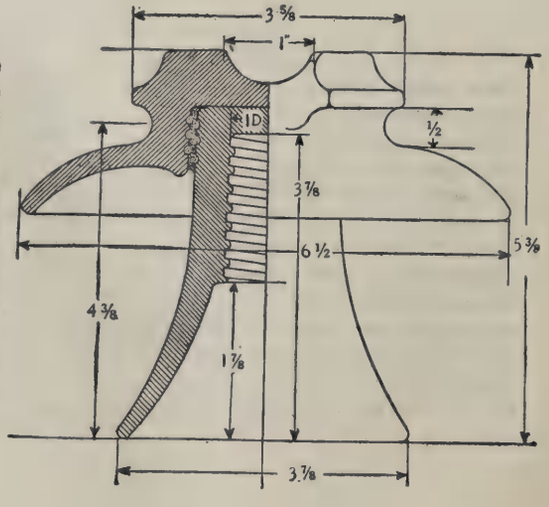


Style No. 195167

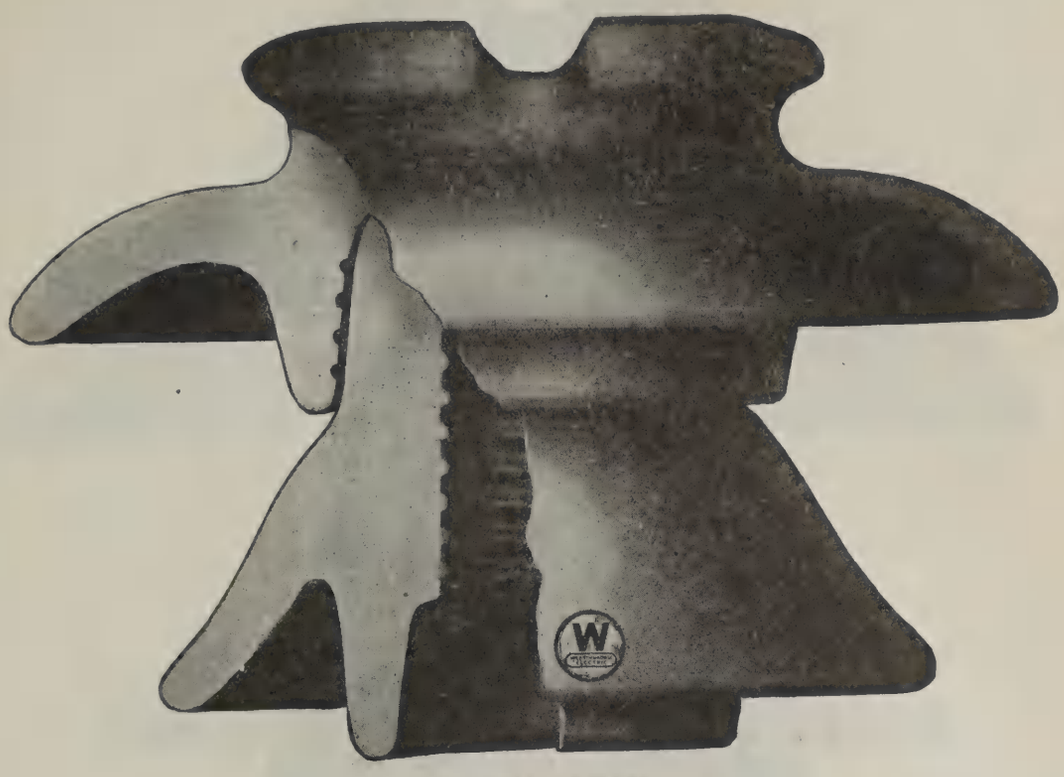
Trade voltage rating	25000
Dry arc-over voltage	78000
Wet arc-over voltage	50000
Leakage distance, inches	11
Wet arcing distance, inches	4¼
Diameter of insulator, inches	6½
Height of insulator, inches	5⅜
Diameter of top groove, inches	1
Size of pin hole, inches	1
Approximate net weight per 100 in pounds	300
Approximate weight packed per 100 in pounds	425
Number per barrel	40

Use 1-inch pin with height above arm 6 inches.

List price per 100 ..... $106 00

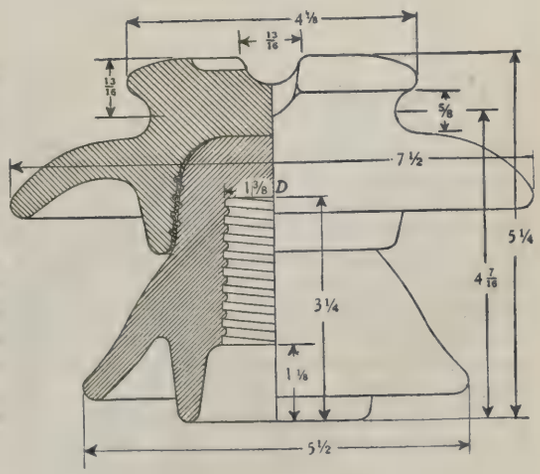


PORCELAIN PIN-TYPE INSULATORS—Continued

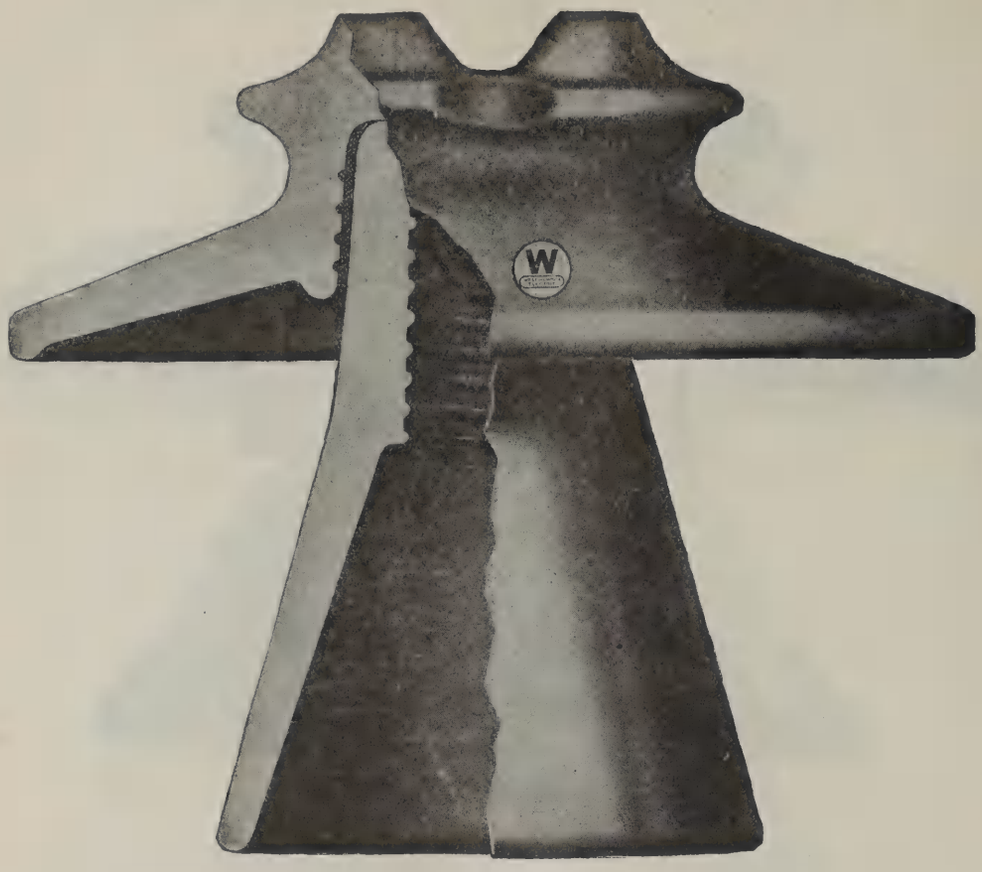


Style No. 243461

Trade voltage rating	27000
Dry arc-over voltage	84000
Wet arc-over voltage	44000
Leakage distance, inches	12
Wet arcing distance, inches	4⅜
Diameter of insulator, inches	7½
Height of insulator, inches	5¼
Diameter of top groove, inches	13/16
Size of pin hole, inches	1⅜
Approximate net weight per 100 in pounds	600
Approximate weight packed per 100 in pounds	800
Number per crate	60
Use 1⅜-inch pin with height above arm 5½ inches.	
List price per 100	$182 00

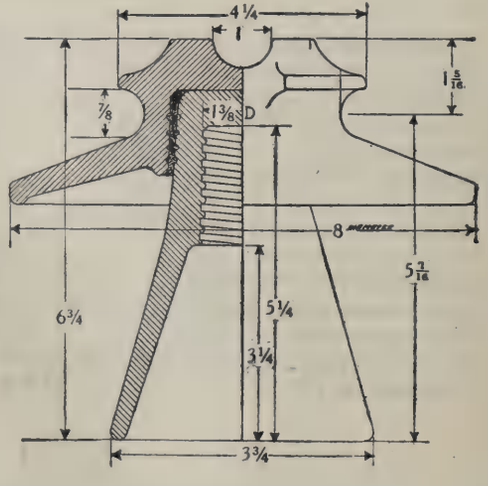


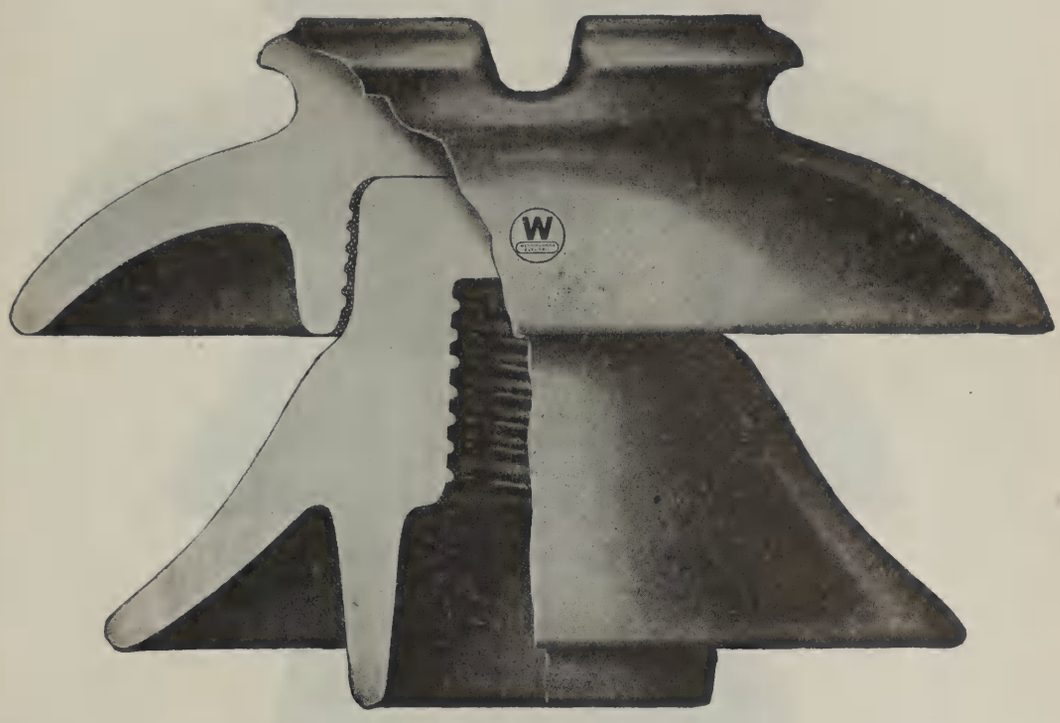
PORCELAIN PIN TYPE INSULATORS—Continued



Style No. 195171

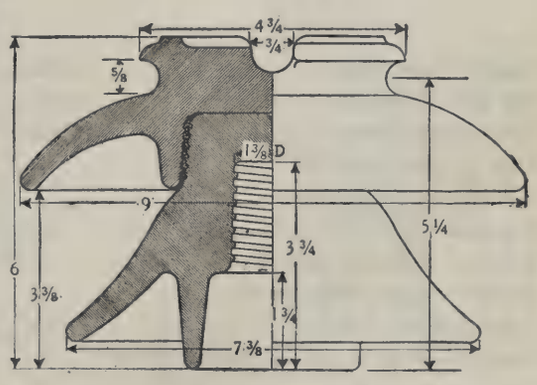
Trade voltage rating	27000
Dry arc-over voltage	85000
Wet arc-over voltage	57000
Leakage distance, inches	14½
Wet arcing distance, inches	4¾
Diameter of insulator, inches	8
Height of insulator, inches	6¾
Diameter of top groove, inches	1
Size of pin hole, inches	1⅜
Approximate net weight per 100 in pounds	550
Approximate weight packed per 100 in pounds	760
Number per crate	48
Use 1⅜-inch pin with height above arm 8 inches.	
List price per 100	$151 00

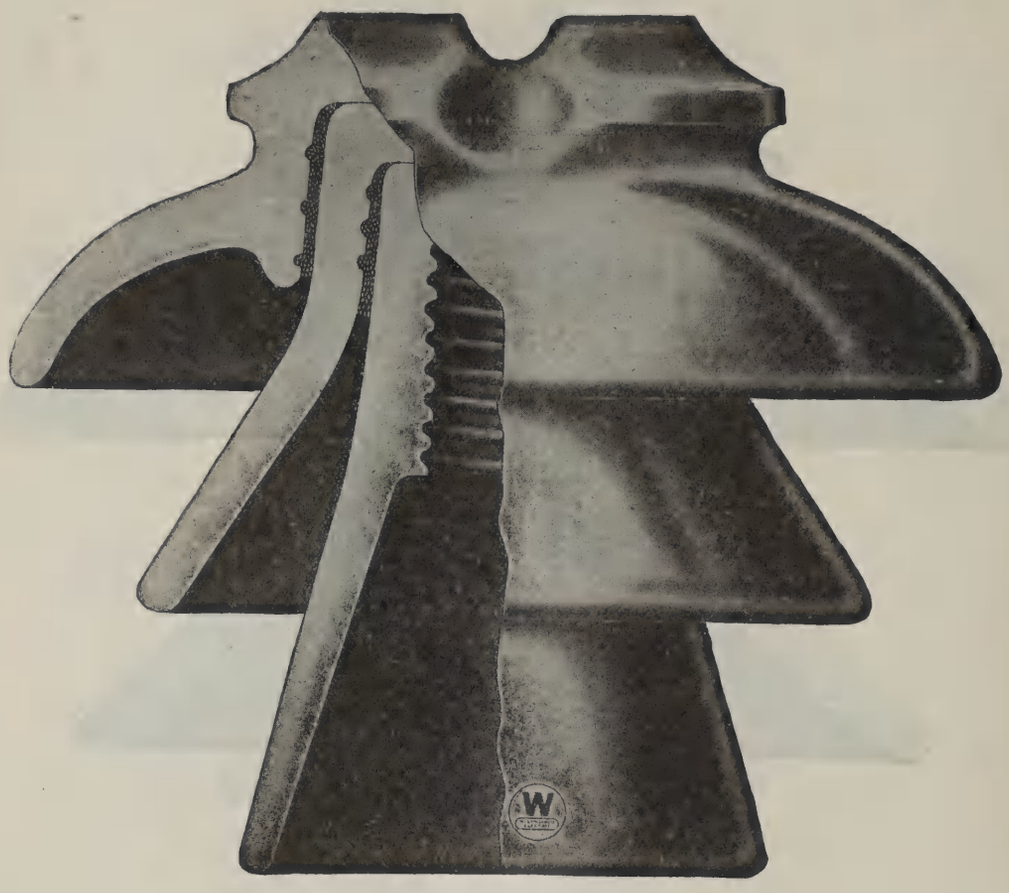




Style No. 224762

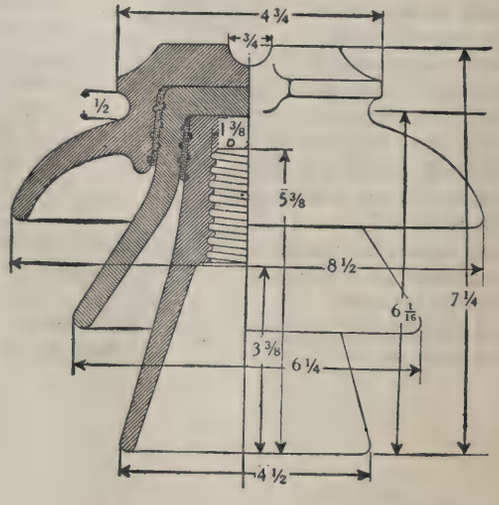
Trade voltage rating	**35000**
Dry arc-over voltage	98000
Wet arc-over voltage	54000
Leakage distance, inches	16½
Wet arcing distance, inches	5½
Diameter of insulator, inches	9
Height of insulator, inches	6
Diameter of top groove, inches	¾
Size of pin hole, inches	1⅜
Approximate net weight per 100 in pounds	1000
Approximate weight packed per 100 in pounds	1110
Number per crate	36
Use 1⅜-inch pin with height above arm 6 inches.	
List price per 100	$251 00



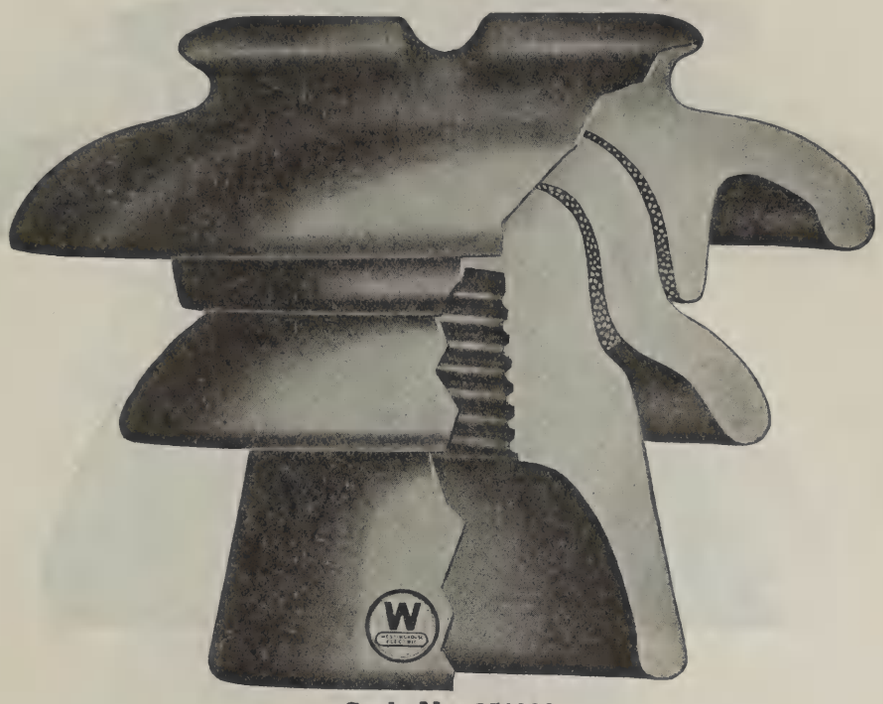


Style No. 195176

Trade voltage rating	**35000**
Dry arc-over voltage	100000
Wet arc-over voltage	66000
Leakage distance, inches	21½
Wet arcing distance, inches	5
Diameter of insulator, inches	8½
Height of insulator, inches	7¼
Diameter of top groove, inches	¾
Size of pin hole, inches	1⅜
Approximate net weight per 100 in pounds	850
Approximate weight packed per 100 in pounds	1330
Number per open crate	6
Use 1⅜-inch pin with height above arm 8 inches.	
List price per 100	**$251 00**

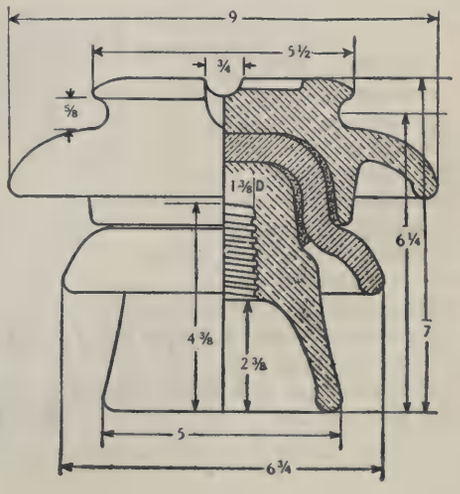


845-50A

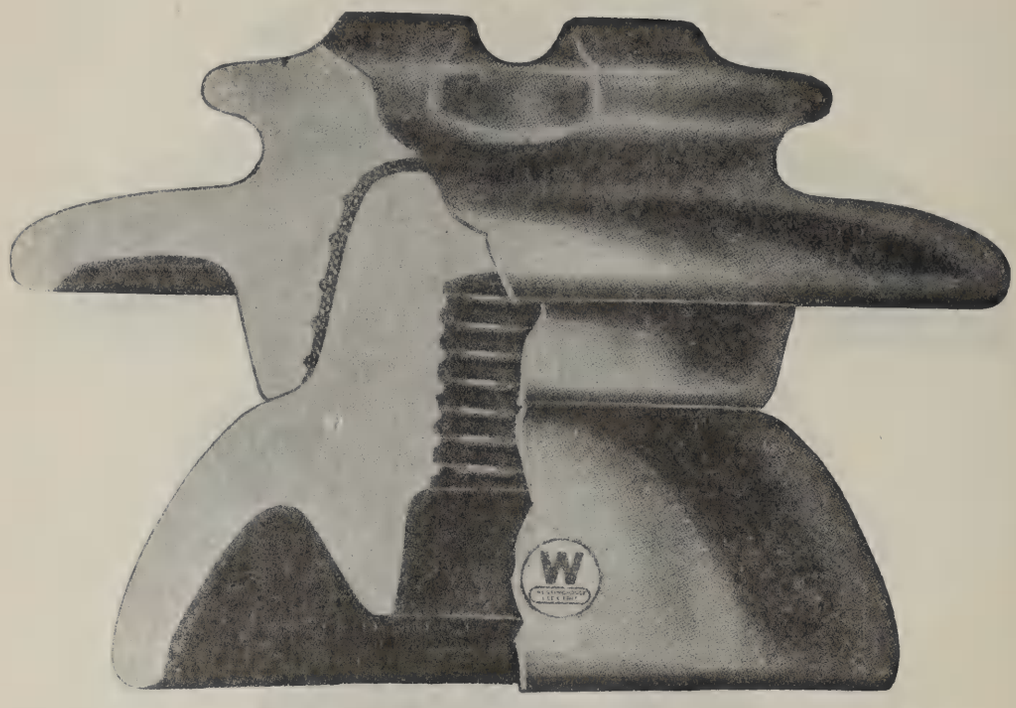


Style No. 250333

Trade voltage rating	**35000**
Dry arc-over voltage	100000
Wet arc-over voltage	66000
Leakage distance, inches	17½
Wet arcing distance, inches	5
Diameter of insulator, inches	9
Height of insulator, inches	7
Diameter of top groove, inches	¾
Size of pin hole, inches	1⅜
Approximate net weight per 100 in pounds	1200
Approximate weight packed per 100 in pounds	1500
Number per open crate	6
Use 1⅜-inch pin with height above arm 7 inches.	
List price per 100	$303 00



PORCELAIN PIN-TYPE INSULATORS—Continued

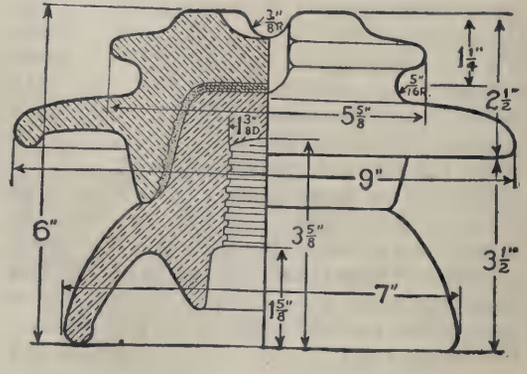


TRADE **FARADOID** MARK

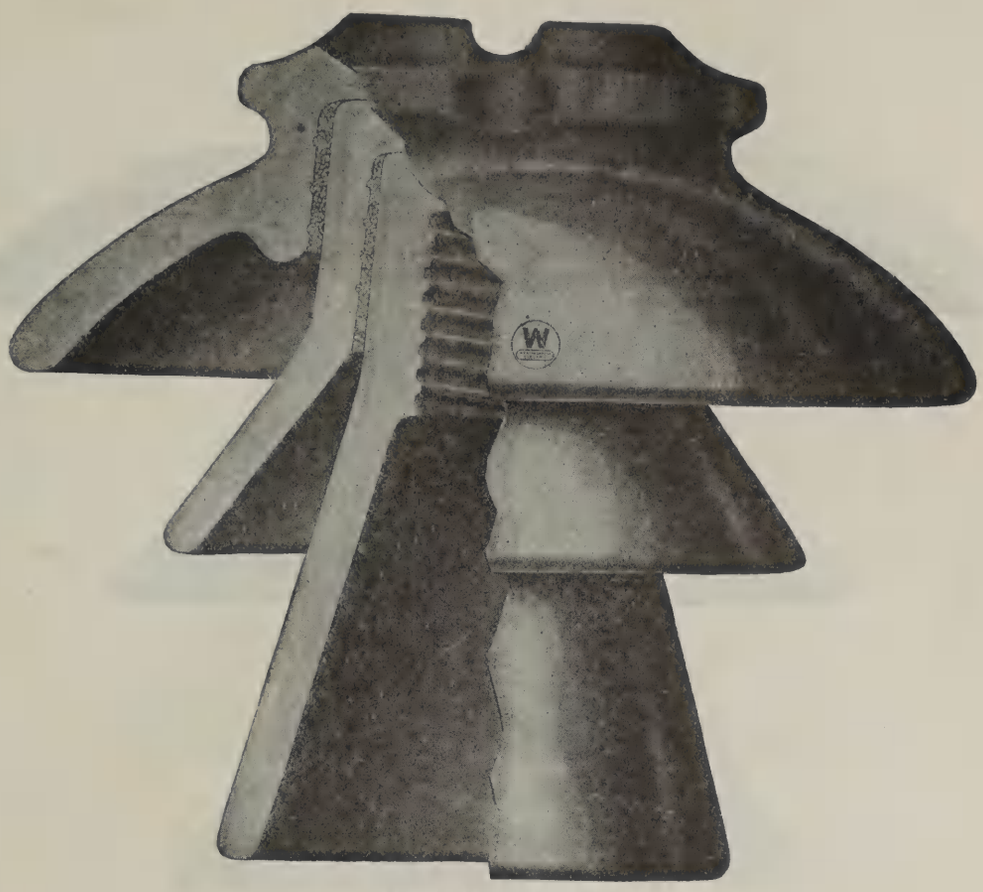
PATENTED

No. 2-22

Trade voltage rating	**35000**
Dry arc-over voltage	105000
Wet arc-over voltage	65000
Leakage distance, inches	13½
Wet arcing distance, inches	5¼
Diameter of insulator, inches	9
Height of insulator, inches	6
Diameter of top groove, inches	¾
Size of pin hole, inches	1⅜
Approximate net weight per 100 in pounds	1100
Approximate weight packed per 100 in pounds	1400
Number per open crate	12
Use 1⅜-inch pin with height above arm 7 inches.	
List price per 100	$262 00

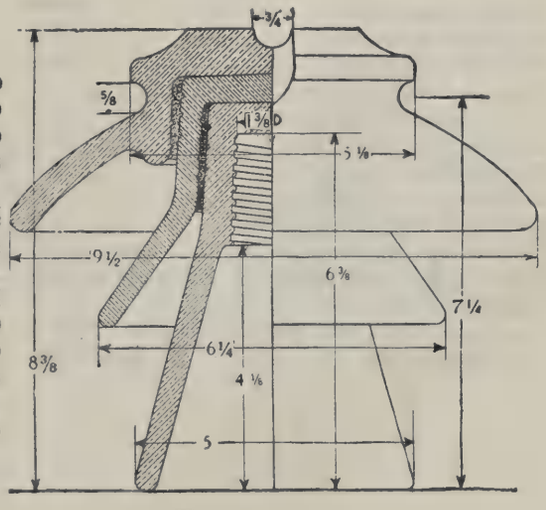


PORCELAIN PIN-TYPE INSULATORS—Continued

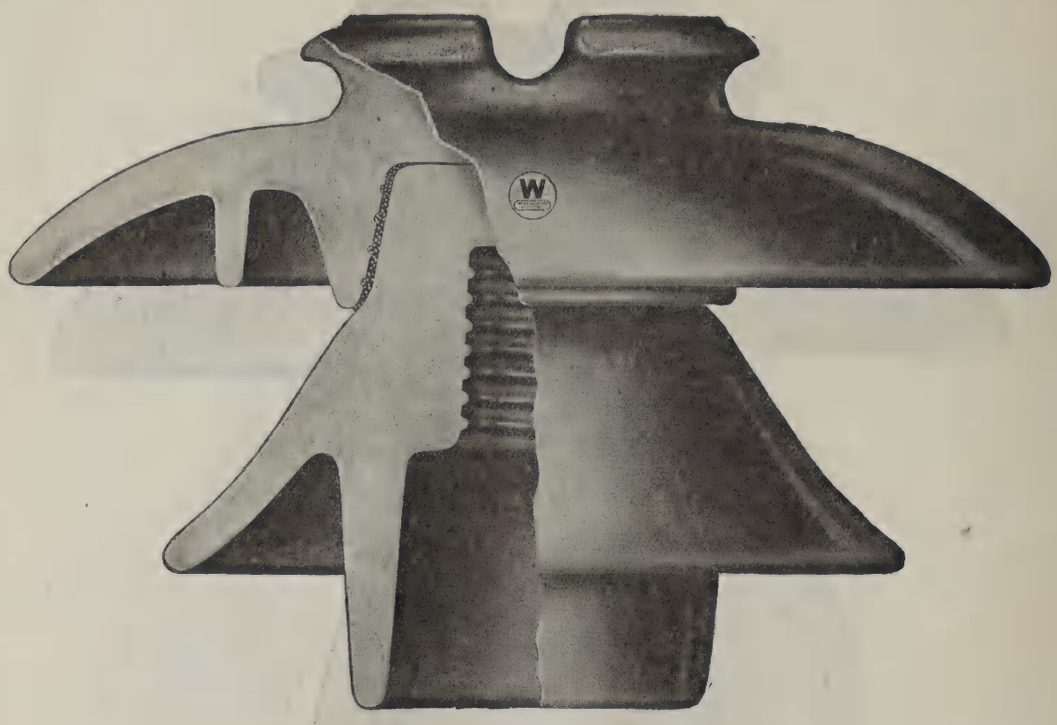


Style No. 195179

Trade voltage rating	**45000**
Dry arc-over voltage	110000
Wet arc-over voltage	70000
Leakage distance, inches	23
Wet arcing distance, inches	5¾
Diameter of insulator, inches	9½
Height of insulator, inches	8⅜
Diameter of top groove, inches	¾
Size of pin hole, inches	1⅜
Approximate net weight per 100 in pounds	1000
Approximate weight packed per 100 in pounds	1410
Number per open crate	6
Use 1⅜-inch pin with height above arm 9 inches.	
List price per 100	$310 00

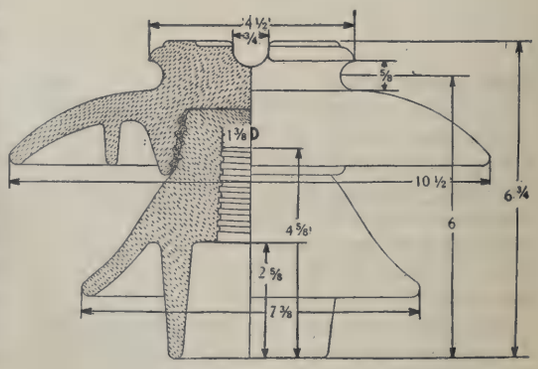


PORCELAIN PIN-TYPE INSULATORS—Continued



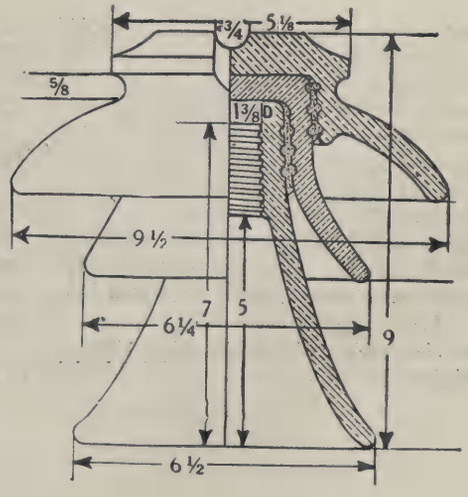
Style No. 224763

Trade voltage rating	**45000**
Dry arc-over voltage	114000
Wet arc-over voltage	76000
Leakage distance, inches	21
Wet arcing distance, inches	6½
Diameter of insulator, inches	10½
Height of insulator, inches	6¾
Diameter of top groove, inches	¾
Size of pin hole, inches	1⅜
Approximate net weight per 100 in pounds	1150
Approximate weight packed per 100 in pounds	1450
Number per open crate	6
Use 1⅜-inch pin with height above arm 7 inches.	
List price per 100	$293 00

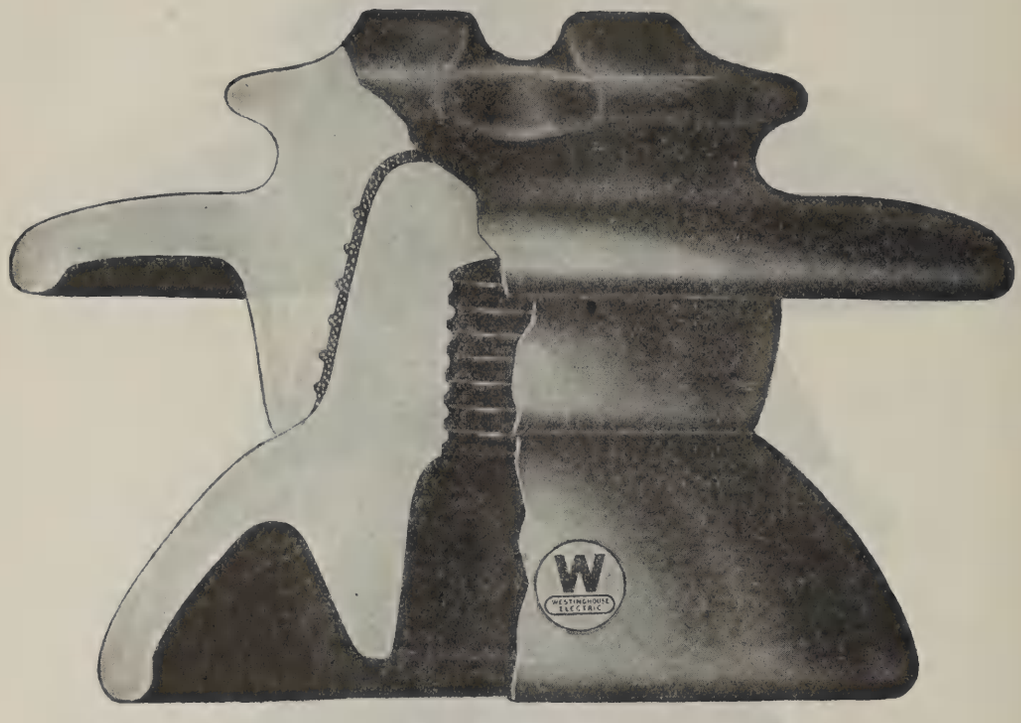


PORCELAIN PIN-TYPE INSULATORS—Continued

Style No. 195180



Trade voltage rating	**45000**
Dry arc-over voltage	120000
Wet arc-over voltage	80000
Leakage distance, inches	25
Wet arcing distance, inches	6⅛
Diameter of insulator, inches	9½
Height of insulator, inches	9
Diameter of top groove, inches	¾
Size of pin hole, inches	1⅜
Approximate net weight per 100 in pounds	1150
Approximate weight packed per 100 in pounds	1490
Number per open crate	6
Use 1⅜-inch pin with height above arm 10 inches.	
List price per 100	$312 00

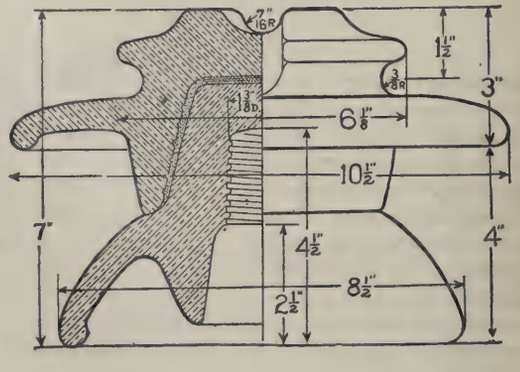


TRADE **FARADOID** MARK

PATENTED

No. 2-33

Trade voltage rating	**45000**
Dry arc-over voltage	135000
Wet arc-over voltage	80000
Leakage distance, inches	17
Wet arcing distance, inches	6½
Diameter of insulator, inches	10½
Height of insulator, inches	7
Diameter of top groove, inches	⅞
Size of pin hole, inches	1⅜
Approximate net weight per 100 in pounds	1600
Approximate weight packed per 100 in pounds	2100
Number per open crate	6
Use 1⅜-inch pin with height above arm 9 inches.	
List price per 100	$350 00



PORCELAIN PIN-TYPE INSULATORS—Continued

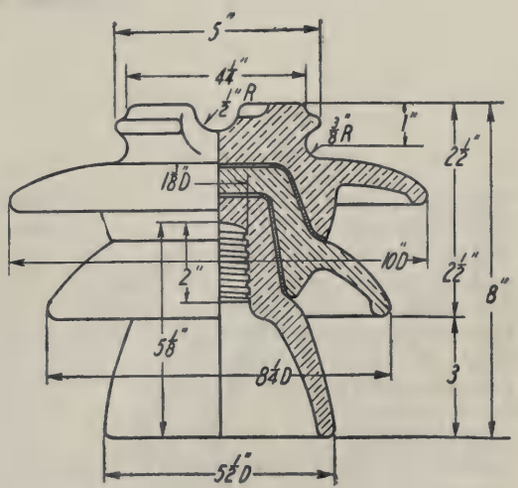
TRADE **FARADOID** MARK

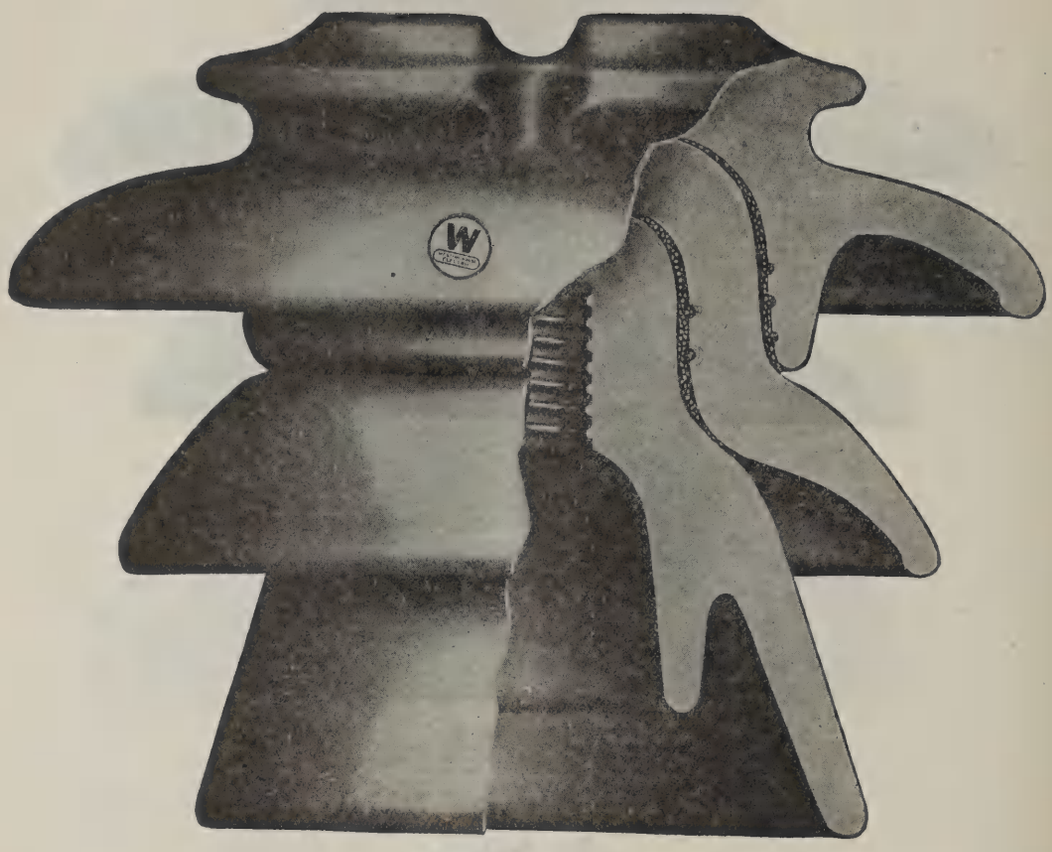
PATENTED

LIGHT-TYPE

No. 3-33

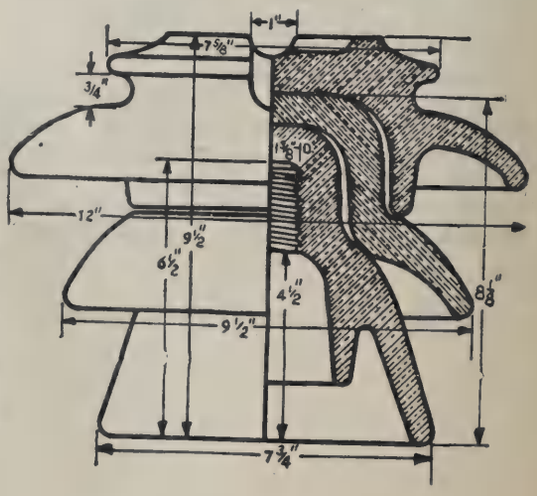
Trade voltage rating	**45000**
Dry arc-over voltage	130000
Wet arc-over voltage	85000
Leakage distance, inches	20
Wet arcing distance, inches	6½
Diameter of insulator, inches	10
Height of insulator, inches	8
Diameter of top groove, inches	1
Size of pin hole, inches	1⅜
Approximate net weight per 100 in pounds	1400
Approximate weight packed per 100 in pounds	2100
Number per crate	3
Use 1⅜-inch pin with height above arm 8 inches.	
List price per 100	**$350 00**



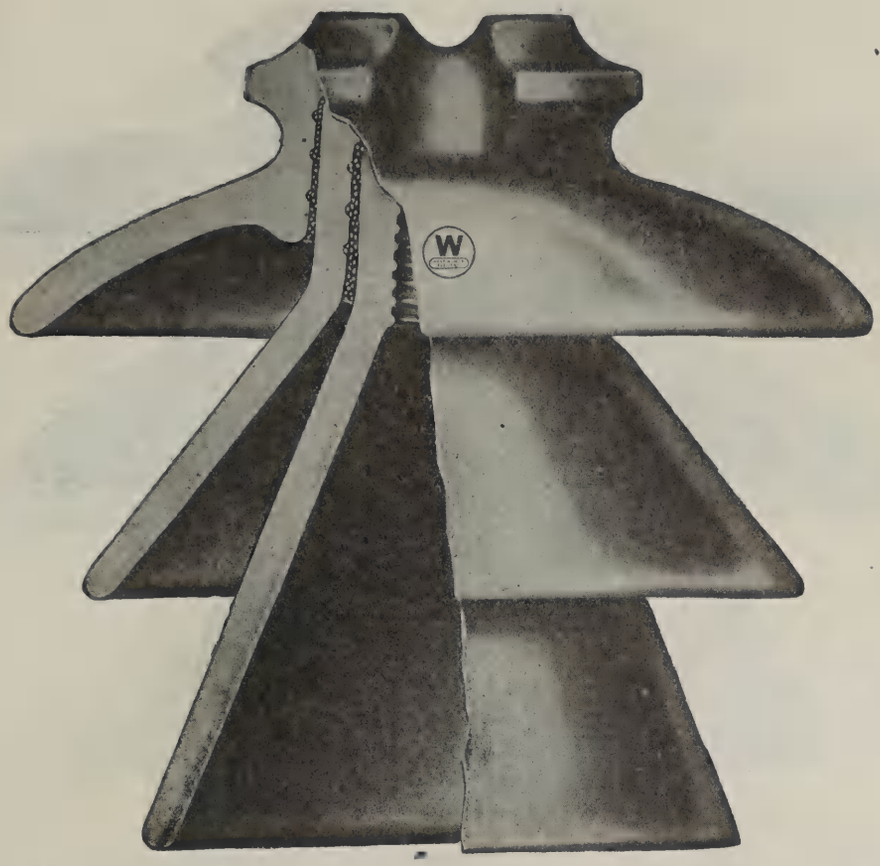


Style No. 253710

Trade voltage rating	**50000**
Dry arc-over voltage	140000
Wet arc-over voltage	90000
Leakage distance, inches	24
Wet arcing distance, inches	7½
Diameter of insulator, inches	12
Height of insulator, inches	9½
Diameter of top groove, inches	1
Size of pin hole, inches	1⅜
Approximate net weight per 100 in pounds	2400
Approximate weight packed per 100 in pounds	3320
Number per open crate	3
Use 1⅜-inch pin with height above arm 10 inches.	
List price per 100	$ 605 00

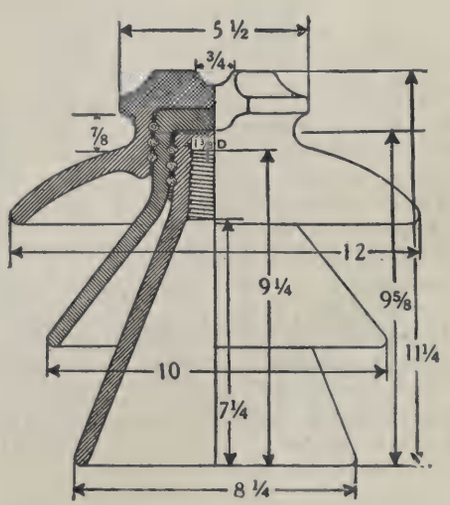


PORCELAIN PIN-TYPE INSULATORS—Continued

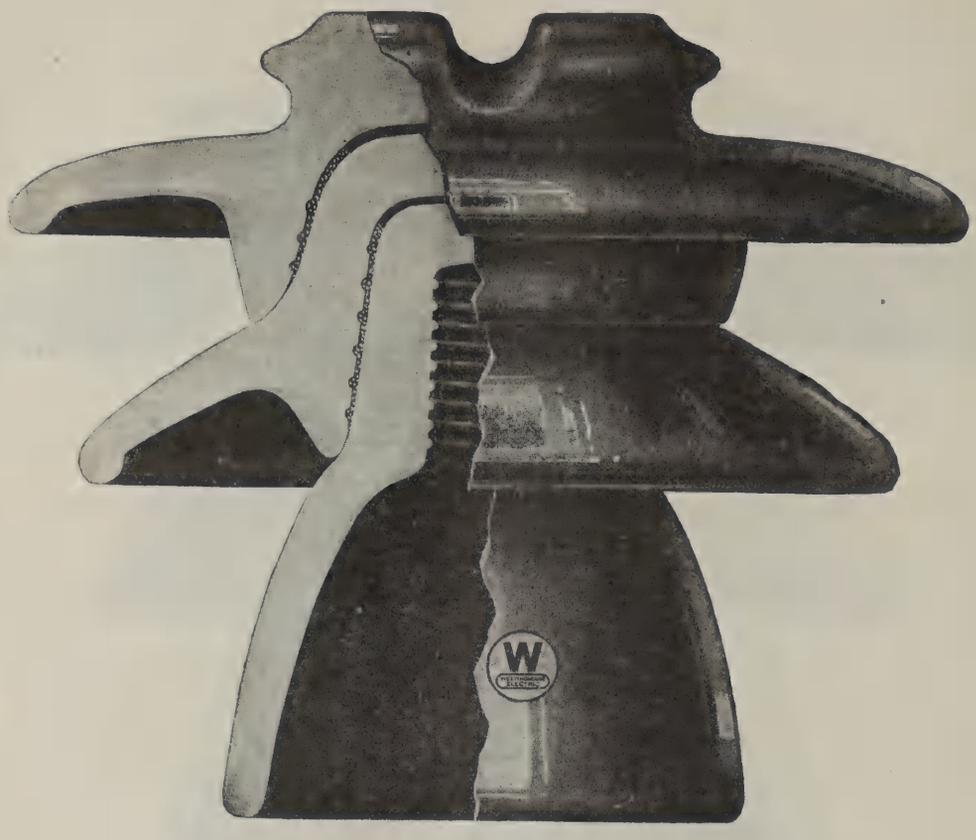


Style No. 244648

Trade voltage rating	**50000**
Dry arc-over voltage	150000
Wet arc-over voltage	100000
Leakage distance, inches	37
Wet arcing distance, inches	8½
Diameter of insulator, inches	12
Height of insulator, inches	11¼
Diameter of top groove, inches	¾
Size of pin hole, inches	1⅜
Approximate net weight per 100 in pounds	2300
Approximate weight packed per 100 in pounds	3300
Number per open crate	3
Use 1⅜-inch pin with height above arm 13 inches.	
List price per 100	$585 00



PORCELAIN PIN-TYPE INSULATORS—Continued



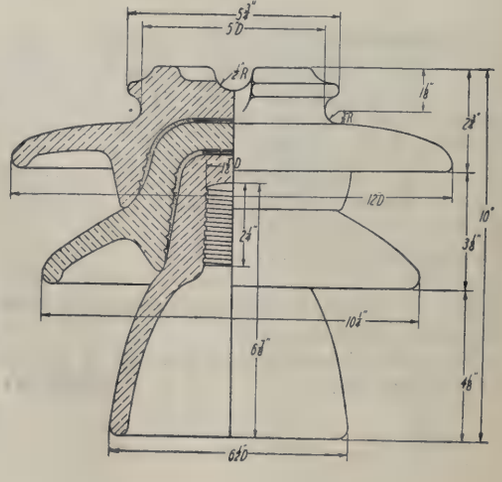
TRADE **FARADOID** MARK

PATENTED

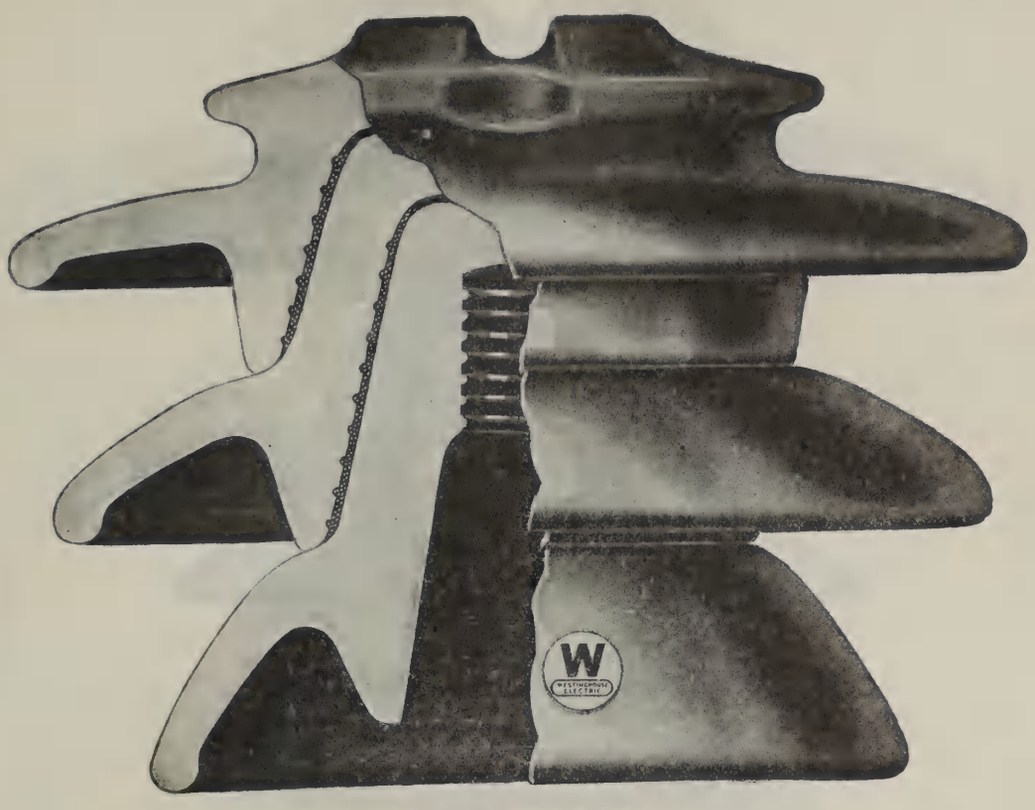
LIGHT-TYPE

No. 3-44½

Trade voltage rating	**50000**
Dry arc-over voltage	160000
Wet arc-over voltage	100000
Leakage distance, inches	26
Wet arcing distance, inches	8¼
Diameter of insulator, inches	12
Height of insulator, inches	10
Diameter of top groove, inches	1
Size of pin hole, inches	1⅜
Approximate net weight per 100 in pounds	2350
Approximate weight packed per 100 in pounds	3300
Number per crate	3
Use 1⅜-inch pin with height above arm 10 inches.	
List price per 100	$640 00



PORCELAIN PIN-TYPE INSULATORS—Continued



TRADE **FARADOID** MARK

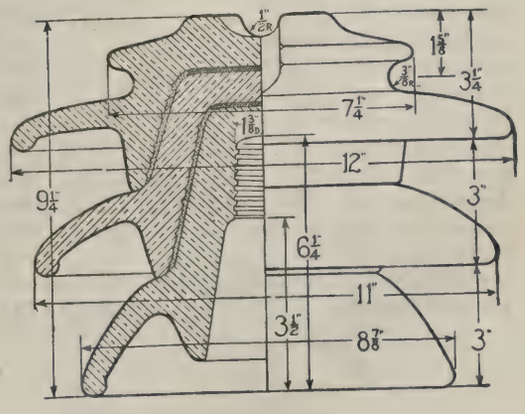
PATENTED

No. 3-44

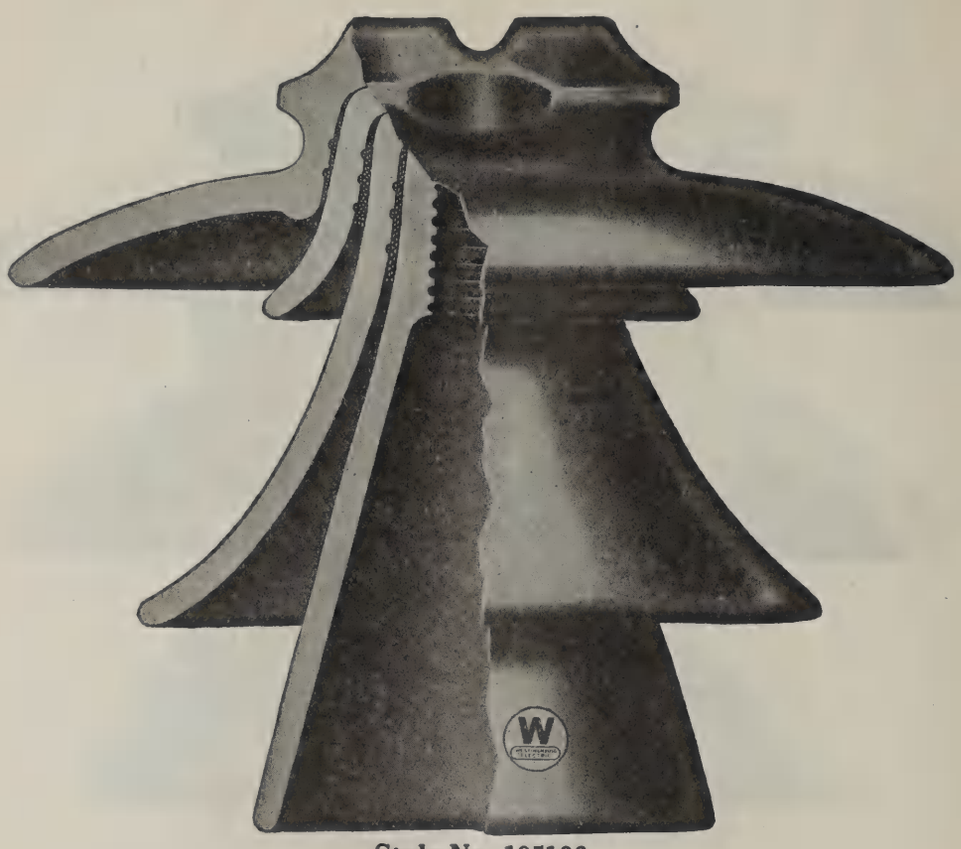
Trade voltage rating	**50000**
Dry arc-over voltage	160000
Wet arc-over voltage	100000
Leakage distance, inches	26½
Wet arcing distance, inches	8¼
Diameter of insulator, inches	12
Height of insulator, inches	9¼
Diameter of top groove, inches	1
Size of pin hole, inches	1⅜
Approximate net weight per 100 in pounds	2800
Approximate weight packed per 100 in pounds	3600
Number per open crate	3

Use 1⅜-inch pin with height above arm 11 inches.

List price per 100 ..... **$805 00**

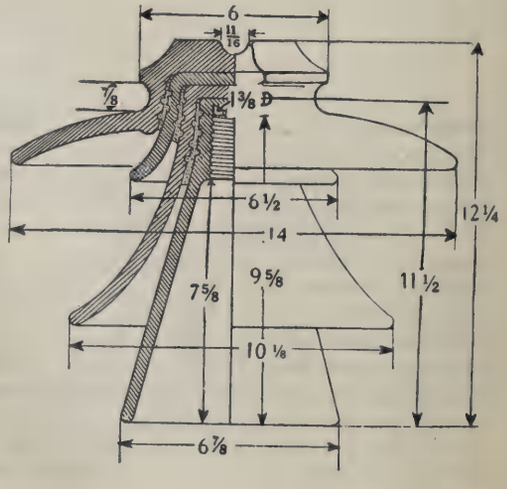


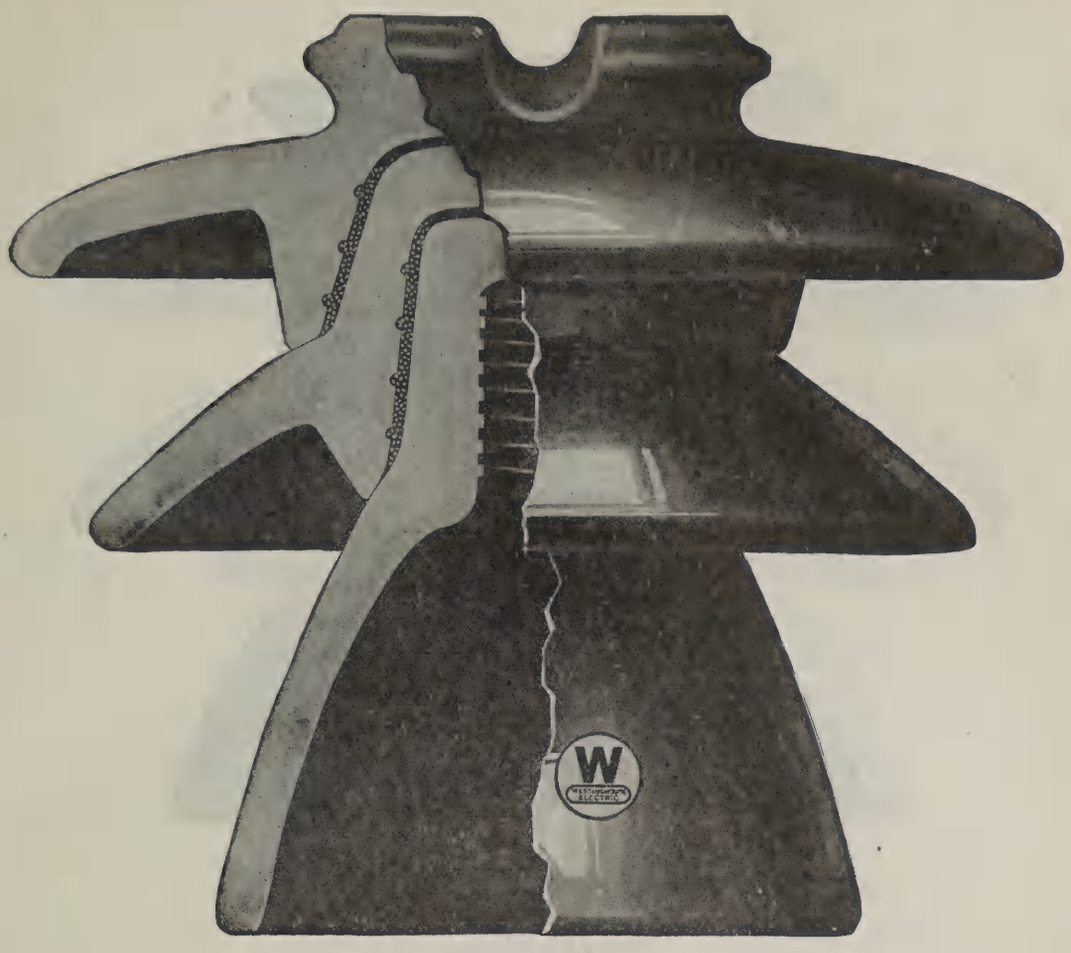
PORCELAIN PIN-TYPE INSULATORS—Continued



Style No. 195186

Trade voltage rating	60000
Dry arc-over voltage	165000
Wet arc-over voltage	110000
Leakage distance, inches	42
Wet arcing distance, inches	10
Diameter of insulator, inches	14
Height of insulator, inches	12¼
Diameter of top groove, inches	11/16
Size of pin hole, inches	1⅜
Approximate net weight per 100 in pounds	2500
Approximate weight packed per 100 in pounds	3600
Number per crate	3
Use 1⅜-inch pin with height above arm 13 inches.	
List price per 100	$800 00





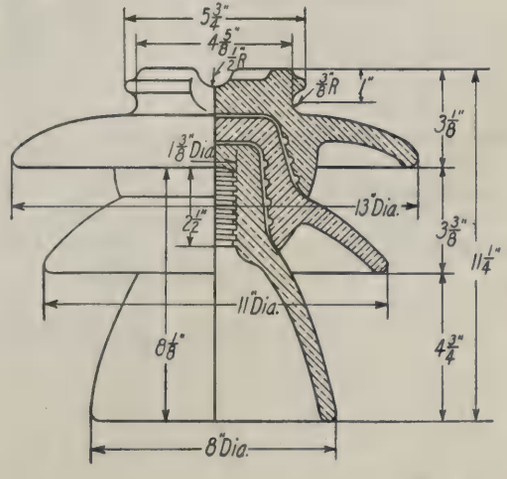
TRADE **FARADOID** MARK

PATENTED

LIGHT-TYPE

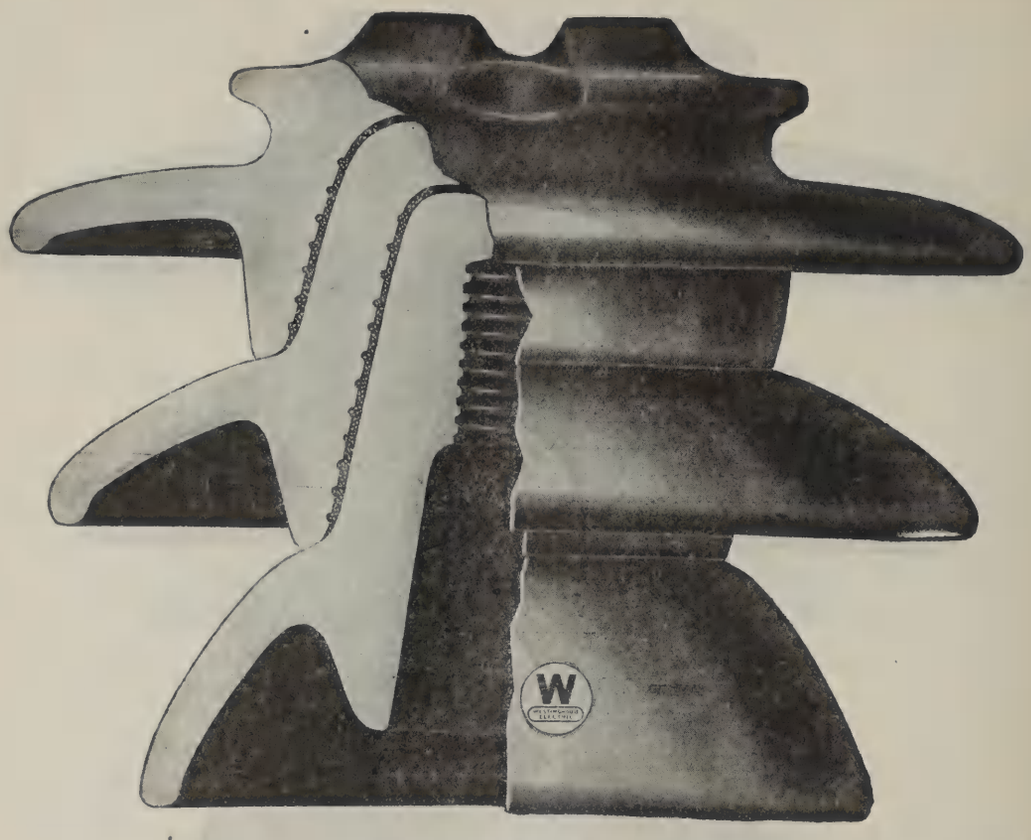
No. 3-55½

Manufacturer's voltage rating	**60000**
Dry arc-over voltage	180000
Wet arc-over voltage	115000
Leakage distance, inches	30
Wet arcing distance, inches	9¼
Diameter of insulator, inches	13
Height of insulator, inches	11¼
Diameter of top groove, inches	1
Size of pin hole, inches	1⅜
Approximate net weight per 100 in pounds	2700
Approximate weight packed per 100 in pounds	3700
Number per crate	3
Use 1⅜-inch pin with height above arm 12 inches.	
List price per 100	**$795 00**



845-100A

PORCELAIN PIN-TYPE INSULATORS—Continued



TRADE **FARADOID** MARK

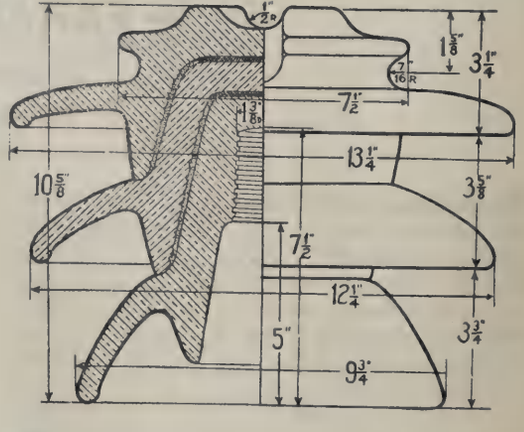
PATENTED

No. 3-55

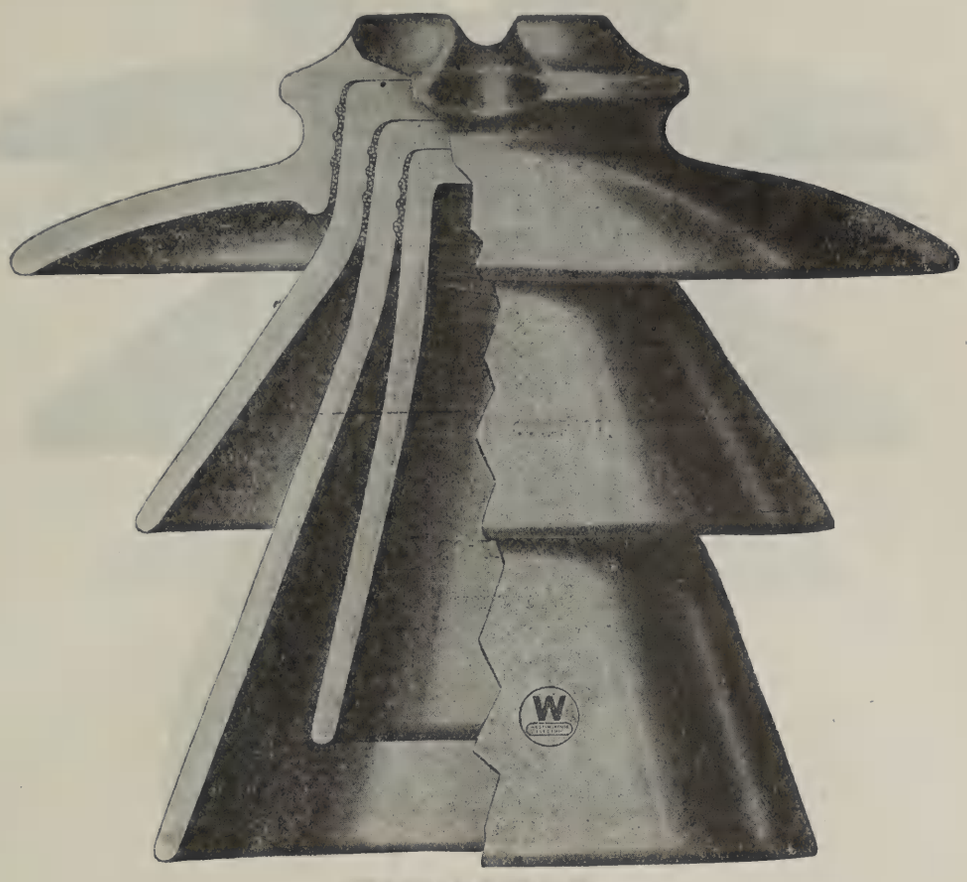
Trade voltage rating	60000
Dry arc-over voltage	185000
Wet arc-over voltage	117000
Leakage distance, inches	30½
Wet arcing distance, inches	9½
Diameter of insulator, inches	13¼
Height of insulator, inches	10⅝
Diameter of top groove, inches	1
Size of pin hole, inches	1⅜
Approximate net weight per 100 in pounds	3800
Approximate weight packed per 100 in pounds	4800
Number per open crate	3

Use 1⅜-inch pin with height above arm 12 inches.

List price per 100 ..... $925 00

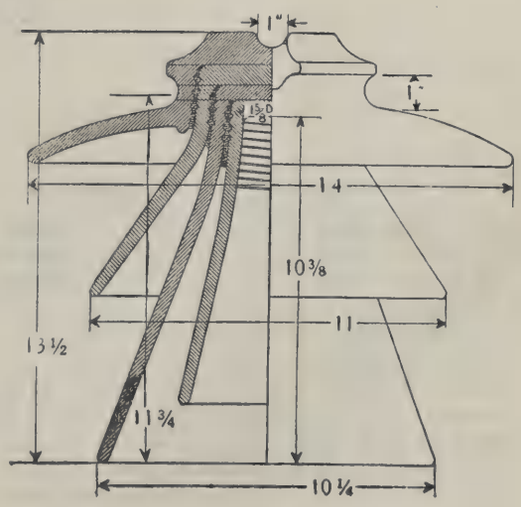


PORCELAIN PIN-TYPE INSULATORS—Continued

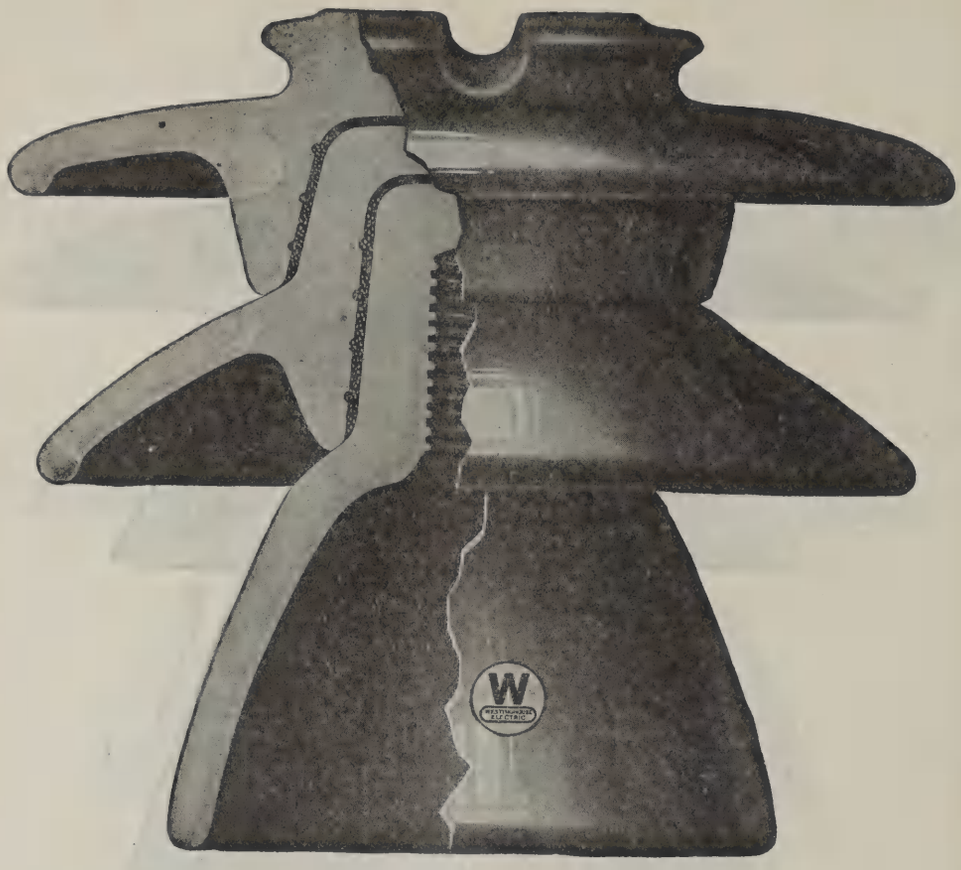


Style No. 195190

Trade voltage rating	66000
Dry arc-over voltage	183000
Wet arc-over voltage	122000
Leakage distance, inches	56
Wet arcing distance, inches	10½
Diameter of insulator, inches	14
Height of insulator, inches	13½
Diameter of wire grooves, inches	1
Size of pin hole, inches	1⅝
Approximate net weight per 100 in pounds	3400
Approximate weight packed per 100 in pounds	4850
Number per crate	3
Use 1⅝-inch pin with height above arm 15 inches.	
List price per 100	$1080 00



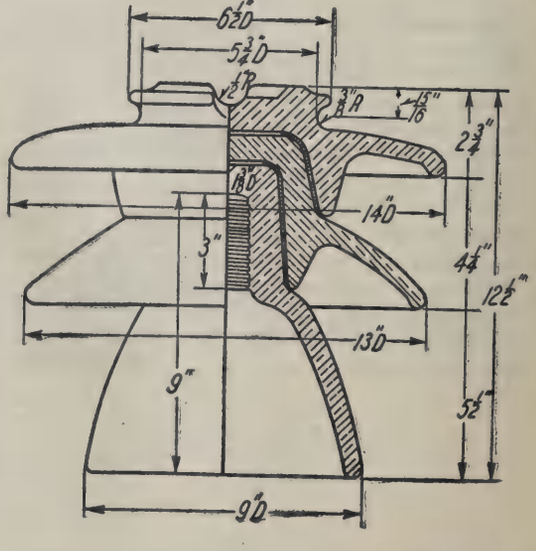
PORCELAIN PIN-TYPE INSULATORS—Continued



TRADE **FARADOID** MARK
PATENTED

LIGHT-TYPE

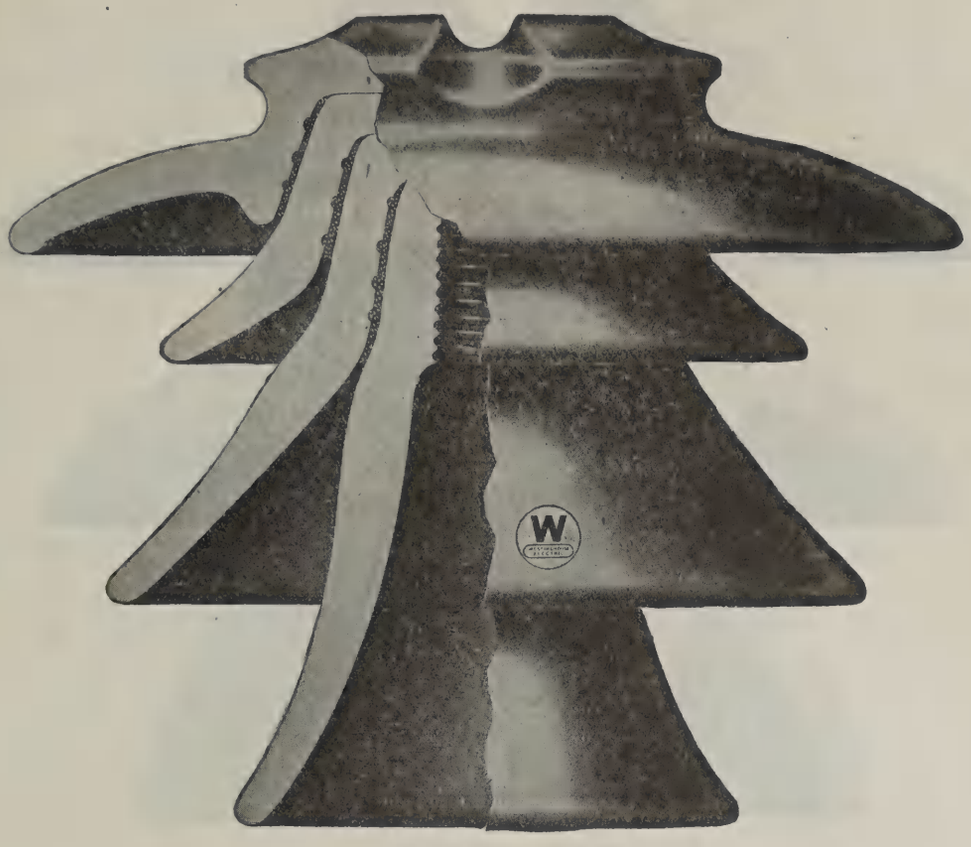
No. 3-66½



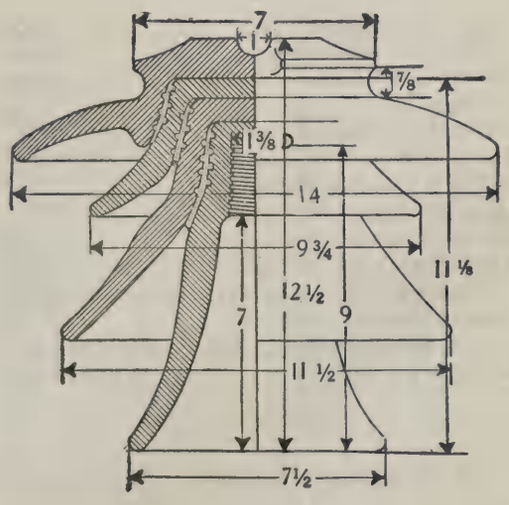
Trade voltage rating	70000
Dry arc-over voltage	195000
Wet arc-over voltage	130000
Leakage distance, inches	35
Wet arcing distance, inches	11
Diameter of insulator, inches	14
Height of insulator, inches	12½
Diameter of top groove, inches	1
Size of pin hole, inches	1⅜
Approximate net weight per 100 in pounds	3800
Approximate weight packed per 100 in pounds	4800
Number per crate	3
Use 1-inch pin with height above arm 13 inches.	
List price per 100	$875 00

845-101A

PORCELAIN PIN-TYPE INSULATORS—Continued

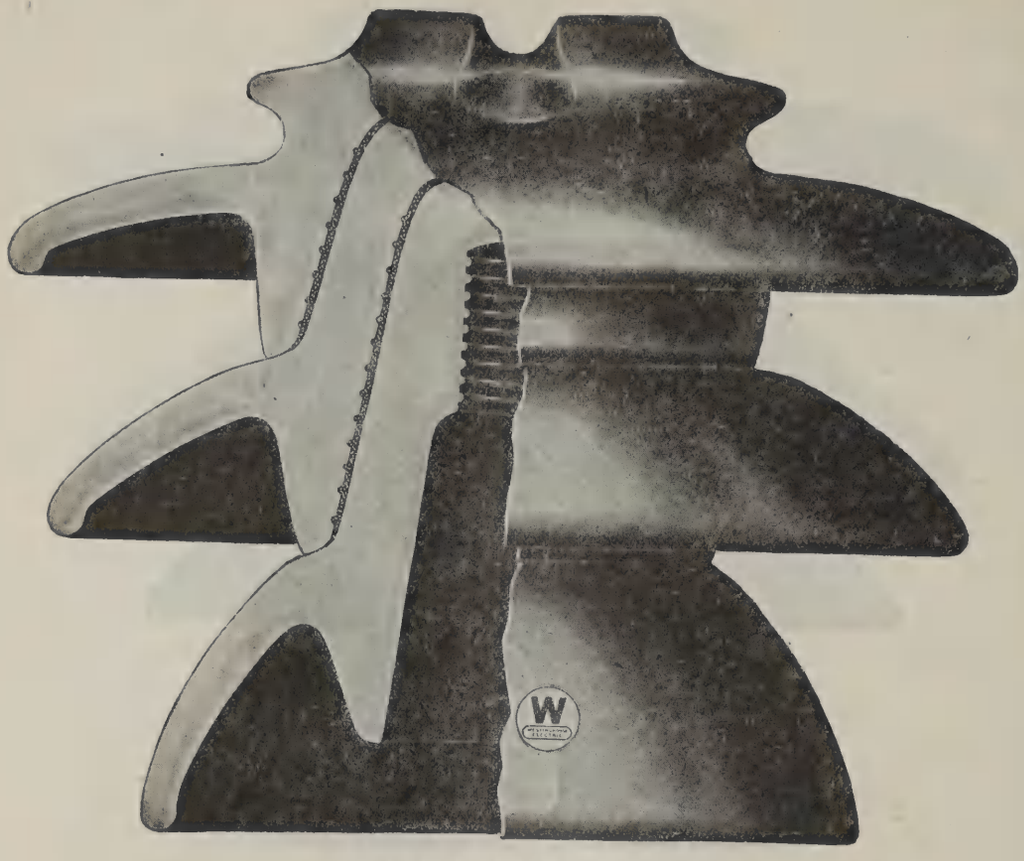


Style No. 195191



Trade voltage rating	**70000**
Dry arc-over voltage	170000
Wet arc-over voltage	120000
Leakage distance, inches	39½
Wet arcing distance, inches	10½
Diameter of insulator, inches	14
Height of insulator, inches	12½
Diameter of top groove, inches	1
Size of pin hole, inches	1⅜
Approximate net weight per 100 in pounds	3700
Approximate weight packed per 100 in pounds	4850
Number per crate	3
Use 1⅜-inch pin with height above arm 13 inches.	
List price per 100	$1130 00

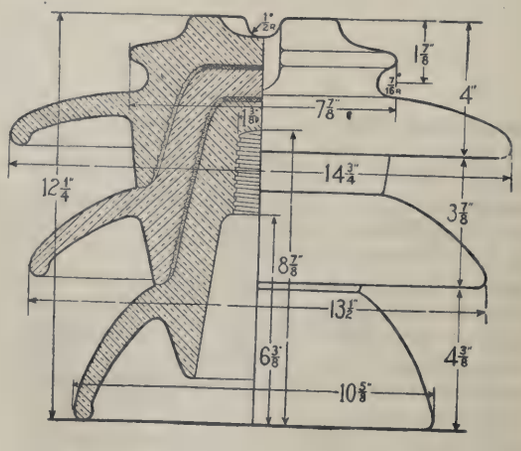
PORCELAIN PIN-TYPE INSULATORS—Continued



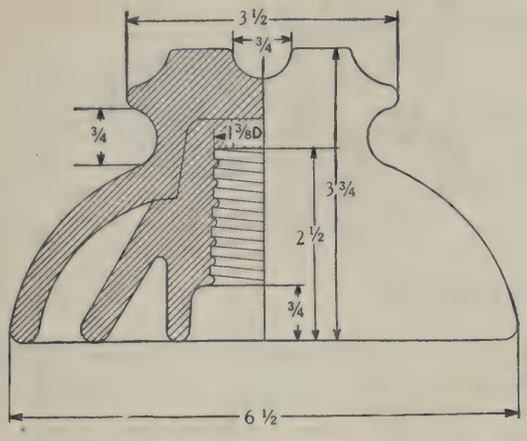
TRADE **FARADOID** MARK
PATENTED

No. 3-66

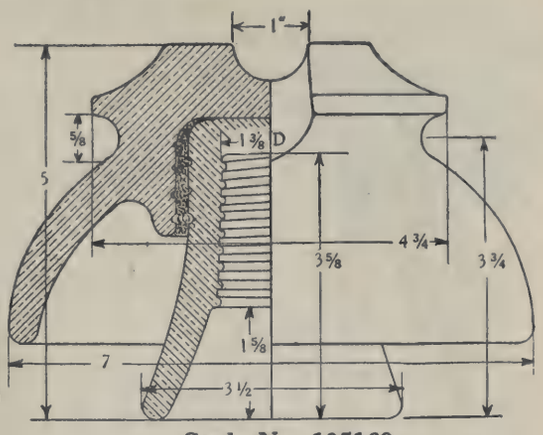
Trade voltage rating	**70000**
Dry arc-over voltage	205000
Wet arc-over voltage	135000
Leakage distance, inches	36
Wet arcing distance, inches	10½
Diameter of insulator, inches	14¾
Height of insulator, inches	12¼
Diameter of top groove, inches	1
Size of pin hole, inches	1⅜
Approximate net weight per 100 in pounds	4800
Approximate weight packed per 100 in pounds	5800
Number per open crate	3
Use 1⅜ inch pin with height above arm 14 inches.	
List price per 100	$1360 00



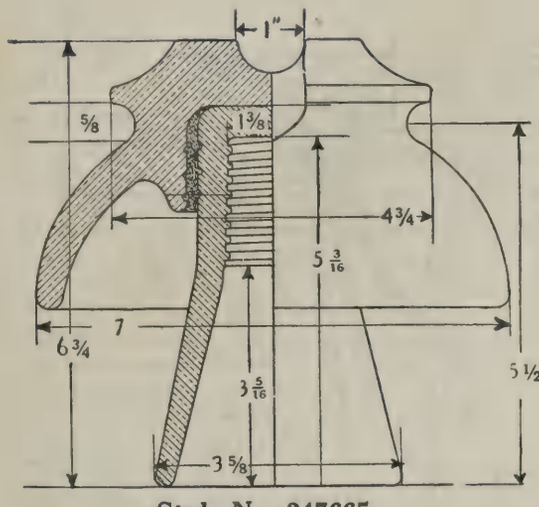
PORCELAIN PIN TYPE INSULATORS—Continued



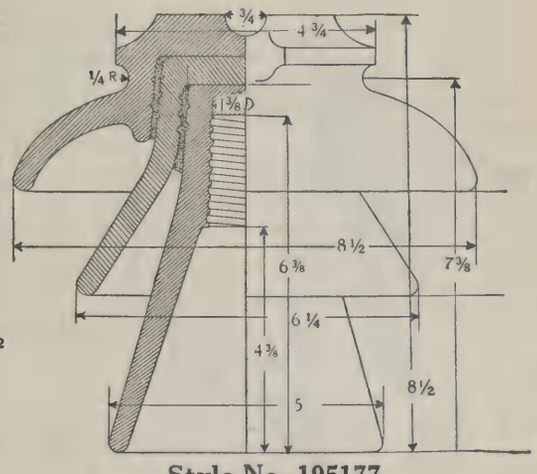
Style No. 195166



Style No. 195169



Style No. 247665

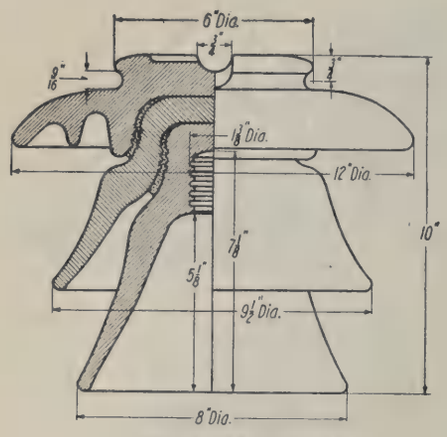


Style No. 195177

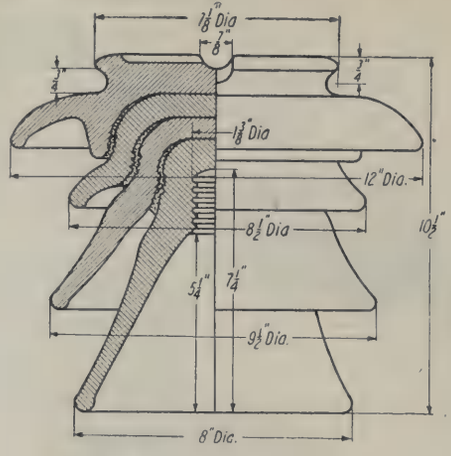
Style No.	195166	195169	247665	195177
Trade voltage rating	13500	20000	27000	35000
Dry arc-over voltage	60000	74000	82000	105000
Wet arc-over voltage	27000	37000	40000	70000
Leakage distance, inches	12	11½	14½	22¼
Wet arcing distance, inches	2⅝	3¼	3½	5½
Diameter of insulator, inches	6½	7	7	8½
Height of insulator, inches	3¾	5	6¾	8½
Diameter of wire grooves, inches	¾	1	1	¾
Size of pin hole, inches	1⅜	1⅜	1⅜	1⅜
Approximate net weight per 100 in pounds	400	500	500	900
Approximate weight packed per 100 in pounds	465	700	760	1200
Number per barrel	45	60	48	6*
Use 1⅜-inch pin with height above arm	6 inches	5½ inches	8 inches	8½ inches
List price per 100	$114 00	$141 00	$151 00	$262 00

*Number per crate.¶

PORCELAIN PIN TYPE INSULATORS—Continued



Style No. 259347



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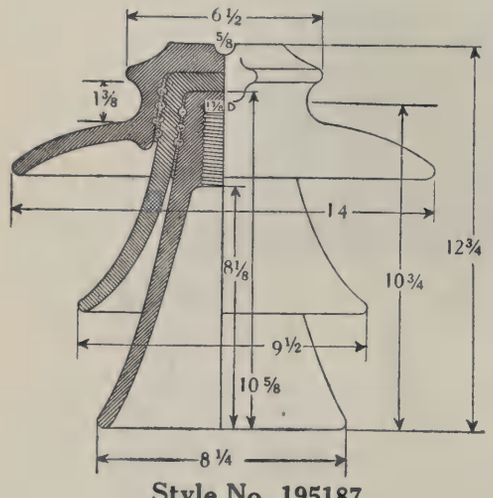
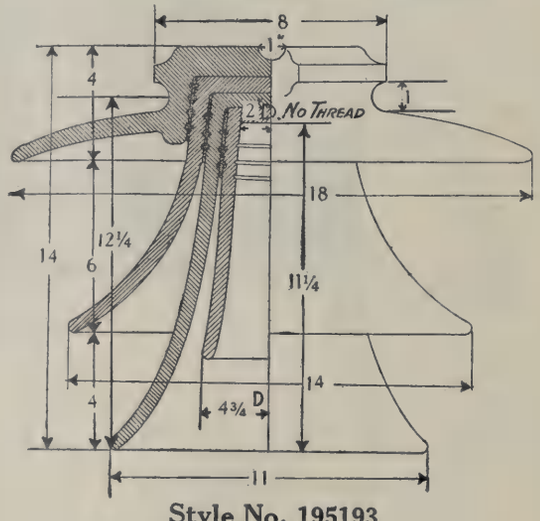


Style No. 195187



Style No. 195193

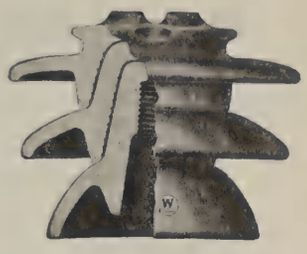
Style No.	259347	259346	195187	195193
Trade voltage rating	**55000**	**55000**	**60000**	**70000**
Dry arc-over voltage	150000	150000	170000	180000
Wet arc-over voltage	110000	110000	124000	132000
Leakage distance, inches	28½	30½	38	62
Wet arcing distance, inches	8¼	8½	10	13¾
Diameter of insulator, inches	12	12	14	18
Height of insulator, inches	10	10½	12¾	14
Diameter of top groove, inches	¾	⅞	⅝	1
Size of pin hole, inches	1⅜	1⅜	1⅜	2
Approximate net weight per 100 in pounds	2500	3000	2600	5200
Approximate weight packed per 100 in pounds	3500	4000	3100	6800
Number per crate	3	3	3	3
Use 1⅜-inch pin with height above arm	11 inches	11 inches	15 inches	18 inches
List price, per 100	$670 00	$854 00	$665 00	$1255 00

TRADE **FARADOID** MARK

PATENTED

HEAVY-TYPE

INSULATORS



11,000 to 66,000 Volts

A study of present commercial types of insulators indicates that most of them have been designed with some definite characteristics predominating while other characteristics have been sacrificed. One design has high puncturing strength, another high surface leakage, etc. As a result, the weaker characteristics have been a cause of failure in service.

In the design of this line of high efficiency pin type insulators, each characteristic which would vitally affect durability in service has been given a degree of uniformity that has not been obtained hitherto. This has been due to a lack of appreciation on the part of the insulator manufacturers, who were not familiar with the principles now used in these insulators, the design of which is based on a thorough knowledge of the dielectric field.

Improvements to be Found in "Faradoid" Insulators

Briefly stated, the advantages of the "Faradoid" type over the older commercial types in resisting failure in service are as follows:

1. When the insulator is dry, the corona and static formations are practically limited to the tie wire and line wire up to flash over voltage.

2. When the insulator is wet, no corona or static formation occurs up to flash over voltage. The flash over voltages for given overall dimensions are thereby increased.

3. The leakage resistance per shell is increased gradually from the head to the center shell. This takes into account the probability of the lower sheds becoming dirtier than the tops. The voltage distribution per shell is, therefore, equal when the insulator becomes dirty and wet and a heavy leakage current passes over the insulator.

4. Since the capacity per shell is about equal, the voltage distribution per shell will be equal when the insulator is clean and in dry air.

5. Since the distribution of voltage per shell depends upon the capacity current and leakage current, the distribution of voltage per shell in these designs should be approximately equal under all operating conditions.

6. The resistance of the insulator to side pull for a given weight and given electrical strength is relatively high. This is due to the feature of the design whereby the flow lines of the electrostatic field and the mechanical stress lines coincide.

7. The design of the individual shells is such that when they are tested before assembly the surface conforms to the electrostatic flow lines. This allows testing of the individual parts to a higher percentage of service voltage than was possible in case of the individual shells of older designs.

8. Due to the shape of individual parts and of the assembled unit, the insulator sheds when hit by stones, rifles, balls, etc., do not break beyond the insulating surface. The unit, therefore, offers a considerable percentage of its original resistance to flash over after the sheds are broken. The same feature tends to protect the insulator from complete failure during flashover in service.

TRADE **FARADOID** MARK

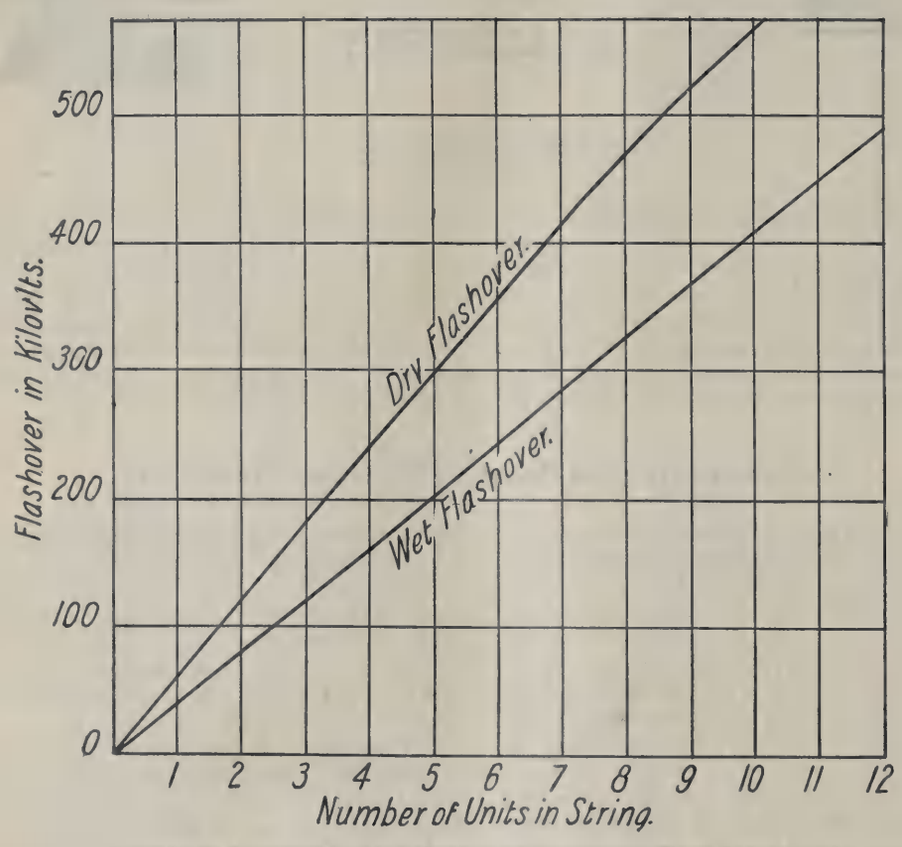
PATENTED

LIGHT-TYPE

INSULATORS

For characteristics of these insulators see their respective pages in this catalogue.

PORCELAIN SUSPENSION-TYPE INSULATORS

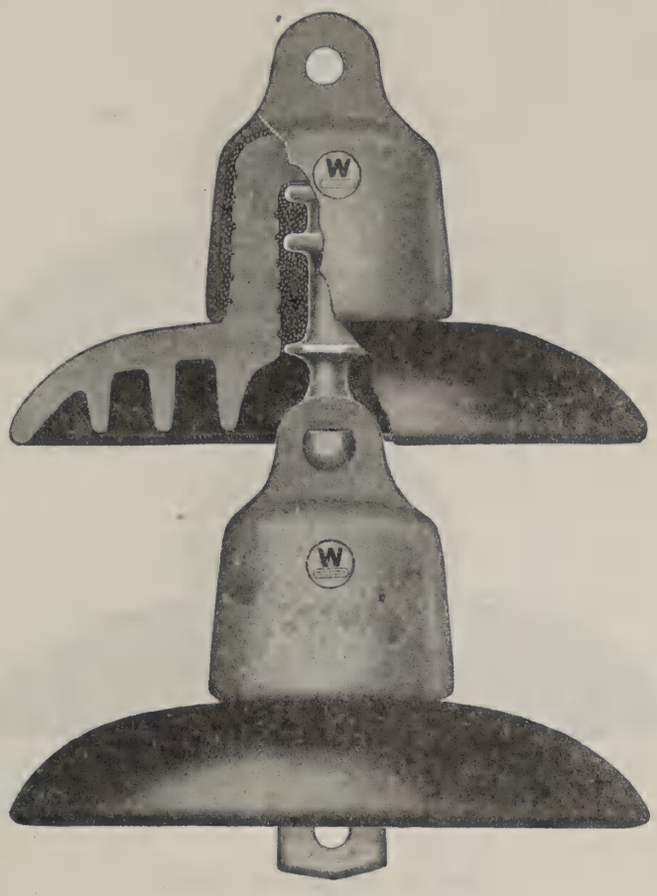


TYPICAL FLASHOVER VOLTAGE CURVES OF SUSPENSION-TYPE INSULATORS IN STRINGS UP TO TWELVE UNITS IN SERIES

Suspension insulators are almost universally used on lines with voltages above 66,000. They are made to assemble in strings, each unit increasing the flash over voltages as indicated. There is no set rule as to how many units should be used for a given voltage, some companies using 8 units per string at 110,000 volts, others 8 units per string at 66,000 volts. There are lines in operation at 150,000 volts having only 9 units per string. The number of units per string in an installation should be based on a careful analysis of type of construction, local climatic conditions, etc.

The suspension insulators listed on the following pages are so designed and assembled that severe temperature changes will not injuriously stress the porcelain.

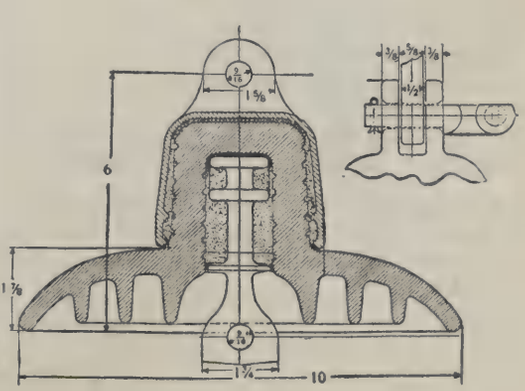
PORCELAIN SUSPENSION TYPE INSULATORS



Two of Style No. 237219

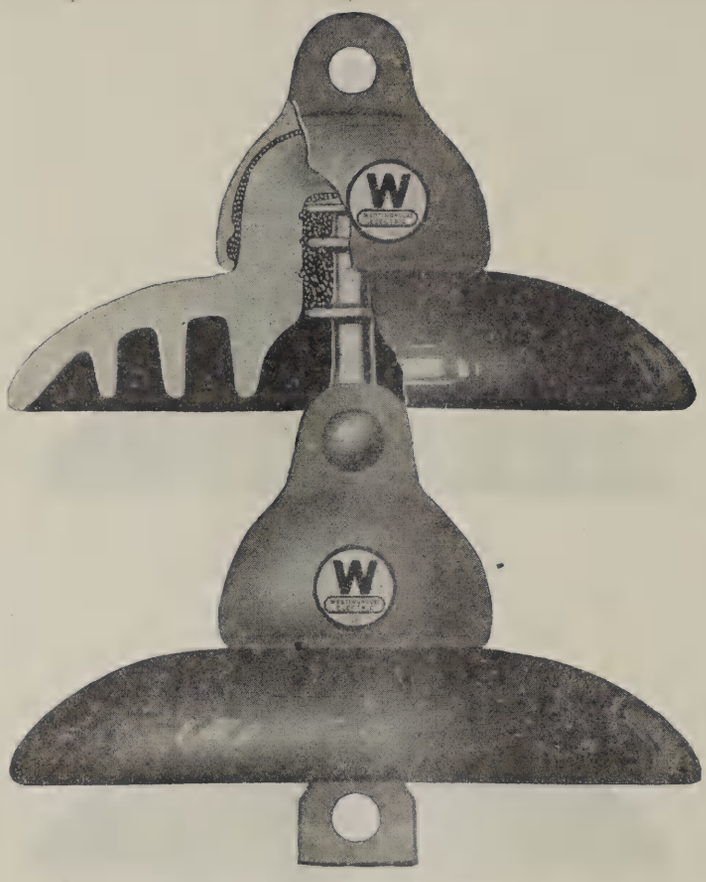
Trade Voltage Rating per unit	**20000**
Dry arc-over voltage	73000
Wet arc-over voltage	45000
Leakage distance, inches	13½
Wet arcing distance, inches	4¼
Diameter of insulator, inches	10
Distance between centers of eyes, inches	6
Approximate net weight per 100 in pounds	1050
Approximate weight packed per 100 in pounds	1355
Number per barrel	15
Style No. of one unit	**237219**
List price per 100 units	**$404 00**

For suspension clamps and links see Pole-line Hardware Section. These insulators will be crated in assembled strings of from two to eight units if so ordered.



845-63A

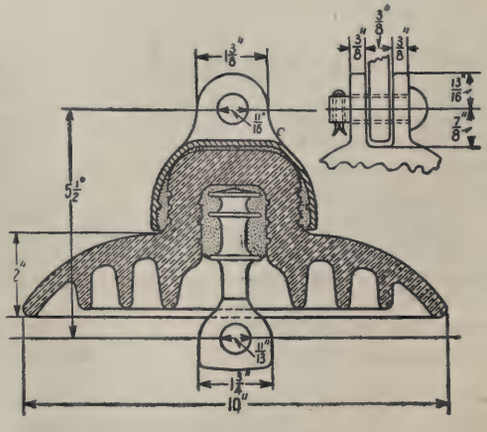
PORCELAIN SUSPENSION TYPE INSULATORS—Continued



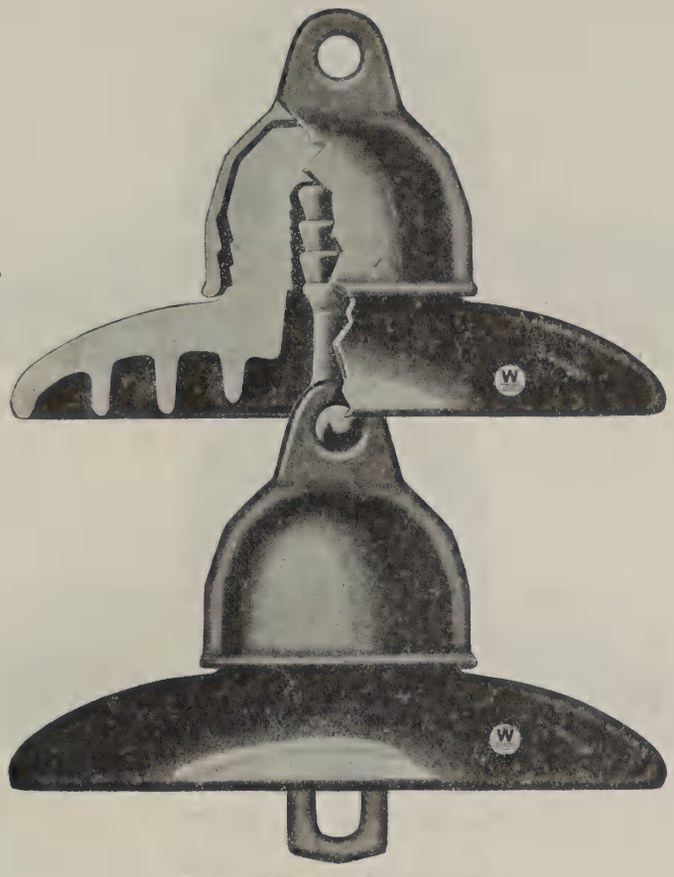
Two of Style No. 244649

Trade Voltage Rating per unit	**20000**
Dry arc-over voltage	73000
Wet arc-over voltage	45000
Leakage distance, inches	13½
Wet arcing distance, inches	4¼
Diameter of insulator, inches	10
Distance between centers of eyes, inches	5½
Approximate net weight per 100 in pounds	950
Approximate weight packed per 100 in pounds	1300
Number per barrel	15
Style No. of one unit	**244649**
List price per 100 units	**$404 00**

For suspension clamps and links see Pole-line Hardware Section. These insulators will be crated in assembled strings of from two to eight units if so ordered.

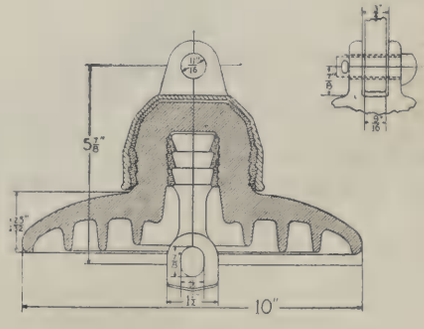


PORCELAIN SUSPENSION-TYPE INSULATORS—Continued

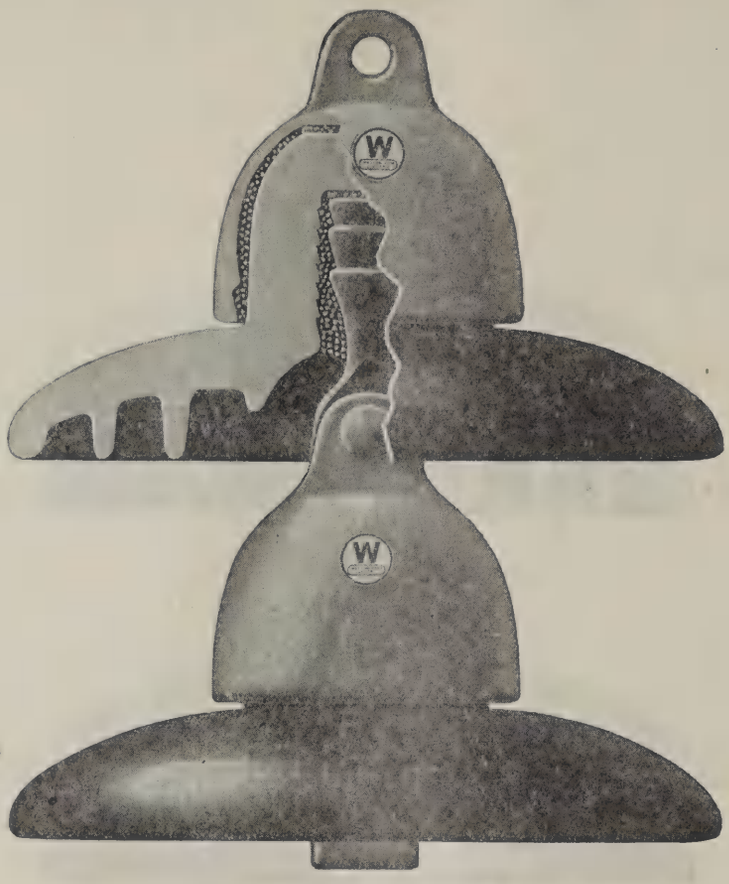


Two of Style No. 255973

Trade Voltage Rating per unit	**20000**
Dry arc-over voltage	80000
Wet arc-over voltage	48000
Leakage distance, inches	13½
Wet arcing distance, inches	4¼
Diameter of insulator, inches	10
Distance between center of eyes, inches	6
Approximate net weight per 100 in pounds	1050
Approximate weight packed per 100 in pounds	1355
Packed—3, 4, 5. or 6 per crate as desired.	
Style No. of one unit	**255973**
List price per 100 units	$404 00

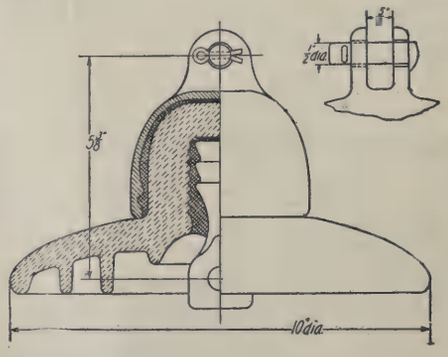


PORCELAIN SUSPENSION TYPE INSULATORS—Continued

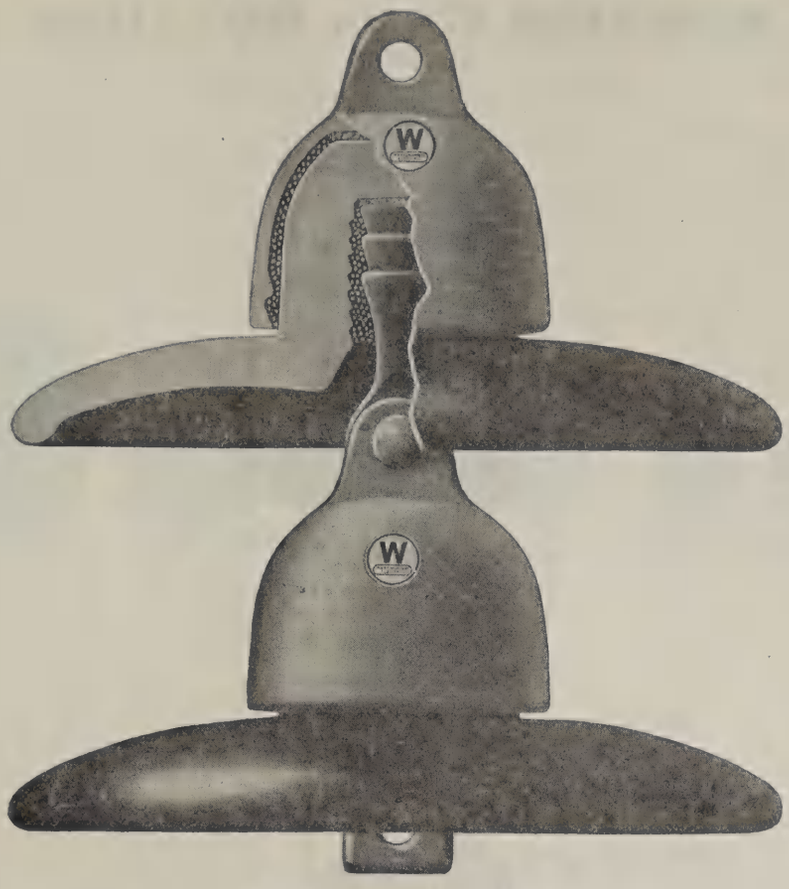


Two of Style No. 286270

Trade voltage rating per unit	**20000**
Dry arc-over voltage	80000
Wet arc-over voltage	48000
Leakage distance, inches	13
Wet arcing distance, inches	4¼
Diameter of insulator, inches	10
Distance between center of eyes, inches	5⅜
Approximate net weight per 100 in pounds	1050
Approximate weight packed per 100 in pounds	1355
Packed—3, 4, 5, or 6 per crate as desired.	
Style No. of one unit	286270
List price per 100 units	$404 00

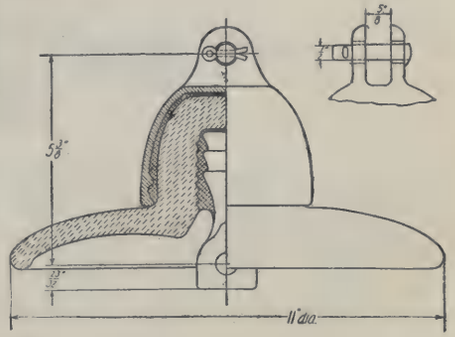


PORCELAIN SUSPENSION TYPE INSULATORS—Continued

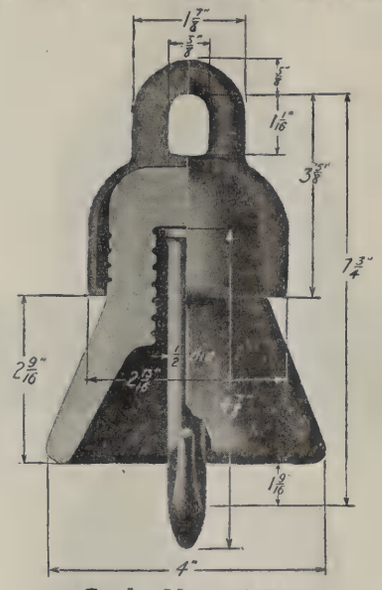


Two of Style No. 290452

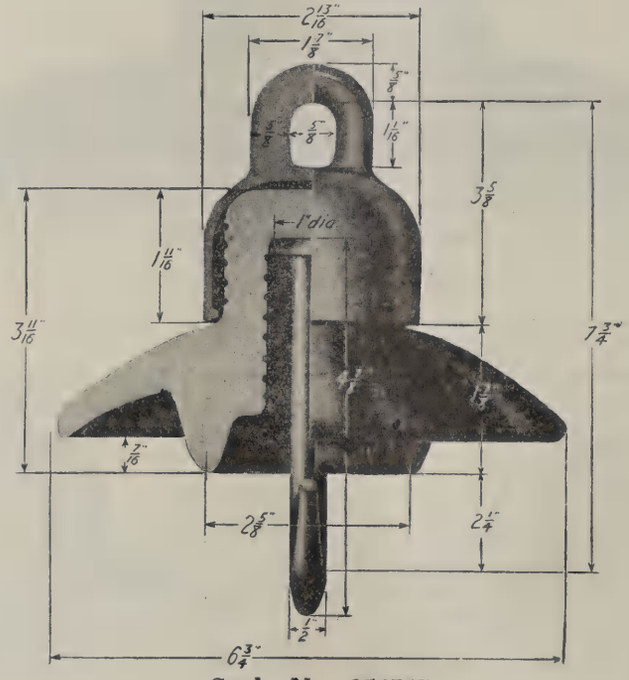
Trade voltage rating per unit	**20000**
Dry arc-over voltage	75000
Wet arc-over voltage	45000
Leakage distance, inches	9½
Wet arcing distance, inches	5
Diameter of insulator, inches	11
Distance between center of eyes, inches	5⅜
Approximate net weight per 100 in pounds	1050
Approximate weight packed per 100 in pounds	1355
Packed—3, 4, 5, or 6 per crate as desired.	
Style No. of one unit	290452
List price per 100 units	$390 00



SUSPENSION STRAIN INSULATORS



Style No. 254746



Style No. 254747

Style No.	254746	254747
Line voltage	8800	11,000
Dry arc-over voltage	49,000	63,000
Wet arc-over voltage	19,000	23,000
Leakage distance in inches	5	7
Wet arcing distance in inches	1	2 7/8
Package quantity	70	30
Approximate net weight, pounds, per 100	375	500
Gross weight, pounds, per 100	500	700
List price per 100	$181 00	$255 00

844-4A

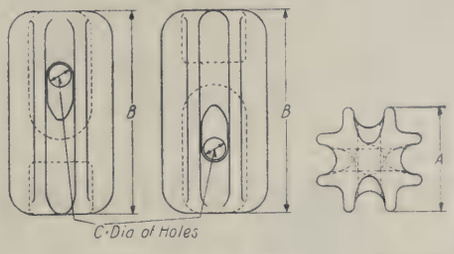
PORCELAIN STRAIN INSULATORS

FOR HIGH-VOLTAGE SERVICE

Westinghouse porcelain strain insulators are made of a grade of porcelain much superior to that ordinarily used for such appliances. The glaze is of a mahogany color so that the insulators do not readily attract attention, sharp corners that would be apt to chip have been avoided and the shape of the grooves is such that the wires lie naturally in them. Large creepage distance between cables is provided.

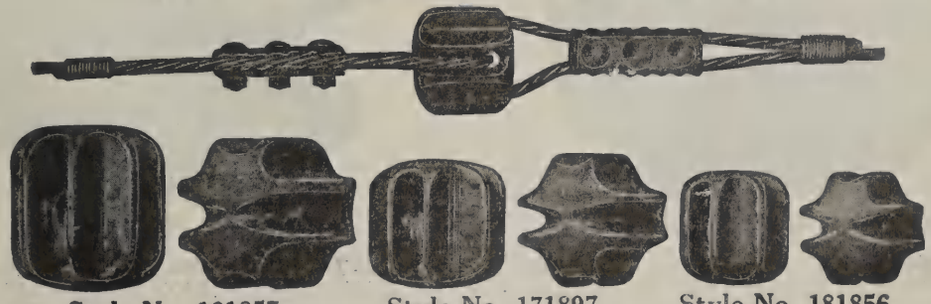
Type PS—Wet Process—Patented September 22, 1914

Style No. 237022 Style No. 237021 Style No. 237020

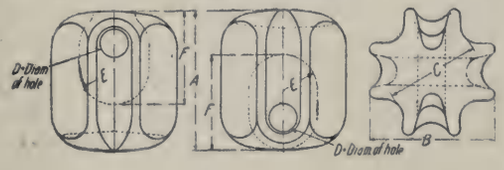


Style No.	Line Voltage	Dry Arcover Voltage	—Dimensions, Inches— A	B	C	No. Per Bbl.	Per 100 Net Wt., Lbs.	Wt. Packed Lbs.	List Price
237020	2400	32000	2½	3½	9/16	300	100	120	$31 25
237021	4400	42000	3¼	5⅜	9/16	125	250	298	62 50
237022	6600	52000	3½	6¾	¾	75	350	428	77 50
249392	6600	52000	3½	6¾	1	75	400	468	77 50

Type PG—Dry Process—Patented September 22, 1914



Style No. 181857 Style No. 171897 Style No. 181856

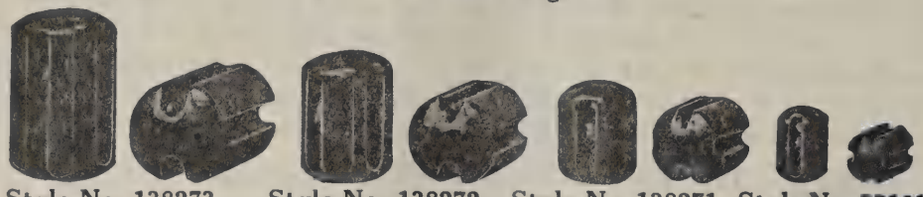


Style No.	Line Voltage	Dry Arcover Voltage	—Dimensions, Inches— A	B	D	No. Per Bbl.	Per 100 Net Wt., Lbs.	Wt. Packed, Lbs.	List Price
181856	2400	20,000	3⅜	3¼	½	200	150	180	$31 25
171897	3300	20,000	3⅞	4	⅝	150	225	310	62 50
181857	3300	20,000	5	4½	1	90	365	465	77 50

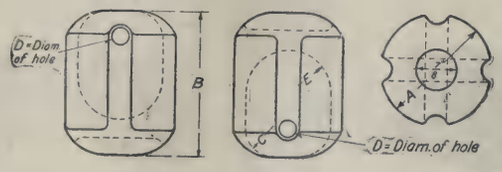
FOR LOW-VOLTAGE SERVICE

Type P-2—Dry Process

The entire surface is glazed.



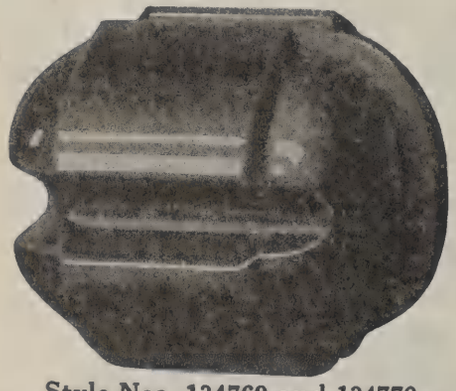
Style No. 138273 Style No. 138272 Style No. 138271 Style No. 229096



Style No.	Line Voltage	Dry Arcover Voltage	Dimensions, Inches A	B	C	D	E	No. Per Bbl.	Per 100 Weight Packed, Lbs.	Per 100 Net Weight, Lbs.	List Price
229096	550	14,000	$1\frac{7}{16}$	$2\frac{1}{4}$	$\frac{1}{2}$ R	$\frac{5}{16}$	$\frac{3}{4}$R	1100	31	25	$ 8 80
138271	750	20,000	$2\frac{3}{8}$	$3\frac{1}{8}$	$\frac{5}{8}$ R	$\frac{3}{8}$	$\frac{15}{16}$R	450	88	75	14 70
138272	750	20,000	$2\frac{3}{4}$	$3\frac{1}{2}$	$\frac{3}{4}$ R	$\frac{1}{2}$	$1\frac{1}{16}$R	225	151	125	18 00
138273	750	20,000	$3\frac{1}{4}$	$5\frac{1}{4}$	$\frac{7}{8}$ R	$\frac{3}{4}$	$1\frac{1}{4}$R	125	320	250	37 35

CIRCUIT BREAK INSULATORS

750 VOLTS



Style Nos. 134769 and 134770

Style No. 254745

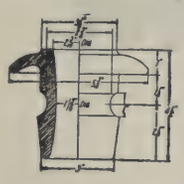
Style No.	134769	134770	254745
Dry arcover voltage	15,000	17,000	25,000
Diameter	$2\frac{3}{16}$	$2\frac{5}{8}$	$3\frac{1}{4}$
Height	$2\frac{1}{2}$	$3\frac{1}{4}$	5
Diameter of groove	$\frac{7}{16}$	$\frac{5}{8}$	1
Package quantity	500	300	125
Approximate net weight per 100 in pounds	75	125	225
Gross weight, pounds, per 100	87	145	273
List price per 100	$8 75	$13 15	$26 40

PORCELAIN PIN-TYPE STRAIN INSULATORS

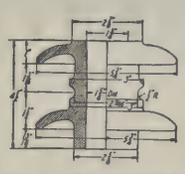
FOR VOLTAGES 6600 to 22000

High-voltage porcelain strain insulators are used at corners, curves, dead-ends, and similar points in transmission lines where the stress is too heavy for the ordinary pin-type insulator.

On extremely high voltages these insulators may be used in series and in case of exceptionally heavy stresses they can be installed in multiple.



Style No. 195194



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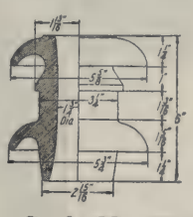

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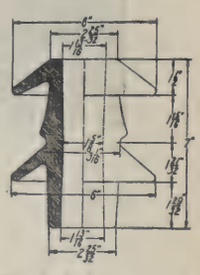

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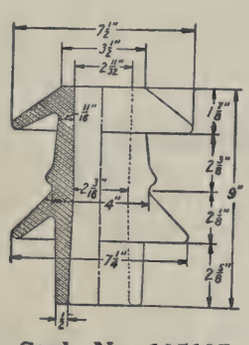
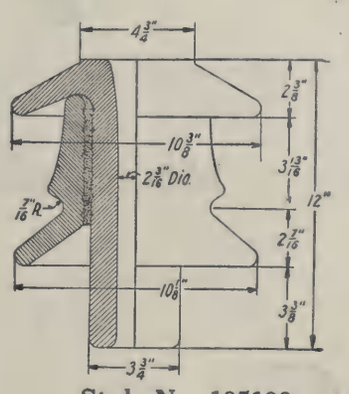


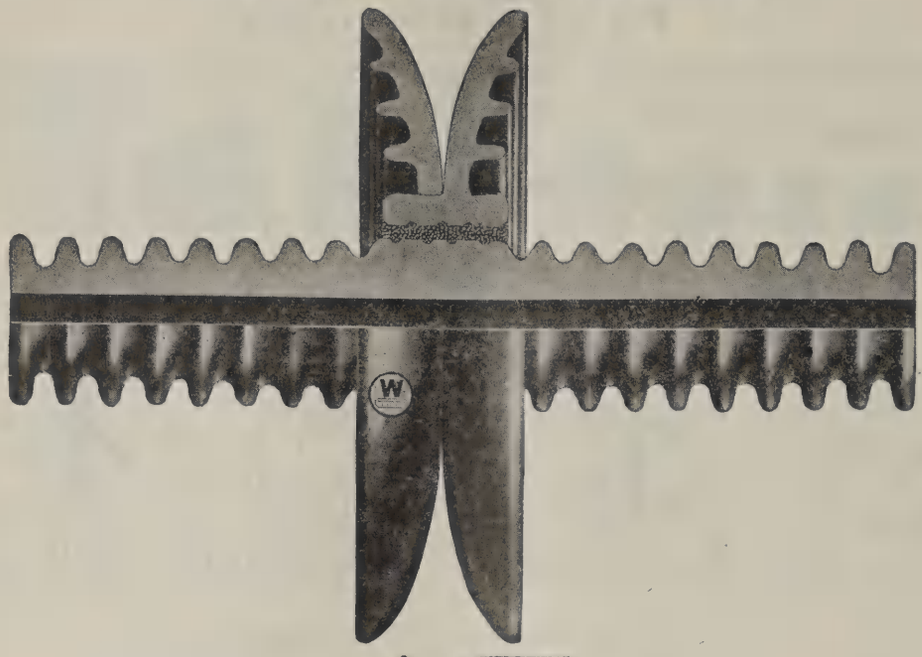
Style No. 195197

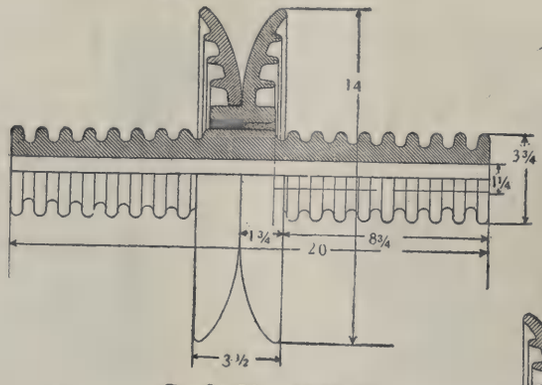


Style No. 195198

Style No.	Voltage: Line	Voltage: Dry Arcover	Voltage: Wet Arcover	Leakage Distance Inches	Wet Arcing Distance Inches	Package Quantity	Per 100: Approx. Wt., Lbs. Net	Per 100: Approx. Wt., Lbs. Packed	List Price
195194	6600	26000	13000	2	...	50	250	370	$200 00
195195	7500	35000	16000	5	1	50	275	395	281 00
68221	10000	44000	20000	5½	1½	25	450	690	349 00
195196	11000	49000	23000	6½	2	20	500	800	511 00
195197	15000	55000	30000	8	3	10	800	1400	575 00
195198	22000	67000	44000	11	3¾	2	1925	4925	1175 00

PORCELAIN WALL BUSHINGS





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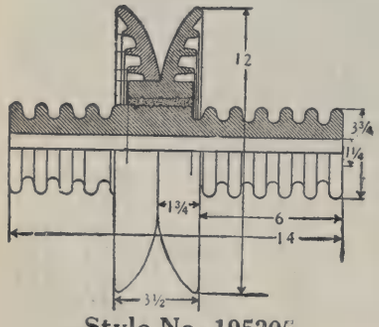

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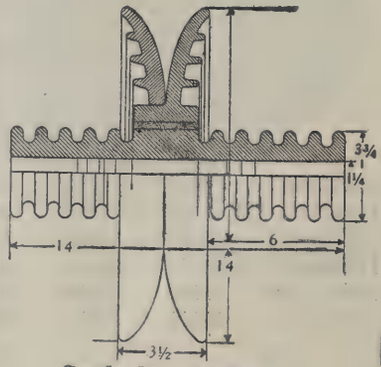
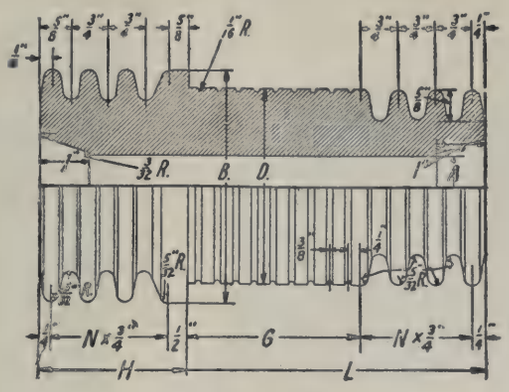


Style No. 195206

	Style No. 195205	Style No. 195206	Style No. 195207
Line Voltage	20000	23500	25000
Dry arc-over voltage	62000	66000	70000
Leakage distance, inches	17	20	24
Diameter of insulator, inches	12	14	14
Length of insulator, inches	14	14	20
Diameter of wire hole, inches	1¼	1¼	1¼
Approximate net weight per 100 in pounds	2300	2700	3400
Approximate weight packed per 100 in pounds	4650	5150	9700
Number per barrel	2	2	1
List price per 100	$1061 00	$2332 00	$3850 00

PORCELAIN WALL TUBES



OUTLINE DIMENSIONS

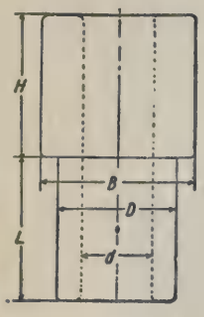
	Dimensions, Inches												
						Dimension G or Thickness of Wall for L Equal to							
Style No.	A	B	D	H	N	6	8	10	12	14	16	18	20	22
195248	1¼	4¾	4	3	3	3½	5½	7½	9½	11½	13½	....	....	..
195249	1¼	4¾	4	3¾	4	2¾	4¾	6¾	8¾	10¾	12¾	14¾	....	..
195250	1¼	4¾	4	4½	5	2	4	6	8	10	12	14	....	..
195251	1¼	4¾	4	6	7	...	2½	4½	6½	8½	10½	12½	14½	..
195252	1¼	4¾	4	7½	9	...	...	3	5	7	9	11	13	15
195253	1½	5	4¼	3	3	3½	5½	7½	9½	11½	13½	....	....	..
195254	1½	5	4¼	3¾	4	2¾	4¾	6¾	8¾	10¾	12¾	14¾	....	..
195255	1½	5	4¼	4½	5	2	4	6	8	10	12	14	....	..
195256	1½	5	4¼	6	7	...	2½	4½	6½	8½	10½	12½	14½	..
195257	1½	5	4¼	7½	9	...	...	3	5	7	9	11	13	15
195258	2	5½	4¾	3	3	3½	5½	7½	9½	11½	13½	....	....	..
195259	2	5½	4¾	3¾	4	2¾	4¾	6¾	8¾	10¾	12¾	14¾	....	..
195260	2	5½	4¾	4½	5	2	4	6	8	10	12	14	....	..
195261	2	5½	4¾	6	7	...	2½	4½	6½	8½	10½	12½	14½	..
195262	2	5½	4¾	7½	9	...	...	3	5	7	9	11	13	15
195263	2½	6	5¼	3	3	3½	5½	7½	9½	11½	13½	....	....	..
195264	2½	6	5¼	3¾	4	2¾	4¾	6¾	8¾	10¾	12¾	14¾	....	..
195265	2½	6	5¼	4½	5	2	4	6	8	10	12	14	....	..
195266	2½	6	5¼	6	7	...	2½	4½	6½	8½	10½	12½	14½	..
195267	2½	6	5¼	7½	9	...	...	3	5	7	9	11	13	15

PRICES (Per 100)

Style No.	L=6 in.	L=8 in.	L=10 in.	L=12 in.	L=14 in.	L=16 in.	L=18 in.	L=20 in.	L=22 in.
195248	$247 50	$292 50	$337 50	$562 50	$675 00	$787 50	.....	.....	.....
195249	270 00	315 00	360 00	585 00	697 50	810 00	978 75	.....	.....
195250	281 25	337 50	398 25	668 75	731 25	843 75	1012 50	.....	.....
195251	.....	371 25	596 25	708 75	821 25	990 00	1327 50	1777 50	.....
195252	.....	.....	675 00	787 50	900 00	1135 00	1575 00	2025 00	2700 00
195253	270 00	315 00	360 00	585 00	697 50	810 00	.....	.....	.....
195254	292 50	337 50	382 50	607 50	720 00	832 50	1001 25	.....	.....
195255	303 75	360 00	416 25	641 25	663 75	866 25	1035 00	.....	.....
195256	.....	393 75	618 75	731 25	843 75	1012 50	1200 00	1800 00	.....
195257	.....	.....	697 50	810 00	922 50	1147 50	1597 50	2047 50	2722 50
195258	292 50	337 50	382 50	607 50	630 00	832 50	.....	.....	.....
195259	315 00	360 00	405 00	630 00	782 50	855 00	1023 75	.....	.....
195260	326 25	382 50	438 75	663 75	776 25	888 75	1057 50	.....	.....
195261	.....	416 25	641 25	753 75	866 25	1035 00	1372 50	1822 50	.....
195262	.....	.....	720 00	832 50	945 00	1170 00	1620 00	2070 00	2745 00
195263	337 50	382 50	427 50	652 50	765 00	877 50	.....	.....	.....
195264	360 00	405 00	450 00	675 00	787 50	900 00	1068 75	.....	.....
195265	371 25	427 50	483 75	708 75	821 25	933 75	1102 50	.....	.....
195266	.....	461 25	686 25	798 75	911 25	1080 00	1417 50	.....	.....
195267	.....	.....	765 00	887 50	990 00	1215 00	1665 00	2115 00	2790 00

PORCELAIN FLOOR TUBES

OUTLINE DIMENSIONS



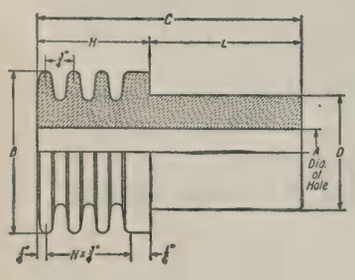
Style No.	Dimensions, Inches d	B	D	H	L*
195223	¾	2½	1¾	3	3, 4, 5, 6, 8, 10, 12, 14, or 16
195224	1	2¾	2	3	3, 4, 5, 6, 8, 10, 12, 14, or 16
195225	1¼	3	2¼	3	4, 5, 6, 8, 10, 12, 14, or 16
195226	1½	3¼	2½	3	5, 6, 8, 10, 12, 14, 16, or 18
195227	1¾	3½	2¾	3	6, 8, 10, 12, 14, 16, or 18
195228	2	3¾	3	3	6, 8, 10, 12, 14, 16, or 18
195229	2½	4½	3¾	3	6, 8, 10, 12, 14, 16, 18, or 20
195230	3	5	4¼	3	8, 10, 12, 14, 16, 18, 20, or 22
195231	3½	5½	4¾	3	8, 10, 12, 14, 16, 18, 20, 22, or 24
195232	¾	2½	1¾	4½	6, 8, 10, 12, 14, 16, or 18
195233	1	2¾	2	4½	6, 8, 10, 12, 14, 16, or 18
195234	1¼	3	2¼	4½	6, 8, 10, 12, 14, 16, or 18
195235	1½	3¼	2½	4½	6, 8, 10, 12, 14, 16, 18, or 20
195236	1¾	3½	2¾	4½	6, 8, 10, 12, 14, 16, 18, or 20
195237	2	3¾	3	4½	6, 8, 10, 12, 14, 16, 18, or 20
195238	2½	4½	3¾	4½	6, 8, 10, 12, 14, 16, 18, 20, or 22
195239	3	5	4¼	4½	6, 8, 10, 12, 14, 16, 18, 20, or 22
195240	3½	5½	4¾	4½	6, 8, 10, 12, 14, 16, 18, 20, 22, or 24
195241	1¼	4¼	3	6	12, 14, 16, 18, 20, 22, or 24
195242	1½	4½	3¼	6	12, 14, 16, 18, 20, 22, or 24
195243	1¾	4¾	3½	6	12, 14, 16, 18, 20, 22, or 24
195244	2	5	3¾	6	12, 14, 16, 18, 20, 22, or 24
195245	2½	5½	4¼	6	12, 14, 16, 18, 20, 22, or 24
195246	3	6	4¾	6	12, 14, 16, 18, 20, 22, or 24
195247	3½	6½	5¼	6	12, 14, 16, 18, 20, 22, or 24

*These tubes can be furnishedin any length L shown. When ordering specify the dimension L in inches desired.

PRICES (Per 100)

Style No.	L=3″	L=4″	L=5″	L=6″	L=8″	L=10″	L=12″	L=14″	L=16″	L=18″	L=20″	L=22″	L=24″
195223	$64 00	$69 50	$ 75 25	$100 50	$119 25	$137 25	$155 25	$175 25	$192 50	.....	.....	.....	.....
195224	65 25	71 10	81 00	110 25	128 25	145 25	164 25	183 50	201 25	.....	.....	.....	.....
195225	.....	81 00	100 50	128 25	145 50	164 25	182 00	201 25	245 25	.....	.....	.....	.....
195226	.....	.....	119 25	145 50	164 25	181 75	208 25	225 25	274 50	$310 50	.....	.....	.....
195227	.....	.....	.....	174 50	192 50	208 25	256 50	292 50	328 50	364 50	.....	.....	.....
195228	.....	.....	.....	200 75	228 50	256 50	292 50	338 75	383 75	427 50	.....	.....	.....
195229	.....	.....	.....	228 50	256 50	292 50	364 50	409 50	455 75	535 50	$641 25	.....	.....
195230	.....	.....	.....	.....	301 50	364 50	455 50	501 75	567 00	648 00	778 50	$915 75	.....
195231	.....	.....	.....	.....	383 75	456 75	567 00	641 25	693 00	794 25	958 50	1142 50	$1341 00
195232	.....	.....	.....	114 50	137 25	158 00	178 25	200 25	221 50	325 25	.....	.....	.....
195233	.....	.....	.....	127 00	147 25	166 50	189 00	210 25	231 75	259 75	.....	.....	.....
195234	.....	.....	.....	147 25	167 50	369 00	209 25	230 75	282 25	315 00	.....	.....	.....
195235	.....	.....	.....	167 00	189 00	208 75	239 50	281 25	319 50	357 25	420 75	.....	.....
195236	.....	.....	.....	200 75	221 75	239 50	294 75	336 25	378 00	418 50	481 50	.....	.....
195237	.....	.....	.....	230 50	262 00	294 75	336 50	389 25	441 00	491 25	609 75	.....	.....
195238	.....	.....	.....	262 00	294 75	336 50	418 50	470 25	523 00	616 50	738 00	864 00	.....
195239	.....	.....	.....	315 00	346 50	418 50	522 00	476 00	652 50	744 75	893 25	1048 50	.....
195240	.....	.....	.....	400 50	441 00	524 25	652 50	778 00	796 50	913 50	1102 50	1314 00	1543 50
195241	.....	.....	.....	.....	.....	.....	254 75	283 50	312 75	351 00	395 00	441 00	510 75
195242	.....	.....	.....	.....	.....	.....	285 75	317 25	350 55	392 50	442 25	499 50	571 50
195243	.....	.....	.....	.....	.....	.....	323 50	360 00	396 50	430 50	499 50	564 75	645 75
195244	.....	.....	.....	.....	.....	.....	369 00	409 50	454 50	506 25	571 50	643 50	738 00
195245	.....	.....	.....	.....	.....	.....	419 75	465 75	513 00	576 00	648 00	733 50	794 25
195246	.....	.....	.....	.....	.....	.....	482 75	578 25	594 00	661 50	747 00	846 00	967 50
195247	.....	.....	.....	.....	.....	.....	558 00	621 00	686 25	774 00	866 25	981 00	1116 00

PORCELAIN TUBES

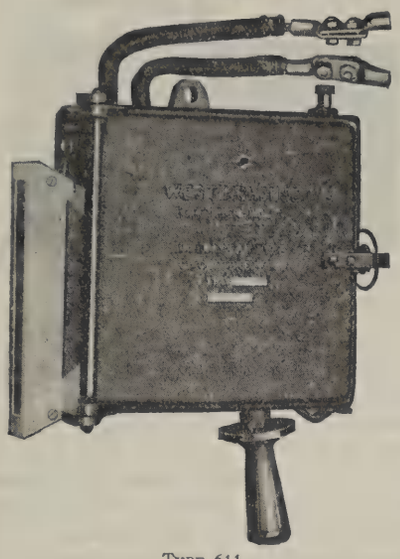


Style No.	Dimensions in Inches A	B	C	D	H	L	N	List Price Per 100
195268	1¼	4¼	7	3	3	4	3	$ 397 50
195269	1¼	4¼	12½	3	4½	8	5	663 00
195270	1¼	4¼	18	3	6	12	7	1392 00
195271	1¼	4¼	23½	3	7½	16	9	2212 50
195272	1½	4½	7	3¼	3	4	3	397 50
195273	1½	4½	12½	3¼	4½	8	5	663 00
195274	1½	4½	18	3¼	6	12	7	1392 00
195275	1½	4½	23½	3¼	7½	16	9	2212 50
195276	2	5	7	3¾	3	4	3	431 75
195277	2	5	12½	3¾	4½	8	5	705 00
195278	2	5	18	3¾	6	12	7	1425 00
195279	2	5	23½	3¾	7½	16	9	2250 00
195280	1¼	4¾	7	4	3	4	3	397 50
195281	1¼	4¾	12½	4	4½	8	5	663 00
195282	1¼	4¾	18	4	6	12	7	1392 00
195283	1¼	4¾	23½	4	7½	16	9	2212 50
195284	1½	5	7	4¼	3	4	3	431 75
195285	1½	5	12½	4¼	4½	8	5	705 00
195286	1½	5	18	4¼	6	12	7	1425 00
195287	1½	5	23½	4¼	7½	16	9	2250 00
195288	2½	5½	7	4¼	3	4	3	552 00
195289	2½	5½	12½	4¼	4½	8	5	750 00
195290	2½	5½	18	4¼	6	12	7	1485 00
195291	2½	5½	23½	4¼	7½	16	9	2295 00
195292	2	5½	7	4¾	3	4	3	552 00
195293	2	5½	12½	4¾	4½	8	5	750 00
195294	2	5½	18	4¾	6	12	7	1485 00
195295	2	5½	23½	4¾	7½	16	9	2295 00
195296	2½	6	7	5¼	3	4	3	663 00
195297	2½	6	12½	5¼	4½	8	5	840 00
195298	2½	6	18	5¼	6	12	7	1575 00
195299	2½	6	23½	5¼	7½	16	9	2385 00

RAILWAY CAR-TYPE CIRCUIT-BREAKERS

WITH MAGNETIC BLOWOUT

For Direct-Current 600-Volt Circuits



TYPE 611

TYPE N

APPLICATION

These circuit-breakers are intended for the protection of street-railway and small electric locomotive equipments, and serve the combined purpose of fuse block and canopy switch. The type 611 breaker is especially applicable to quick-service and other light cars, where light weight, accessibility, and simplicity are essential features.

Choice of Breaker—It is not an advantage to have a breaker with a larger rated continuous capacity than required by the equipment; in fact it is desirable to use one having as small a rated continuous capacity as possible. For a given current, the blowout effect of a small-capacity breaker is greater than that of a large-capacity breaker, as the blowout force is a function of the ampere turns in the coil and the breaker of the smaller capacity has the greater number of turns. Therefore, in interrupting a comparatively small current with a large capacity breaker the breaker may be subjected to unnecessary abuse. In most cases the continuous capacity should be between 65 and 70 per cent of the total motor hour-rating current.

The breakers listed are built extremely rugged and will interrupt loads usually met under ordinary operating conditions. Under heavy service conditions, it is often impossible to obtain adequate protection by the use of a hand-operated or a platform interrrupting device; to meet such conditions, the use of an electro-pneumatically operated line switch* mounted beneath the car sills is recommended.

Mounting—In standard railway practice these circuit-breakers are usually fastened, by means of the mounting lugs on the box, under the canopy over the motorman's head, with the arc chute pointing to the side. Here the breaker is readily accessible and can be quickly reset or closed. The breaker can be mounted in other locations if desired, but under no conditions is it to be enclosed in a box without proper ventilation.

CONSTRUCTION

Adjustment of the tripping current in these breakers is made by means of a knurled-head screw (normally locked with a check-nut in the type 611), which varies the tension on the tripping lever.

The **arc chute** is substantially made from arc resisting material and is easily removed without opening the breaker cover.

Insulation—All current-carrying parts are thoroughly insulated from the case.

*For prices and description of electro-pneumatically operated line switches, apply to nearest district office.

RAILWAY CAR-TYPE CIRCUIT-BREAKERS—Continued

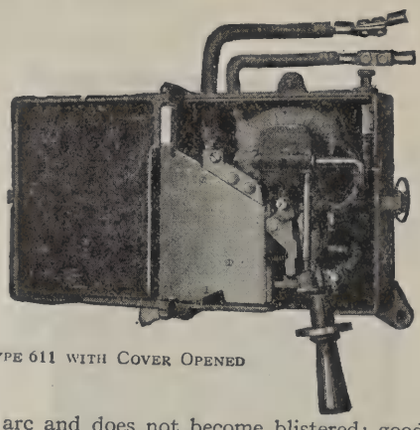
Type 611

A number of improvements in circuit-breaker design have been incorporated in the type 611 breaker, making it more compact, more accessible for repairs and less liable to get out of order, even under the severe service to which a breaker of this kind is always subjected.

The breaker is mounted in a metal box with cover hinged on and held closed by a simple, rugged latch. This makes it very easy to open the breaker in case of trouble and still all parts are fully protected while in service.

The moving parts are mounted on a treated insulating base. By withdrawing four machine screws, the whole mechanism and base may be removed from the enclosing box as a unit. This permits heavy inspections and overhaulings to be made on the bench without the necessity of holding cars out of service.

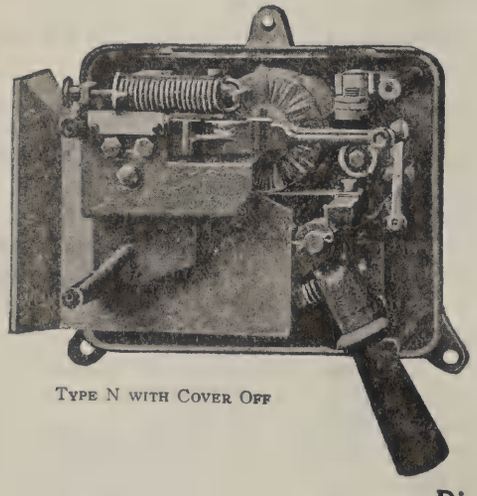
The contacts and arcing horns are removable and may be readily renewed when necessary. They come together and separate with a rolling and wiping motion. Thus the portion of the contact surface which carries the load does not break the arc and does not become blistered; good contact is therefore assured.



TYPE 611 WITH COVER OPENED

Operation—The breaker is closed by pulling the handle to the "on" position. It is tripped automatically under overload and can be tripped manually by pulling the handle to the "off" position—the same handle answers both purposes.

Interchangeability—All of the type 611 circuit-breakers are interchangeable in all parts except coils. If it becomes necessary at any time to change the capacity of the equipment, new coils can be supplied for these breakers at small expense.



TYPE N WITH COVER OFF

Type N

Operation—The breaker is set by a hand-closing lever at the bottom of the box. It is tripped automatically on overload and can be tripped manually by a release button on the front.

Contacts—The current-carrying contacts of the 200-ampere breakers consist of a phosphor-bronze brush and a solid brass contact block; of the 300- and 400-ampere breakers these parts are of copper. An auxiliary contact or "arcing tip" at the end of the switch lever takes the burning of the arc when the breaker opens, and thus confines the burning to a very small piece which can be easily removed and replaced at small cost.

Dimensions

Type 611—11¼ x 14 3/16 x 4¼ inches. **Type N**—13¾ x 14½ x 8 inches.

PRICES

Style number and list price include railway type circuit-breaker complete. but without mounting bolts.

Continuous Capacity Amperes	Adjustment Range, Amperes	Type	Each — Approx. Wt. Lb. Net	Each — Approx. Wt. Lb. Shipping	Style No.	List Price Each
60	110–330*	611	24	34	266321-F	$60 00
90	170–500*	611	24	34	256782-F	60 00
110	200–600*	611	24	34	256781-F	60 00
140	250–750*	611	24	34	256780-F	60 00
200	200–600*	N	40	52	44887-D	110 00
300	300–900*	491-A	40	52	166955-	110 00
400	400–1200*	491-A2	40	52	166956-	110 00

*When choosing a breaker for a specific motor see that the continuous rating of the breaker is at least equal to 65 per cent of the motor hour-rating and that it can be adjusted to trip at 150 to 300 per cent of the total hour-rating of the motors.

Order by Style Number

RAILWAY FUSE BOXES AND FUSES

FOR 600-VOLT SERVICE*

GENERAL

As part of a railway car equipment, a fuse box will afford protection dependent upon its reliability and durability as well as upon the proper application. That these qualities of ruggedness in service have been secured by careful design and improvements, is demonstrated by the operation of the fuse boxes under the severe conditions obtaining in railway and allied work. The abusive nature of this service necessitates particular attention to the selection of fuses in order to secure close protection against overheating of the apparatus. Sufficient information is given to insure an intelligent selection of boxes and fuses.

Types of Fuse Boxes—The fuse boxes listed in this section include three different types; namely boxes of the magnetic blow-out type, for holding copper ribbon fuses; boxes of the expulsion type, for holding copper wire fuses; and boxes for holding enclosed or cartridge type fuses.

For general railway work, the copper ribbon magnetic blow-out type is standard.

For mine locomotives, the copper wire expulsion type is standard. The fact that the fuse consists merely of a short piece of ordinary copper wire and that the operation of replacing it is so simple, has made this very popular for rough work, particularly where small capacities are required, even though it is not as effective as the magnetic blow-out type.

For special cases, where the noise and arcing must be reduced as much as possible, the boxes for holding standard or cartridge type fuses are used.

Arrangement of Blowout—In fuse boxes of the magnetic blow-out type the fuse itself is the source of the blowout. It is so located with reference to certain iron parts of the box that it forms a coil of one-half turn and sets up the magnetic flux necessary to extinguish the arc. All 600-volt copper ribbon magnetic blow-out fuse boxes, although differing slightly in detail, are arranged in the same general way.

Permissible Range of Fuses for Magnetic Blow-out Fuse Boxes—Since all fuse boxes of the magnetic blow-out type have a one-half turn blow-out winding, regardless of the current or the size of the fuse they are intended to carry, it is evident that with a heavy current a much stronger blow-out effect will be obtained than with a small current. Thus it may sometimes happen that a given box will open the circuit with the current that will just blow a 500-ampere fuse more easily than it will with a current that will just blow a 100-ampere fuse. On this account, it is usually the minimum rather than the maximum size of fuse which limits the application of a given box. For the same reason it is usually found that the more severe the short-circuit, the more easily the fuse opens it.

Continuous Capacity—On account of the intermittent character of the loads on railway equipments, the rated capacity of the fuses which must be installed is much greater than the equivalent continuous current that they must carry. For instance in the case of a quadruple equipment of 40-horsepower motors, a fuse rated at 300 amperes is ordinarily required. The equivalent current that the box need be able to carry continuously, however, is approximately 200 amperes. On this account, for railway service, fuse boxes may be used with fuses rated at currents considerably in excess of the continuous capacity of the box. In other classes of service, however, this is not usually the case. It might easily happen that a fuse box which would be entirely satisfactory for use with a 300-ampere fuse in railway service, might have too small a carrying capacity for use with the same fuse in industrial service where the continuous load was nearly equal to the maximum.

In order that the fuse boxes listed may be applied intelligently to other classes of service if desired, their continuous capacity is given in addition to the range of fuses ordinarily employed with them.

All fuse boxes listed for 600-volt service may be used on any circuit where the momentary peaks do not exceed 750 volts. The copper wire type boxes, however, should not be used where the maximum momentary peaks exceed 600 volts.

Current and Voltage Rating of Fuses—Fuses for railway service are rated at one-half the current that will cause them to blow in 30 seconds; that is, a 500-ampere fuse is one that will blow in 30 seconds if a current of 1000 amperes is maintained through it.

Application of Fuses—It is usual to install in the trolley circuit of railway equipments, fuses of the same capacity in amperes as the combined one-hour rating of the motors. For instance: a quadruple equipment of 40-horsepower motors (one-hour rating 73 amperes each) is ordinarily supplied with a 300-ampere fuse; a quadruple equipment of 50-horsepower motors (one-hour rating 89 amperes each), with a 350-ampere fuse; and so on.

*For fuse-boxes for use on 1200 and 1500 volts request information from nearest District Office.

RAILWAY FUSE BOXES AND FUSES—Continued

COPPER RIBBON MAGNETIC BLOW-OUT TYPE FUSE BOXES

STYLE NO. 58653

Fuse boxes, Style Nos. 169235-C and 175758-C, are made with skeleton frames of hard white fibre, and backs and lids of non-warping moulded sheet material. The iron which forms the pole pieces and magnetic circuit of these boxes is arranged on the outside of the box in such a way as to give an iron-bound effect and make these boxes particularly strong and substantial. The front side is hinged to act as a cover. It may be readily opened to insert a fuse by unloosening the winged nut and hinged screw which form the latch.

Style No. 58653, is of the same general construction but is not provided with a hinged lid, since fuses can be readily inserted without this feature on account of the greater width of the box.

Style No. 126561-B, is also made without a hinged lid. A moulded box forms the framework in this case, instead of a built-up fibre structure. This fuse box comes with mounting bolts for attachment to a vertical wooden surface. It is designed especially for use on third rail shoe beams.

These last two boxes are used extensively in heavy electrification and rapid transit work.

Style number and list price of fuse box do not include fuses.

PRICES

Magnetic Blow-Out Fuse Boxes

Style No.	Continuous Capacity Amperes	Range of Fuses	Application—Total Horsepower Per Equipment at 600 Volts	Each: Net Weight Lbs.	Each: List Price
169235-C	250	150- 400	100 to 300	11½	$26 00
175758-C	400	500–1000	475 to 720	27	67 50
58653	600	600–1800	.....	30	75 00
126561-B	600	750–2250	.....	30	84 00

Fuses

For Box Style No. 169235-C

Style No.	Application: Rating Amperes	Application: Total Rated Horsepower at 600 Volts	List Price Per 100
249205	100	60	5 00
249204	125	85	5 00
283009	150	105	7 50
283010	200	140	7 50
91350	250	175	7 75
91351	300	210	11 50
173489	350	250	11 50
171538	400	280	15 50

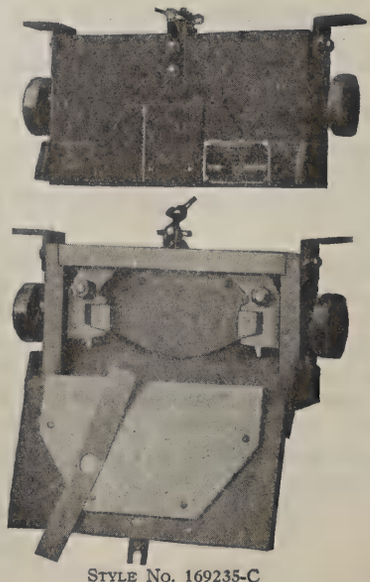
For Box Style No. 175758-C and 126561-B*

180316	350	250	$27 50
180317	400	280	32 50
173861	500	350	24 00
174889	600	420	24 00
175759	750	525	35 00
.....*	1000*	700	.....
272153	1200	800	15 00
.....*	1500	1000	.....

For Box Style No. 58653*

91354	500	350	$15 00
91355	600	420	15 00
175521	800	575	15 00
.....*	1000	700	.....
.....*	1200	800	.....
.....*	1600	1100	.....

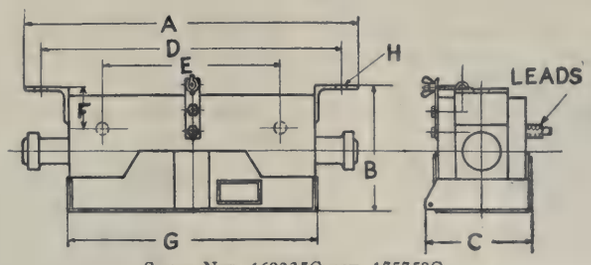
*Note—Additional fuse capacities for these boxes are ordinarily obtained by using two suitable fuses in parallel and soldered together at one end.



STYLE NO. 169235-C

RAILWAY FUSE BOXES AND FUSES—Continued

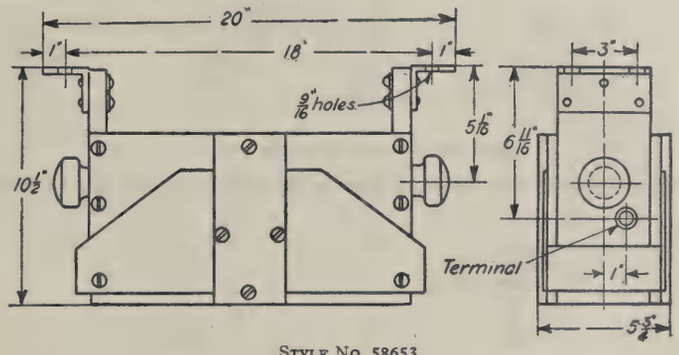
OUTLINE DIMENSIONS



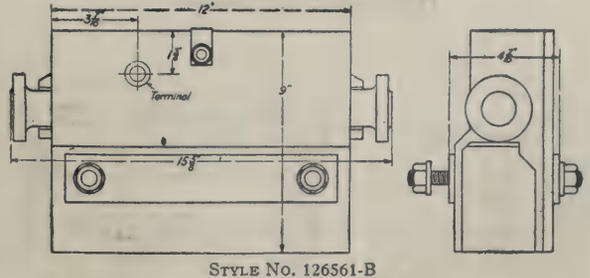
STYLE NOS. 169235C AND 175758C

DIMENSIONS IN INCHES

Style No.	A	B	C	D	E	F	G	H
169235C	13	6⅛	3 1/16	11⅝	7⅛	2⅛	10¼	1/16
175758C	19	7⅝	5	17⅛	10	2⅜	14¼	H



STYLE NO. 58653



STYLE NO. 126561-B

Dimensions given are for reference only. For official dimensions apply to the nearest district office.

COPPER WIRE TYPE FUSE BOXES

The copper-wire type fuse boxes consist of two cast-iron shells fastened together with a toggle hinge. The cable leads are attached to two wedge-shaped terminals supported by a hardwood block in the upper or stationary half. The fuse—a straight piece of copper wire—is laid between two grooved terminals in the lower half, and these are pressed against the upper terminals when the box is closed, thus clamping the fuse and completing the circuit through it.

Except for the vent extending through the bottom, this fuse box is completely enclosed by the two iron shells.

To renew a fuse it is only necessary to open the box, drop a piece of straight copper wire in place, and close the box. This is a particularly desirable feature in cold or stormy weather. When the box is open, the contacts on which the fuse is supported are disconnected from the circuit.

Style number and list price of fuse box do not include fuses.

STYLE NO. 3794—CLOSED

STYLE NO. 3794—OPEN

PRICES

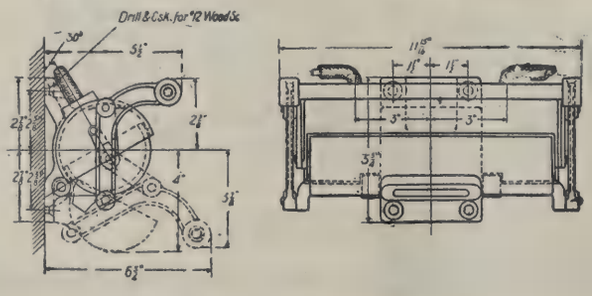
Style No.	Continuous Capacity Amperes	Size Copper Wire for Fuses	Application—Total Horsepower Per Equipment 500 V.	250 V.	Each—Net Weight Lbs.	Each—List Price
3794	100	No. 12 to No. 18	15 to 70	7½ to 35	10	$25 00
5624	250	No. 6 to No. 11	70 to 240	35 to 120	10	27 00

Fuses for Copper Wire Boxes

Approximate ratings of copper wire fuses to blow in 30 seconds at 100 per cent overload in above fuse boxes.

Size of Wire B. & S.	Approx. Rating Amperes	Size of Wire B. & S.	Approx. Rating Amperes
No. 18	33	No. 11	139
No. 17	41	No. 10	174
No. 16	50	No. 9	217
No. 15	60	No. 8	270
No. 14	74	No. 7	336
No. 13	90	No. 6	433
No. 12	111		

OUTLINE DIMENSIONS



STYLE NOS. 3794 AND 5624

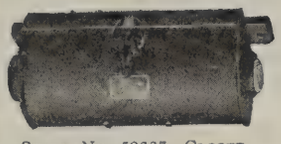
Order by Style Number

ENCLOSED FUSE BOXES

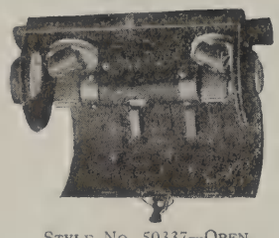
The enclosed fuse boxes consist of cast-iron frames with hinged sheet-iron covers. The fuse clips or jaws are carried on porcelain insulators, and porcelain bushings are provided for carrying the cable leads through the frame.

The box is equipped with a toggle latch which holds the cover securely in position and at the same time allows it to be readily opened without tools. The cover swings away from the box so that the fuse can easily be handled.

Style number and list price of fuse box do not include fuses.



STYLE NO. 50337—CLOSED



STYLE NO. 50337—OPEN

PRICES

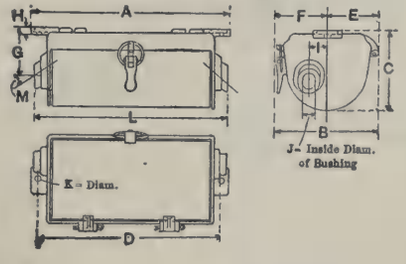
Enclosed Fuse Boxes

Style No.	Continuous Capacity Amperes	Range of Fuses Amperes	Application—Total Nominal Horsepower Per Equipment at 600 Volts	EACH—Net Weight Lbs	EACH—List Price
50337	400	201–400	120 to 300	30	$40 00
58496	600	401–600	360 to 480	35	45 00

Fuses

Style No.	Ratings Amperes	Application—Total Nominal Horsepower Per Equipment at 600 Volts	List Price
37210	225	120	See Section 1-B Part I.
37211	250	145 to 180	
37212	300	190	
37213	350	240	
37214	400	290 to 300	
37215	500	360	
37216	600	480	

OUTLINE DIMENSIONS



DIMENSIONS IN INCHES

Style No.	A	B	C	D	E	F	G	H	I	J	K	L	M
50337	17¼	8¾	6$\frac{11}{16}$	16	4$\frac{7}{16}$	4$\frac{5}{16}$	4$\frac{13}{16}$	⅝	1$\frac{7}{16}$	⅛	$\frac{5}{16}$	16¾	30°
58496	19¼	9¾	7$\frac{11}{16}$	20	4$\frac{13}{16}$	4$\frac{13}{16}$	5	¾	1$\frac{7}{16}$	1$\frac{1}{16}$	$\frac{5}{16}$	18$\frac{1}{16}$	30°

Order by Style Number

RAILWAY FUSE BOXES AND FUSES—Continued

AUXILIARY CIRCUIT FUSE BOXES

Small capacity fuse boxes are often required in connection with lighting, control and auxiliary circuits. For use particularly on 1200 and 1500 volt car equipments and circuits up to 3000 volts the following self contained boxes are recommended.

The boxes are enclosed and may be mounted underneath car floors or other places as long as the exhaust holes for expulsion of the gases are free from obstruction for a distance of 10 inches. The holes should preferably point downwards or horizontally. Boxes are well built and have hinged covers fastened with substantial toggle latch.

Inside the box is mounted a porcelain supported expulsion type fuse tube, which uses aluminum wire as the fusible element. For complete description of this method of fuse protection, and of similar fuse boxes refer to pages in this catalogue under expulsion fuse blocks and transformer fuse blocks.

The **type 230-A** fuse box is single pole.

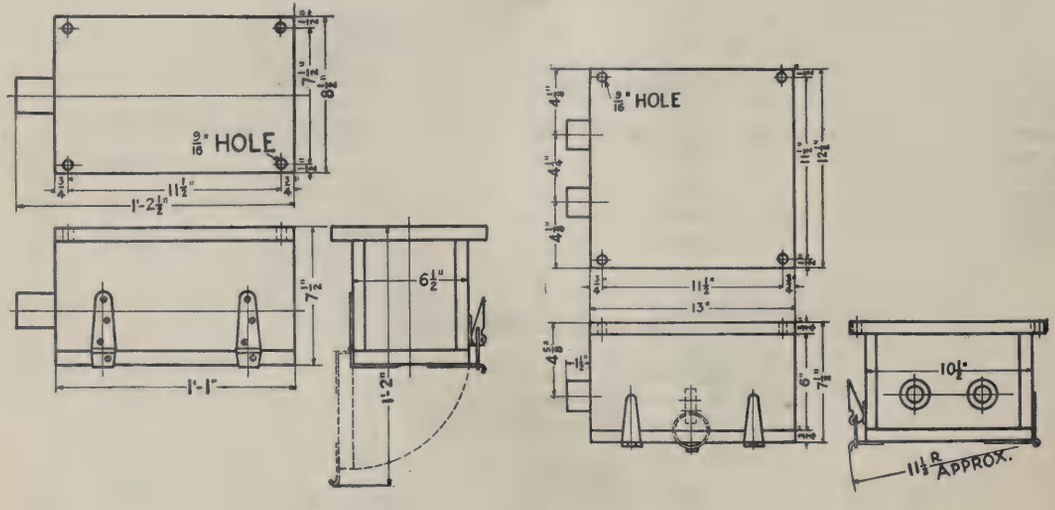
The **type 231-A** fuse box is for two separate circuits; it has two supports and fuse tubes connected at one end with a strap connection.

Style number and list price include fuse box complete with fuse tube or tubes except without fuse wire or asbestos sleeving for the same. For data on aluminum fuse wire see pages of Catalog Sect. 1-B on "Fuse Wire, Fuse Ribbon and Link Fuses." About 8 inches length of wire is required for each fuse. Before inserting the fuse wire it should be encased in asbestos sleeving; the asbestos prevents the gradual charring of the fuse tube by an overheated fuse and thereby lengthens the life and prevents a burning out of the fuse tube or chamber. For asbestos sleeving refer to catalog section on "Insulating Materials and Supplies."

Style No,	Type No.	Features	Capacity Volts	Amperes Continuous	Each Weight	Each List Price
200643	230-A	Single Circuit	3000	30	12	$43 20
231158	231-A	Two Circuit	3000	30	17¾	25
165477	.....	Extra Fuse Tube	....	..	1½	*

*See price under "Type OD Safety-First Fuse Boxes" in this catalogue.

OUTLINE DIMENSIONS



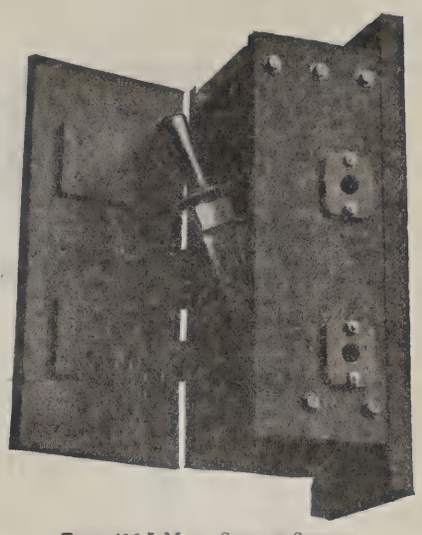
MAIN CUTOUT KNIFE SWITCHES

For 600 and 1500 Volt Service

Every car equipment should have provision for isolating all apparatus in order to make adjustments, tests, or inspection. For multiple unit equipments where no canopy switches are used a plain enclosed knife switch is generally mounted under the car to be used as a main cutout. The switches described below are especially arranged for railway work. Whenever a cabinet or panel board is employed for other car circuits, a plain knife switch may be used. Suitable switches are the Type A, front or rear connected switches for 600 volt, listed in this catalogue under "Knife Switches."

Switches have approved forms of break and hinge jaws, liberally proportioned with respect to strength and contact area with the blades used. The break jaws have flared lips. The best grade copper and other materials are used and the whole design follows latest switch practice.

Boxes are solidly constructed from hard wood, given a protective treatment and finished with a dull black paint. Tie bolts are used to reinforce the wood screw fastenings. Covers are hinged on one side and secured on the other with substantial toggle latches. Bushings for the incoming cables are properly located in one of the box sides. In order to economize in space the boxes are arranged so that blades and handles swing outside through a slot when opened. When the switch is closed all parts are covered. The Type 496-I switch has the usual wooden handle grip. The 496-C and H Switches can be used on 1500 volts and are operated with a separate hook and handle similar to disconnecting switches. This switch hook is included with the switch.



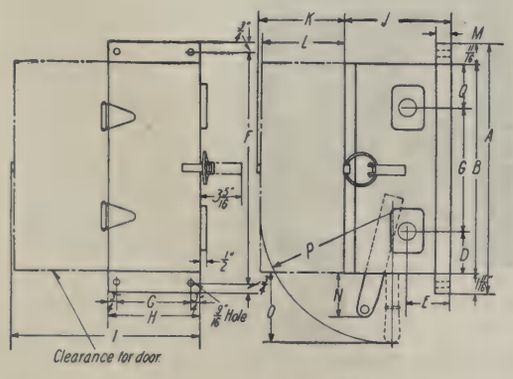
TYPE 496-I MAIN CUTOUT SWITCH

It is recommended that boxes be mounted vertically so that handles are up when switch is in closed position.

Terminals

The switches have plain studs with nuts and lock washers to fasten copper tube terminals, which should be selected to suit the size of cable to be used. A range of suitable terminals is given below:

Style number and list price include complete switch, omitting terminals.



Style No.	Type No.	Application Cont. Amperes	Application Total hp. at 600 V.	Each Wt. Lbs.	Each List Price
284908	496-I	400	400	25	$32 00
191048*	496-C	200	200	25	33 50
291963*	496-H	400	400	28	40 00

*Insulated for 1500 volts.

Copper Tube Terminals

Nominal Amperes	Inside Diameter	Circular Mills Stranded Cable	Style No.	List Price Each
100	.384	83000	229113	$0 40
125	.402	105000	229116	28
170	.432	133000	243986	25
220	.558	211000	269917	60
275	.734	300000	243988	.....
325	.87	400000	229125	75
400	.918	500000	229127	1 00
450	1.02	600000	229129	.....

Type	DIMENSIONS IN INCHES A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
496-I	19½	16⅛	6¾	4 3/16	2¾	18	5½	7	14¾	7¼	7½	7	1	...	5 5/16	9⅞	7 1/16
496-C	19½	16⅛	7⅞	4⅛	2¾	18	5½	7	14¾	7¼	7½	7	1	1¾	...	...	4⅛
496-H	20¼	16⅞	9¾	3 3/16	3 3/16	18¾	5⅞	7⅛	16	8 1/16	7⅞	7⅛	1¼	3⅛	...	...	3 3/16

RAILWAY TYPE SWITCHES

600 VOLTS, A.C. OR D.C.

STYLE NO. 5793-A—CANOPY SWITCH WITHOUT MAGNETIC BLOW-OUT

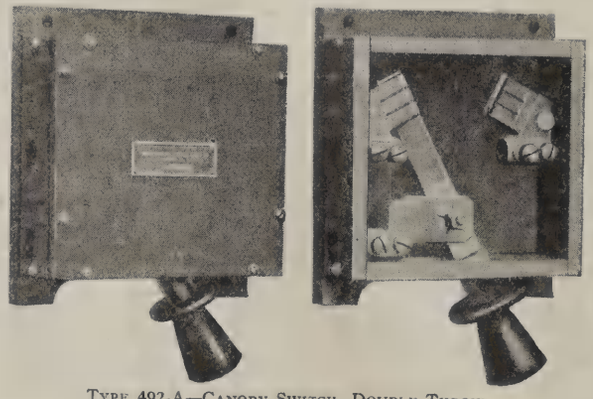
CANOPY SWITCHES WITHOUT MAGNETIC BLOW-OUT COILS

Application—These canopy switches are used in railway or mining service as a disconnecting switch where no current is to be broken. They have no magnetic blow-out and should not, therefore, be used to open ciruits carrying current.

The single-throw switches are used on electric systems that have ground return circuits only; and the double-throw switches are used where both ground and metallic circuits are employed. The double-throw switches are also used on mining locomotives to transfer the connections of the motor circuit from the trolley to the gathering-reel.

Construction—These switches are simple knife-blade switches pivoted at a point near the handle. The single-throw switches are mounted between blocks of slate, the whole enclosed within an iron case; and the double-throw switches are mounted in a box made of insulating board. Perfectly fire-proof construction is obtained in both forms. All exposed parts of the switches are "dead" so that they can be handled safely even in the dark.

Capacity—Single-throw switches are listed having capacities of 150 and 250 amperes. The outside dimensions of these switches are the same but the 250-ampere switch is provided with heavy terminals bored to receive a larger wire than the 150-ampere switch. The double-throw switch is made for 200 amperes only.



TYPE 492-A—CANOPY SWITCH, DOUBLE-THROW

Style No.	Description	Capacity Amperes	Each: Approx. Net Weight, Lbs.	Each: List Price
5793-A	Single-pole, single-throw	150	20	$17 50
5225-A	Single-pole, single-throw	250	20	18 25
180281-A	Single-pole, double-throw, Type 492-A	200	13	35 25

CANOPY SWITCHES WITH MAGNETIC BLOW-OUT COILS

Application—These switches have the same application as those previously described, but, having blow-out coils, they can be used to break their rated current occasionally. Type 503-A is used in particular on electric systems that employ a metallic return circuit, both sides of the line being opened or closed at the same time.

Construction—These switches consist of knife-blade switches mounted in vulcabeston boxes and with magnetic blowouts made up of two coils each, one on each side of the switch jaw. These are wound so as to produce a strong magnetic field across the point where the circuit is opened, thus fitting these switches to open heavy currents. The complete switch is enclosed in a cast-iron case with four lugs on its back for mounting.

TYPE 503 SWITCH, COMPLETE

TYPE 503 SWITCH, COVER REMOVED

TYPE 493-C SWITCH, COMPLETE

TYPE 493-C SWITCH, COVER REMOVED

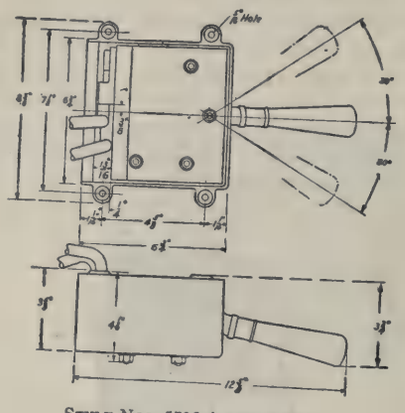
The blow-out coils are wound on slotted iron cores so that the switch may be operated on either alternating or direct-current circuits.

Types—These switches are designated as types 503, 503-A, 503-B and 493-C. Types 503 and 503-B differ only in the capacity of the blow-out coils. Type 503-A is a two-pole switch made up by mounting two type 503 switches side by side in the same horizontal plane and same case, with their handles connected by an insulating link. Type 493-C differs from the other three in being of smaller capacity and size. Type 493-C has the line terminals outside instead of within the case. Refer to type 495 control switches for additional canopy switches for small capacity apparatus such as blowers and air compressors.

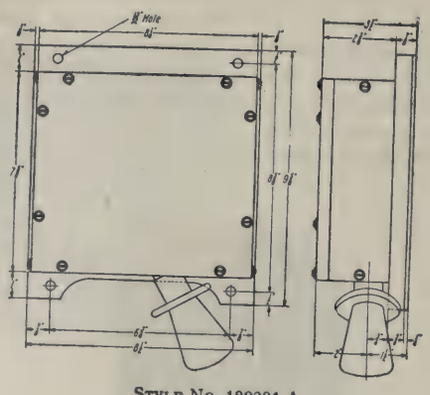
Style No.	Type	Description	Capacity Amperes Per Pole	Each — Approx. Net Weight, Lbs.	Each — List Price
238692	493-C	Single-pole, single-throw	60	8	$ 45 00
120962	503-B	Single-pole, single-throw	100	25	50 00
83805	503	Single-pole, single-throw	200	25	60 00
120961	503-A	Two-pole, single-throw	200	60	100 00

RAILWAY-TYPE SWITCHES—Continued

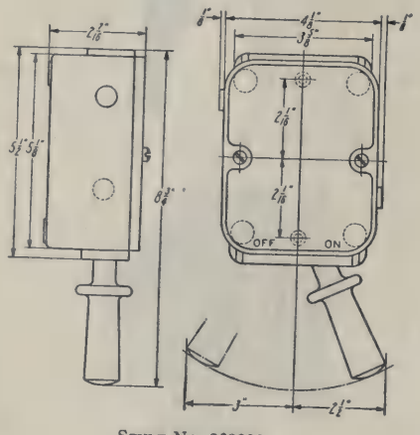
OUTLINE DIMENSIONS



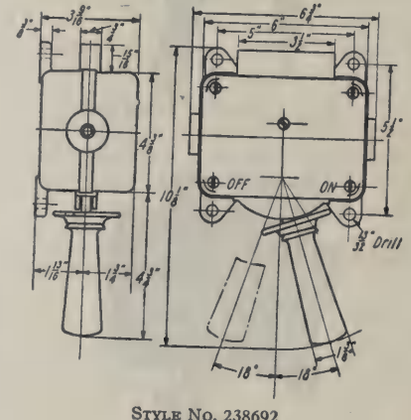
STYLE NOS. 5793-A AND 5225-A



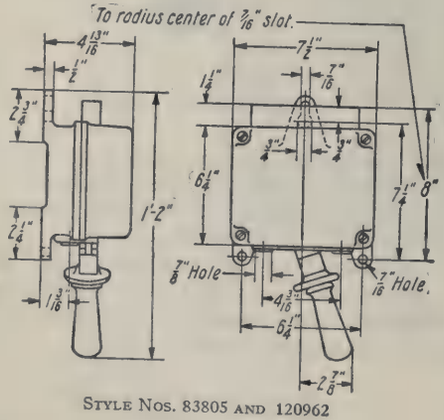
STYLE NO. 180281-A



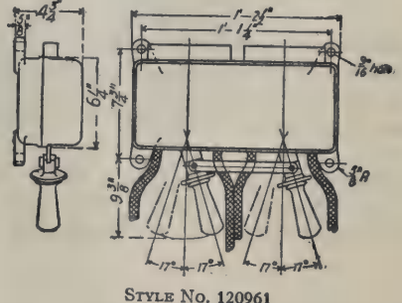
STYLE NO. 239000



STYLE NO. 238692



STYLE NOS. 83805 AND 120962



STYLE NO. 120961

These dimensions are for reference only. For official dimensions apply to the nearest district office.

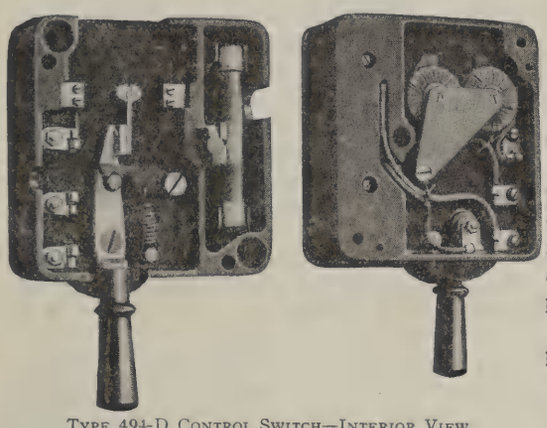
TYPE 494 CONTROL SWITCHES

FOR 600 VOLTS

This line meets fully the requirements of a switch for auxiliary and control circuits in 600 volt railway service. They include in the same case a 600 volt fuse for final protection against short circuits and overload. The chief characteristic is the switch action with effective magnetic blow out.

The main case or switch box is made of moulded insulating composition taking a very smooth brown finish. Partitions divide the interior into three compartments. The back cover which is held by screws opens upon one section containing formed and taped blowout coils. These are carried on a magnetic circuit. An iron plate on the front cover constitutes another part of this circuit. Pole pieces are located to distribute the flux in order to obtain the most advantageous blowout action.

TYPE 494-B CONTROL SWITCH—FRONT VIEW



TYPE 494-D CONTROL SWITCH—INTERIOR VIEW

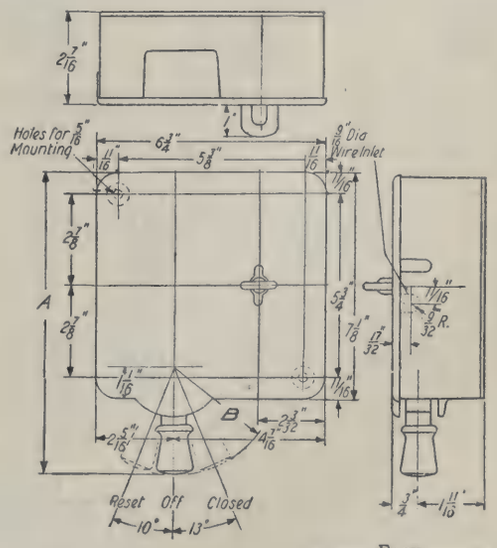
A spring button latch extending through the flat front cover allows the latter to be removed easily, rendering the main part of the switch box readily accessible. The fuse and clips in one of the front compartments are standard for 600 volts. In the other division are the main switch lever, mechanism and butt contacts. A pawl and spring acting on a roller and pin attached to the switch lever are used to register the points and to assist in the switch action.

Types 494-B and 494-B-2—These switches are ordinarily used as the "Control Cut-out and Reset Switches" for remote control equipments. They have an "off" position with handle in the center. Throwing the handle to the right makes positive connections for customary use. In the other direction a spring return acts upon the switch lever, so that the reset contact is obtained only while held by hand.

Type 494-C—Is a single pole switch similar to the 494-B, except that the reset position is omitted, making it "single throw."

Types 494-D D-2, D-3—These switches have three positions and are commonly used as selector or transfer switches, for instance, in the control of remotely operated shoe trolley change overs. They are essentially two way switches with an "off" position.

Style number and list price include switch complete with fuse.

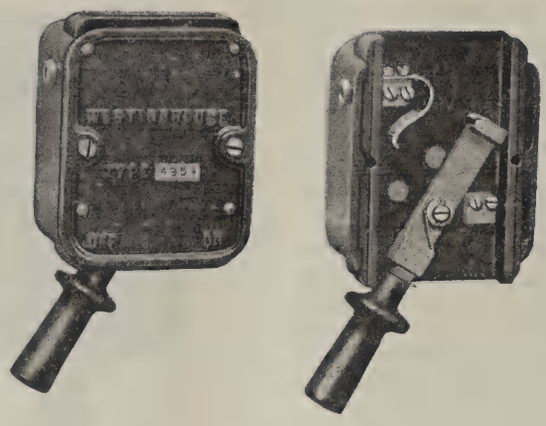


Style No.	Type No.	Continuous Amps.	Dimensions in Inches A	B	Style No. of Fuse	Each Weight Lbs.	Each List Price
192486	494-B	8	9 1/4	3 1/16	37192	6 1/4	$30 00
263532	494-B-2	15	9 1/4	3 1/16	37194	6 1/4	30 00
291965	494-C	8	9 1/4	3 1/16	37192	5 3/4	30 00
263328	494-D	1	10 1/16	4 3/8	37186	6 1/4	30 00
263329	494-D-2	4	10 1/16	4 3/8	37189	6 1/4	30 00
263330	494-D-3	15	10 1/16	4 3/8	37194	6 1/4	30 00

220-6A

TYPE 495 CONTROL SWITCHES

FOR 600 VOLTS



Where single point control switches can be used (with outside fuse protection, if required) the type 495 switches are applicable. These are compactly arranged in a metal case and are provided with magnetic blowouts. The switch mechanism is contained in a moulded composition structure, which forms the arc chute. It is a good arc-resisting material. The blowout coil is also supported from this structure.

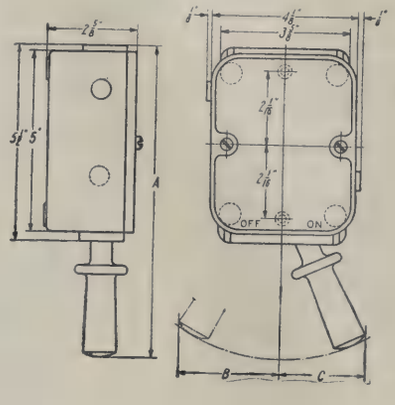
The **types 495 and 495-C** switches have compression springs arranged to return the handle to the "off" position. They are commonly used as "resetting" switches in connection with power operated circuit breakers and line switches of car equipments.

Types **495-B and B-2** have a light torsion spring to assist the switch action in breaking the arc and to hold the lever in the "off" position. They are arranged to remain in the "in" position, and are suitable for use on compressor or blower motor and similar circuits.

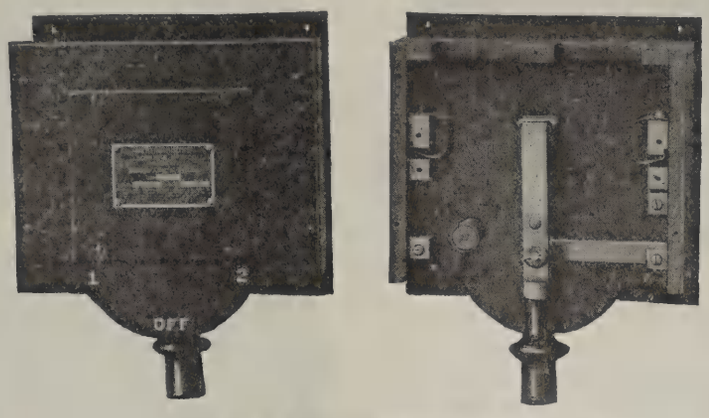
Although designed principally for 600 volt railway service these switches can be applied on any circuit as long as the rated current capacity and voltage are not exceeded.

Style No.	Type No.	Features	Continuous Amperes	Weight Lbs.	List Price
162591	495	Spring return	4	4¼	$20 00
292095	495-C	Spring return	15	4¼	20 00
292096	495-B-2	On or Off	6	5	20 00
239000	495-B	On or Off	30	5	20 00

OUTLINE DIMENSIONS



TYPE 449-A CONTROL AND RESET SWITCH
TYPE 543-A AUXILIARY CONTROL SWITCHES
FOR 1200-1500 VOLTS



TYPE 543-A AUXILIARY CONTROL SWITCH

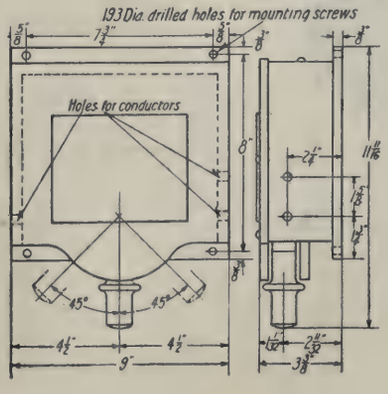
The switches listed below are similar in purpose and design to the types 494 and 495 switches except that greater clearances and insulation strength are afforded. They adequately perform the duty of control switches on high voltage equipments and are recommended for use as transfer or two way switches for lighting and auxiliary circuits. No fuses are included in the switches. When external fuse protection is desired, Style numbers 200643 or 231158 listed under fuse boxes may be used.

Type 499-A is regularly used as the control cut-out and reset switch for multiple unit control apparatus. When thrown to the left hand side or reset position, the handle returns to the middle or "off" position upon being released. Upon throwing to the right hand side the switch lever is retained in the "on" position for regular operation until the motorman throws the handle "off." A spring acting directly on the lever keeps the handle in the middle position unless thrown. This same spring in conjunction with a secondary spring contact assists in breaking the current arc by giving a snap action and accelerated motion to the switch lever.

The type 543-A switches are similar to the foregoing switch, but are arranged as double-throw switches with central "off" position. The switch remains in the position to which it is set. It possesses the same effective arc breaking feature described for the type 499-A.

All switches have liberal blow-out capacity. The enclosing case is built up from composition lumber, and so designed in connection with the guarded handle as to protect the operator from contact with "live" parts.

Style No.	Type No.	Features	Continuous Amperes	EACH Weight Pounds	EACH List Price
176972	499-A	Spring return for reset	10	11¾	$37 50
195643	543-A2	Double throw	1	12	50 00
176970	543-A	Double throw	5	12	50 00
176973	543-A3	Double throw	16	12	50 00



TRAIN LINE JUNCTION BOXES

TYPE 426-D CAST IRON JUNCTION BOX—CLOSED

TYPE 426-D JUNCTION BOX—COVER OPEN

Junction boxes are primarily designed for making control circuit connections in car wiring. Their use wherever taps or branch circuits from multi-conductor cables in conduit are to be made is a convenience of the highest order both in ease of equipping and later upkeep. This is especially true in the case of wiring on multiple unit car equipments where a secure installation of control circuits is so essential.

The types **426** and **431** Junction boxes are shallow cast iron boxes with various sizes of conduit taps around the sides, and types **46** and **651** are similarly made from thick sheet steel. Pipe flanges are provided. Excepting in the type **651**, the covers are hinged on one side and clamped on the other with wing nuts running on hinged screws as shown in the illustrations. The screws are riveted at the ends in order to prevent loss of the wing nuts. The type **651** box has a cover fastened with tap bolts from the front and can be used for flush mounting or for inserting in floors or panels.

TYPE 46-C JUNCTION BOX—COVER OPEN

Two or more rows of terminal studs are mounted on a carefully treated wood base. Three clips are supplied per stud. They are designed for soldering to wires of up to 20 amperes nominal capacity, 600 volt insulation. The terminal screws themselves are secured with lock washers, and the connection clips are fastened with lock nuts. A convenient tool for these terminal nuts is socket wrench, style No. 77533, listed under Control Tools.

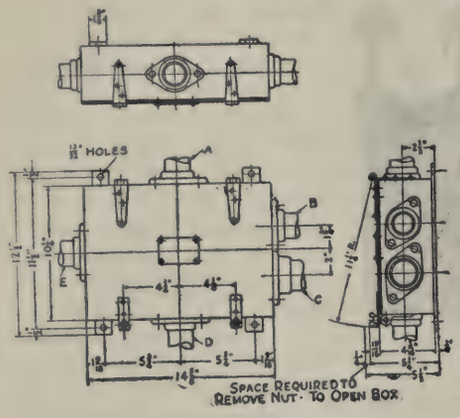
The type **426-D** Junction Box, style No. 134218, is standard for most car equipments supplied by this company. The use of this box is strongly urged, since it may be arranged with pipe plugs or reducers to secure so many combinations. If it or the other junction boxes listed do not meet the particular needs, inquiries are solicited for boxes to suit special layouts.

Style number and list price include complete junction box. Refer to outline drawings for size of pipe taps regularly furnished.

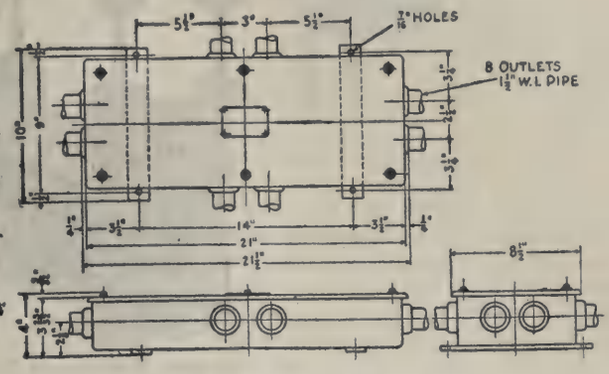
Style No.	Type No.	No. of Studs	Outlets: Number	Outlets: Size in Inches	Weight Pounds	List Price
125235	426-A	10	8	1	27	$19 00
134218	426-D	14	4 4	1¼ 1½	27	21 50
199362	426-G	20	4 4	1¼ 1½	28	22 75
64421	431	20	■	1½	40	29 00
214241	431-B	30	8	1¼	42	33 75
288730	46-C	23	4 1	1½ 2	27	30 00
274228	651-A	20	8	1½	26	26 00

TRAIN LINE JUNCTION BOXES—Continued

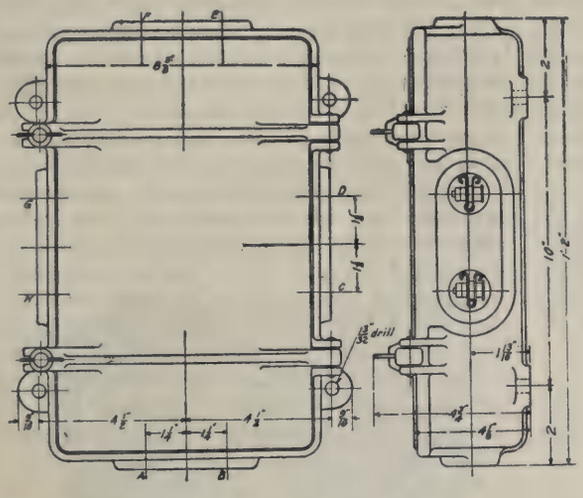
OUTLINE DIMENSIONS



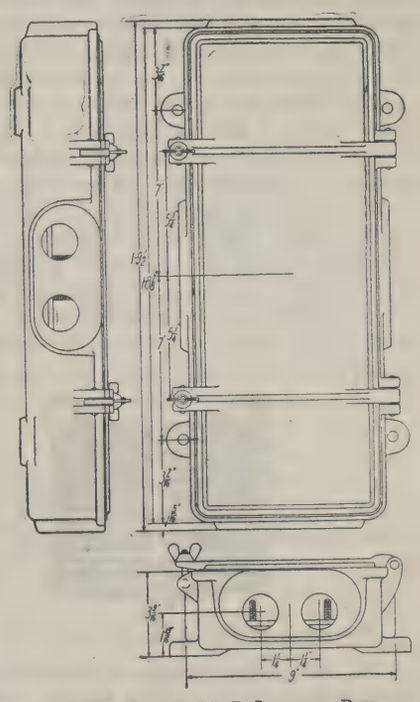
TYPE 46-C JUNCTION BOX



TYPE 651-A JUNCTION BOX



TYPE 426-A, 426-D AND 426-G JUNCTION BOX



TYPE 431 AND 431-B JUNCTION BOX

Size of Pipe—Inches

Type	A	B	C	D	E	F	G	H
426-A	1	1	1	1	1	1	1	1
426-D	1½	1½	1¼	1¼	1½	1½	1¼	1¼
426-G	1½	1½	1¼	1¼	1½	1½	1¼	1¼

STANDARD RESISTORS FOR RAILWAY SERVICE

Three Point Suspension Type

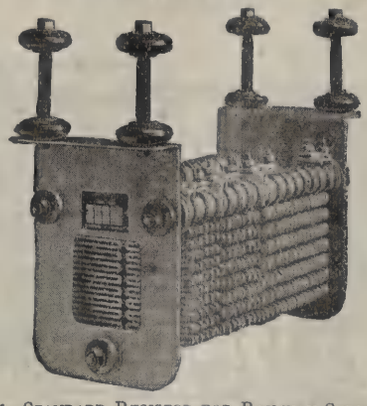


FIG. 1—STANDARD RESISTOR FOR RAILWAY SERVICE

General Construction—Resistors* supplied by the Westinghouse Electric & Manufacturing Company for railway equipments are assembled by "stacking" on three mica-insulated tie rods (See Fig. 1) groups of from 10 to 30 cast-iron resistor grids. There are several different forms of grids, each having a different resistance. One is shown in Fig. 2. The tie rods are supported, at each end, by sheet steel end frames. All members are securely clamped together by means of nuts screwing on the tie-rod ends. Spring washers arranged under the nuts and between the two outside grids and the end frames tend to counteract the tendency of the components to become loose because of the vibration incident to railway conditions, or because of expansion.

FIG. 2—EIGHT INCH THREE-POINT RESISTOR GRID

The triangularly arranged tie-rods provide a rigid support for the grids at both top and bottom. Because of the fact that the grids are supported at three points the appliance is sometimes called a "three-point resistor."

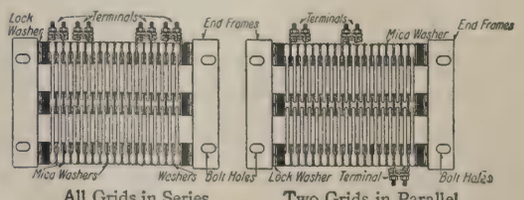
Frames of required resistance values or current carrying capacities may be built up by selecting a suitable number of the proper type of individual grids. The grids may be assembled and connected so that they will either be all in series or in series-parallel combination. No combustible material enters into the construction of the resistor. It will carry heavy overloads for long periods without being adversely affected thereby.

Grids used in assembling the resistor are cast in the form shown in Fig. 2 from a tough freely-flowing iron. Those usually supplied by the Westinghouse Electric & Manufacturing Company for use with car equipments measure 8 inches between the centers of the two upper of the three-bolt holes and also 8 inches vertically between the center lines of the upper holes and lower hole. Because of this dimension these grids are designated as "eight inch."

The grid crossection affects both the electrical resistance and mechanical strength; the smaller crossection being the higher resistance. Naturally the smaller crossection is the weaker mechanically and where it is necessary to use small crossection grids it is desirable to use a tougher metal than cast iron. Cast nickel alloy grids are available for this.

The 5-inch grids have smaller dimensions and are suitable for mine locomotives, low floor cars and other places where clearance requirements necessitate their use.

Connections—The faces of the bosses are surface ground and of ample proportions. The bosses are not slotted, thus avoiding incorrect assembling and assurance that total area of boss is available for electrical contact. A mica washer is inserted between the bosses of adjacent grids wherever insulation is necessary. This applies to the two upper bosses only, as mica washers are always used between the lower bosses of adjacent grids. In order to obtain current carrying capacity grids are often connected in parallel. (See Fig. 3.)



All Grids in Series Two Grids in Parallel

FIG. 3— DIAGRAM ILLUSTRATING METHOD OF MAKING CONNECTIONS BETWEEN GRIDS

*In future Westinghouse Electric & Manufacturing Co. publications the words "Resistance," "Resistor" and "Rheostat" will have meanings as indicated below:—

A Resistance is a physical property of a body by virtue of which the body limits the intensity of an electric current.
A Resistor is a body interposed in a circuit for the purpose of introducing resistance.
A Rheostat is a combination of a resistor and a device whereby the effective resistance of the resistor can be varied.

STANDARD RESISTORS FOR RAILWAY SERVICE—Continued

Terminals—Taps are taken off by means of improved clamp type terminals, shown in Fig. 5, which may be inserted between any two grids after loosening the nuts on the corresponding tie-rod. The terminals can be swiveled around the rod into any position desired. They are adjustable to various sizes of cable and are so designed as to make the use of sleeves and solder unnecessary on the resistor leads entering the terminals.

End frames for standard resistors are formed from sheet steel and then galvanized. They are practically indestructible. The use of sheet steel for the end frames reduces the weight of the supporting structure to a minimum and renders that of the active material an exceptionally large percentage of the total. The upper portion of each end plate is bent over, as shown in Fig. 1, to form a flange. Two oblong bolt-holes (See Fig. 6) are punched in this flange so that the completed resistor or "frame" of grids (Fig. 1) may be bolted to the resistor hangers on the car. Steel bushings set in the tie-rod holes provide a generous bearing area at the points where the tie rods are supported and prevent any possibility of the frame chafing through the tie-rod insulation.

With 5-inch grids a special double frame (See Fig. 5) is ordinarily used when the grids can be put into this type frame which accommodates from 28 to 66 grids. This simplifies the installation and results in a very compact resistor.

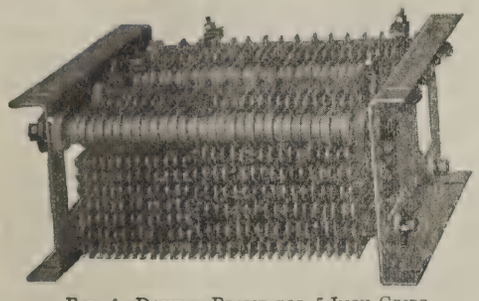


FIG. 4—DOUBLE FRAME FOR 5-INCH GRIDS

Tie rods for this service are made of round iron stock ½ inch in diameter and are mica insulated. This member is generously proportioned so that it is practically indestructible.

Finish—After being formed and after the steel bushings have been set in them, the end frames are heavily galvanized. Resistor grids are dipped in aluminum paint. This finish has given excellent satisfaction. The tie-rods are given a heavy coat of asphaltum varnish after assembling.

Insulation—Mica is used for insulation throughout. This material successfully withstands the effect of the high temperatures to which a resistor is sometimes subjected. Each tie-rod is heavily insulated with built up sheets of mica, wrapped around the rod. Where insulation is required between adjacent

FIG. 5—FORKED TERMINAL FOR RESISTOR

grids, mica washers are used. Mica washers are also used for insulating the grids from the end frames. (See Fig. 6). Each frame during inspection is subjected to an insulation test at a pressure of 2400 volts. This pressure is applied between the grids and the tie-rods and between the tie-rods and the end frames.

Railway type grid resistor frames are furnished with additional mounting insulation for use in hanging the resistor. Porcelain washers and insulating details complete but without hardware are included. The length of insulating tube with 8-inch resistors is sufficient for ½-inch diameter bolts up to 5 inches in length and with 5-inch resistors accommodates ⅜ inch bolts 4½ inches long or less.

Name Plate—On the end of each frame of grids a name plate gives the ohmic value per step, the pattern number and the arrangement of the grids in the steps of the resistor in that frame. This affords a ready reference for the inspectors going over the equipment.

The proper resistance values for use on the various controller notches, with any given railway equipment, are not determined merely by the horsepower of the motors and the type of their controller, as is sometimes supposed. The function of the resistance is to limit the current taken by the motors to such an amount that the tractive effort developed by them will not exceed a certain value per ton of car weight, which experience has shown to be desirable. It is, therefore, necessary in selecting a set of resistors for a given motor equipment, to consider the gear ratio of the motors and the weight of the car, line voltage (average, and maximum), wheel diameter and service in addition to the other conditions. It is impossible to specify a resistor of proper resistance for a given application without this data. The following is a typical form of order reading. If orders are entered with all blanks properly filled out, there will be no delay in furnishing the most satisfactory and economical design possible.

"—— Sets of —— inch grid resistors for use with —— number—— motors, gear ratio——to—— wheel diameter and —— inches, line voltage —— maximum to —— volts average and type—— controller on car weighing —— tons complete with equipment but without load."

STANDARD RESISTORS FOR RAILWAY SERVICE—Continued

TYPICAL DATA OF COMPLETE SETS OF RESISTORS

For Two-Motor Car Equipments

Type of Motor	Kw. at 600 Volts	Hp. at 600 Volts	Average Line Voltage	Gear Ratio	Wheel Diam. Inches	Car Weight Tons	Type Controller	No. Frames	Grids per Frame	Total Resistance	Each Wt. Lbs.
506-A2	19	25	500	14.68	24	10.7	K-10-Q	1	*56	6.40	60
506-A2	19	25	500	14.68	24	6.9	K-10-Q	1	*60	9.75	65
506-A2	19	25	500	14.68	26	6.9	K-63-A	1	*56	9.18	60
514-A	30	40	500	15.58	26	8.3	K-63-A	3	*30	8.34	115
514-A	30	40	525	15.58	26	10.5	K-10-Q	2	25	7.08	220
514-C	30	40	550	15.76	33	13.5	K-11-A	3	*28	6.26	95
532-B	37	50	500	15.69	33	15.7	K-36-J	2	20	4.59	170
532-A	37	50	550	18.54	28	12.6	K-36-J	2	25	5.00	217
632-B	37	50	525	17.67	33	13.3	K-36-J	3	25	5.16	320
306-V	48	65	500	26.58	33	18.9	K-36-J	2	28	3.02	240
306-V	48	65	550	15.69	33	12	K-36-J	2	30	6.36	255

For Four-Motor Car Equipments

506-A2	19	25	500	14.68	24	16.5	K-12-A	3	*30	3.99	110
506-A	19	25	470	14.58	24	15.7	K-35-G2	3	*22	3.34	80
506-C2	19	25	575	13.78	33	15.0	K-12-A	2	25	4.73	205
514-A	30	40	575	15.58	26	16.0	K-12-A	2	30	4.50	255
514-C	30	40	550	15.76	33	17.5	K-35-G2	1 2	14 28	4.22	335
514-C	30	40	550	19.72	33	20.3	K-35-G2	2	28	2.96	240
632-B	37	50	525	21.64	33	19.4	K-35-G2	3	22	2.6	310
532-B	37	50	525	16.69	33	23.5	K-35-G2	2	30	3.08	268
306-V	48	65	500	20.64	33	29.2	K-35-G2	3	28	1.72	372
306-V	48	65	600	15.69	33	26.0	K-35-G2	3	25	3.25	325
306-V	48	65	500	18.66	33	24.0	K-35-G2	3	30	2.40	405

*Five inch grids used in this set. First 3 sets listed are in the double frame.

Note—Use the above resistor data for estimating purposes only, and when ordering, fill in blanks in suggested form of order reading given on a preceding page.

BUS LINE RECEPTACLES AND JUMPERS

600 Volts

For transferring power circuits from one car to another a flexible length of cable is used with a plug at each end, the whole called a jumper. The jumper plugs engage with a suitable receptacle fitting at either end of the car. Cars will generally have to be equipped with two receptacles at each end if it is necessary to avoid interference with end doors.

Selection of the type and form of receptacle depends on the size of motor equipment and operating arrangements, as well as upon the mounting location on the car. In regard to the latter factor the dashboard form is recommended for general use. This form has a flange arranged for fastening against a vertical support as when it is inserted in the car dashboard. The alternative or bumper type has a bracket and lugs designed for attachment under a horizontal support, and is quite commonly suspended under the car-platform or bumpers.

When the larger motor equipments are involved and when power must be supplied to more than one trailing motor car, the capacity of bus line fittings must be of corresponding size.

Not only the curvature of the track, but also the truck center distance, the overhang from truck to location of receptacle, the type and length of car couplers, and other factors influence the flexible length of cable between jumper heads or plugs, and consequently the overall length of jumper by which length they are generally ordered. This length is preferably determined by actual measurements and should be forwarded to factory if special jumpers are to be made up. In general, the minimum workable length of jumper is desirable, and receptacles should be mounted as high on the dashboard as possible.

Among the notable construction details of the bus line receptacles are the phosphor bronze contact pins, split in order to obtain a tight spring effect, insuring good contact. These engage with brass contact blocks which also receive the cable by soldering at the rear end. Moulded material insulation is employed liberally and arranged so that the cover lid of the receptacle is entirely insulated from the main body casting. This prevents an arc being drawn to ground if the jumper is removed while current for compressor or lights is passing. Unless otherwise advised, the maximum size cable is used, extra flexible for jumpers and a stiffer stranded cable for receptacles.

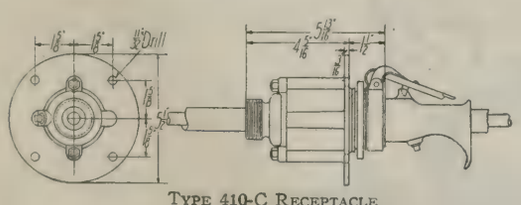
TYPE 410 RECEPTACLES AND TYPE 411 JUMPERS

The type 411 jumper is used with the various forms of type 410 receptacles. Two forms of the latter are listed; both for dashboard mounting. The type 410-C has the conduit outlet directly to the rear, while a curved casting is furnished with type 410-D. This will be assembled so that it has a direction towards the right hand when viewed from the front, although it may be adjusted to any of the three other quadrants. The bumper form of mounting is considered special, but can be supplied with conduit outlet to the rear.

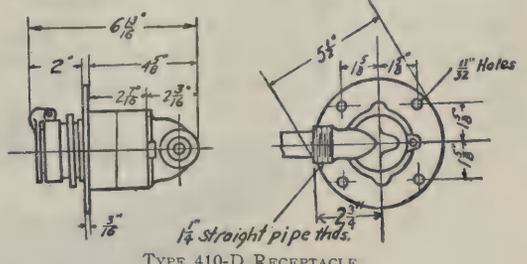
Description	Length Overall	Nominal Amperes Continuous	Mounting Form	Conduit Direction	Type No.	Style No.	Each Weight Lbs.	Each List Price
Receptacle	0 ft.*	200	Dashboard	Rear	410-C	114102	7	$21 50
Receptacle	6 ft. 6 in.*	200	Dashboard	Right Hand side	410-D	113495	12	30 00
Receptacle	8 ft. 0 in.*	200	Dashboard	Right Hand side	410-D	139281	13¼	31 50
Receptacle	9 ft. 0 in.*	200	Dashboard	Right Hand side	410-D	157275	14	33 00
Jumper	6 ft. 0 in.	200	.....	.....	411	113496	7½	28 75
Jumper	8 ft. max.	200	.....	.....	411	281154	9	30 75

Style 281154 is shipped with one jumperhead unattached, but with all details for cable to be cut off a suitable distance and jumper finished to the exact length required.

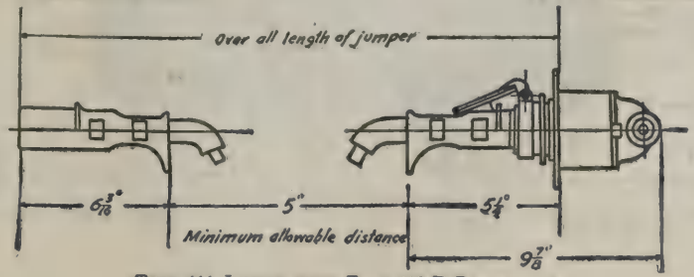
*Length given for receptacles is the free length of cable attached to the receptacle, measured outside of the casting. Style No. 114102 has no cable.



TYPE 410-C RECEPTACLE



TYPE 410-D RECEPTACLE



TYPE 411 JUMPER WITH TYPE 410-D RECEPTACLE

TYPE 440 RECEPTACLES AND TYPE 441 JUMPERS

TYPE 440-B RECEPTACLE WITH LID RAISED

These fittings are similar to the foregoing except that additional contacts are used and the size is increased generally to accommodate the larger capacity.

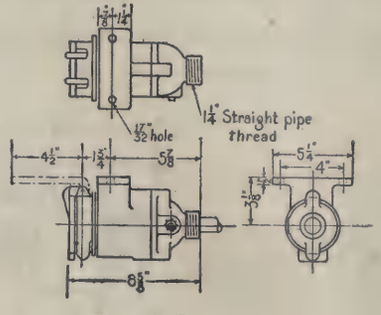
The receptacles have the protective cover construction described previously. Special forms can be supplied on order which meet various other mounting arrangements than are shown and listed. Besides the styles below, 1200 volt bus line fittings of this capacity can be furnished. Both bumper and dashboard forms have been developed in this latter class.

Type 441-B jumpers interchange with type 441 but differ in having a heavy casting arranged with a driving lug to withstand hammering.

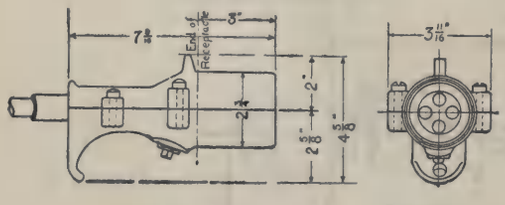
Description	Length Overall*	Nominal Amps. Continuous	Mounting Form	Conduit Direction	Type No.	Style No.	Weight Lbs.	List Price
Receptacle	0 ft.	400	Bumper	Rear	440-B	73853	12	$26 50
Receptacle	9 ft. 0 in.*	400	Bumper	Rear	440-B	281156	22	41 00
Jumper	5 ft. 11 in.	400	.....	.....	441	73854	16¾	41 00
Jumper	6 ft. max.	400	.....	.....	441	281155	17	33 00
Jumper	6 ft. 6 in.	400	.....	.....	441-B	254688	18	46 50

Style 281155 is shipped with one jumper head unattached, but with all details for cable to be cut off a suitable distance and jumper finished to the exact length required.

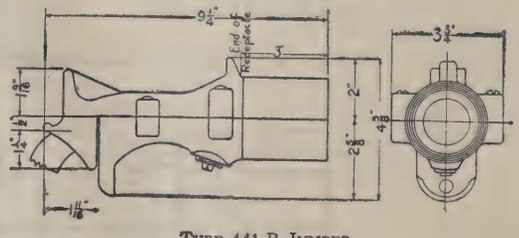
*Length given for receptacles is the free length of cable measured outside casting.



TYPE 440 RECEPTACLE

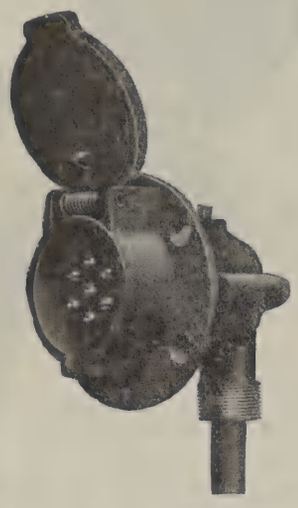


TYPE 441 JUMPER



TYPE 441-B JUMPER

TRAIN LINE RECEPTACLES AND JUMPERS



TYPE 436-D TRAIN LINE RECEPTACLE, DASHBOARD TYPE

TYPE 448-D TRAIN LINE RECEPTACLE, DASHBOARD TYPE

Train line receptacles and jumpers are devices used for extending from car to car the multi-conductor control wires required for effecting multiple unit operation of the main controlling apparatus on cars of a train. The different systems of control and the use of auxiliary circuits necessitate various numbers of train line wires. 7, 9 and 12 point lines are in common use for 600 volt railway control, and the apparatus described below is that largely used in the Westinghouse electro-pneumatic control.

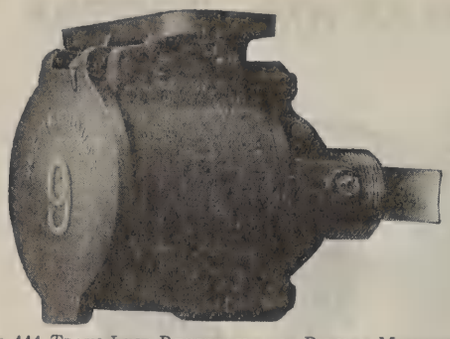
The general information given under bus line fittings applies to train line details as regards the length of jumpers, and the mounting forms of receptacles. Since the manufacturer has better facilities for assembling the train line details with the multi-conductor cables, more attention should be paid in order to secure the proper length of cables already attached.

A Receptacle is made of an iron casting in cylindrical form with a back casting which is provided for conduit attachment. Some forms are curved and permit of adjustment in four directions while others lead straight back. A hinged lid is provided to cover the front and contains a leather pad to act as packing. A spring keeps the cover shut unless a jumper plug is inserted in which event the combination assists in retaining the jumper. Should cars become uncoupled without pulling out the jumper, the latter will release itself from the spring cover.

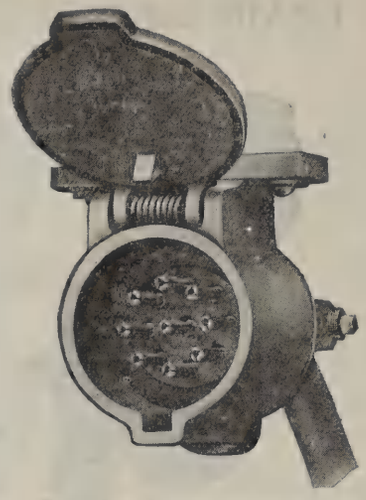
The jumper consists of two jumper heads at the ends of a suitable length of cable. The plug castings have guides to insure that they are inserted in the receptacle properly. The pins which transfer the individual circuits consequently mate properly with the contacts in the jumper. The jumper contacts are provided with an internal sliding member having a helical spring to force this sliding wedge into the points of the receptacle pin where the latter is split. Exceptionally reliable contacts are secured by this method of construction.

TYPE 449 TRAIN LINE JUMPER

TRAIN LIN RECEPTACLES AND JUMPERS—Continued



TYPE 444 TRAIN LINE RECEPTACLE FOR BUMPER MOUNTING, CLOSED



TYPE 444 TRAIN LINE RECEPTACLE WITH COVER OPEN

Cables for train line details are made up in multi-conductor sets, each conductor consisting of 19 strands of ″.0142 copper wire or equivalent. Each conductor is insulated and the bunch are made up into one cable with the use of binding tape, filler, and outer braids. In order to make the jumper cable extra flexible, very fine copper wires are used braided around a central steel core which itself is made of stranded wires. Special rubber insulation and braid are applied to these individual conductors and the proper number are made up into the final jumper cable which has paper and rubber insulation layers and additional tape and double outer braids. In making up complete jumpers turns of phosphor bronze wire spaced a quarter inch apart are wound around the central portion of the jumper, this armor serving as a protection to the cable.

Jumpers as listed under style number, unless otherwise ordered, have one pair of wires interchanged; the remaining points are correspondingly connected. Inquiries for special jumpers complete (two jumper heads assembled with cable) should be addressed to nearest district office. Overall length of jumper measured over ends of jumper heads should be specified.

Apparatus	Length*	No. of Conductors	Mounting Form	Conduit Direction	Style No.	Type No.	Wt., Lbs.	List Price
Receptacle	0 ft.	7	Bumper	R. H. Side	65608	436-B	11½	$26 50
Receptacle	0 ft.	7	Bumper	L. H. Side	65609	436-B	11½	26 50
Receptacle	0 ft.	7	Bumper	Rear	65610	436-C	11¼	24 00
Receptacle	0 ft.	7	Dashboard	Curved down	70555	436-D	12	26 50
Receptacle	10 ft. 0 in.*	7	Dashboard	Curved down	61433	436-D	16	26 50
Jumper	6 ft. 0 in.	7	.....	.....	61434	437-A	15½	41 00
Receptacle	10 ft. 0 in.*	9	Dashboard	R. H. Side	87637	444-C	16¾	26 50
Receptacle	7 ft. 0 in.*	9	Dashboard	L. H. Side	97870	444-C	18	36 25
Receptacle	0 ft. 0 in.	9	Dashboard	Rear	254679	444-D	12	24 50
Receptacle	0 ft. 0 in.	9	Bumper(Inverted)	Rear	61721	444-G	13	24 00
Receptacle	0 ft. 0 in.	9	Bumper	Rear	61720	444	13	24 00
Jumper	6 ft. 10 in.	9	.....	.....	97878	445	14	37 50
Receptacle	0 ft. 0 in.	12	Bumper	Rear	99008	448	11½	22 00
Receptacle	0 ft. 0 in.	12	Dashboard	Curved down	93596	448-D	12½	20 75
Receptacle	7 ft. 0 in.*	12	Dashboard	Curved down	138877	448-D	17	8 60
Receptacle	9 ft. 0 in.*	12	Dashboard	Curved down	141426	448-D	18	36 25
Receptacle	0 ft. 0 in.	12	Dashboard	Rear	254683	448-F	11½	28 75
Jumper	5 ft. 0 in.	12	.....	.....	207313	449	20½	60 00
Jumper	5 ft. 6 in.	12	.....	.....	207314	449	21	61 75
Jumper	6 ft. 10 in.	12	.....	.....	138885	449	22¼	66 60
Jumper	8 ft. 0 in.	12	.....	.....	141769	449	25	70 75

*Length given for receptacles is the free length of cable measured outside of casting.

TRAIN LINE RECEPTACLES AND JUMPERS—Continued

OUTLINE DIMENSIONS

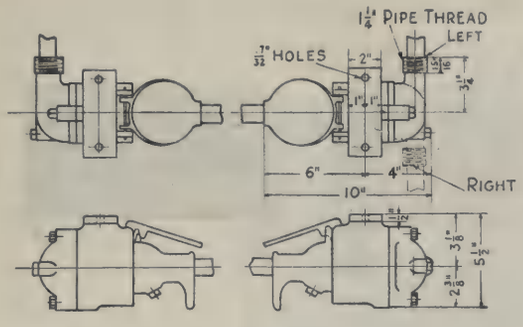


FIG. 1

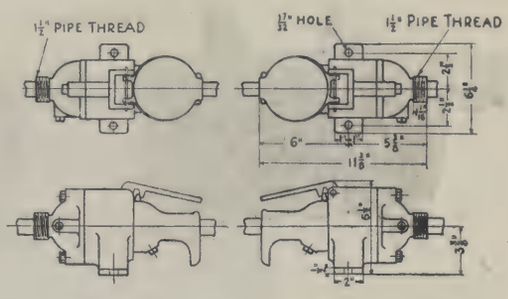


FIG. 2

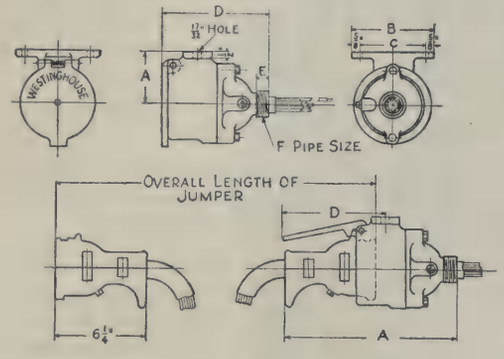


FIG. 3

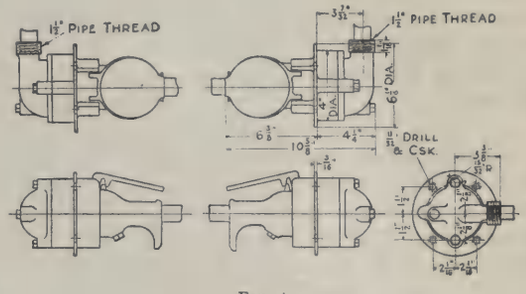


FIG. 4

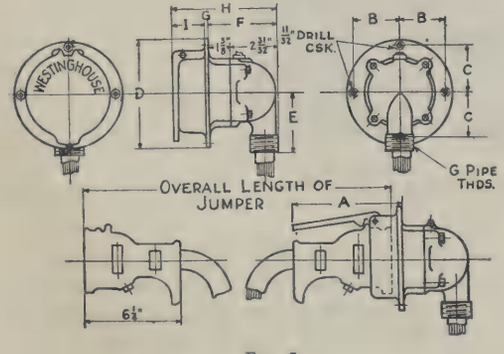


FIG. 5

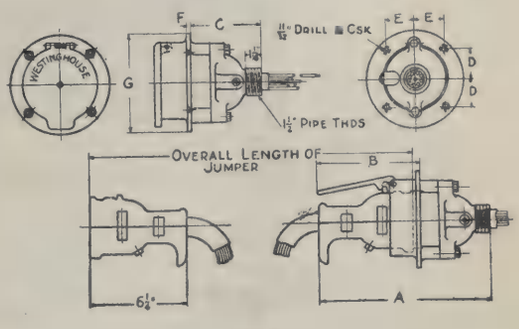


FIG. 6

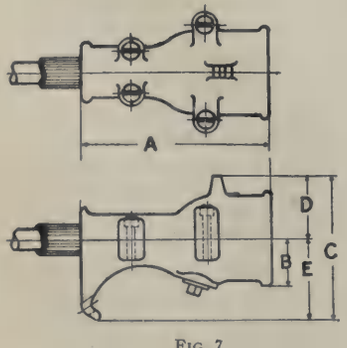
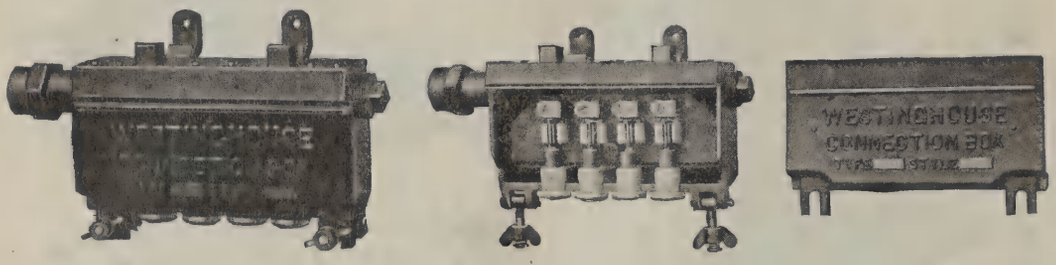


FIG. 7

Type	Fig.	Dimensions in Inches A	B	C	D	E	F	G	H	I	J
436-B	1	...	...	...	...	...	...	...	...	...	...
436-C	3	3 1/8	5 1/4	4	6 1/8	...	1 1/4	...	...	...	...
436-D	5	5 11/16	1 7/8	1 3/8	3 1/4	5 3/4	3 7/8	1/16	5 1/8	1 7/8	1 1/4
437-A	7	6 1/16	1 3/4	4 5/8	2	2 5/8	...	...	...	...	...
444-C	4	...	...	...	...	...	...	...	...	...	...
444-D	6	11 3/8	6 1/16	4 1/16	1 1/2	2 1/16	3/8	6 1/4	...	...	...
444-G	2	...	...	...	...	...	...	...	...	...	...
444	3	3 3/8	5 1/4	4	6 5/8	1 1/16	1 1/2	...	...	...	...
445	7	6 1/16	1 1/16	4 7/8	2 3/16	2 1/16	...	...	...	...	...
448	3	3 1/16	5 3/4	4 1/2	6 1/16	1 1/16	1 1/2				
448-D	5	7 1/2	3	3	3 1/4	6 3/4	4 1/2	1/4	6 3/4	2 3/8	1 1/2
448-F	6	11 11/16	6 3/4	5 1/8	2	2	1/4	6 3/4	...	...	...
449	7	6 1/4	2 1/8	5 1/4	2 3/8	2 7/8	...	...	...	...	...

MOTOR CONNECTION BOX

Type 151



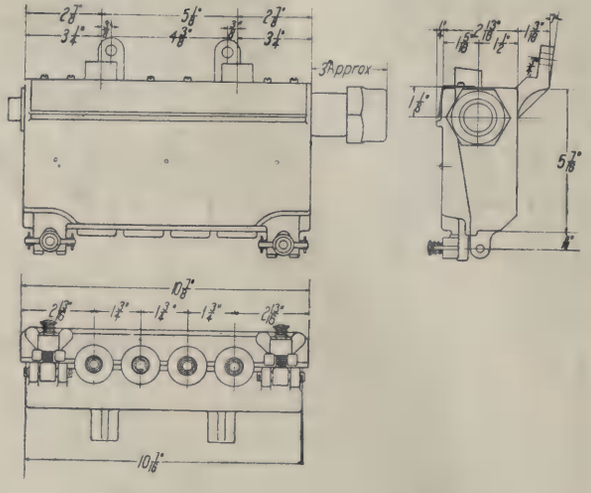
This main circuit connection box is essentially a conduit fitting designed to serve as a junction box for the flexible motor cables leading from the trucks to the car body. This box is to be installed permanently along with the car wiring to main controllers, reversers and grid resistors. It is arranged for the ready disconnection of the motor leads and eliminates the necessity of other separable connectors.

A cast iron base constitutes the main part of the box. Access is obtained by removing the cast iron cover which is held by two eyebolts and secured thumb nuts. The car cables enter from either end of the box at the top and fasten to terminal lugs carried on an insulated base. Brass sleeve bushings are provided for soldering to these leads which are then clamped by the stationary terminal lugs. The incoming motor leads are to be fitted with the copper tube terminal supplied. These are designed for connection to the lower jaws of the stationary terminal lug, and are as readily removable as a knife blade type of fuse is from its holder.

Soft rubber bushings in the lower part of the box clamp the motor leads when compressed by the cover. The whole box is made weather-proof.

Style number and list price include the box complete with a nipple and bell-mouth fitting for one end of the box. The bell-mouth bushing has an inside diameter of $1\frac{3}{32}$ inches. A $1\frac{1}{4}$-inch pipe plug is provided for the other tapped hole.

OUTLINE DIMENSIONS



Style No.	Description	Approx. Wt., Lbs.	List Price
169764	Type 151 Connection Box	25	$25 00

RICO COASTING TIME RECORDERS

FOR USE ON ELECTRIC CARS, CITY AND INTERURBAN TYPES, AND ON MULTIPLE-UNIT TRAINS

FIG. 1—RICO COASTING TIME RECORDER IN A CAR

The Rico Coasting Time Recorder is an instrument which records the **actual number of minutes that an electric car or train is operated without the use of power or brakes.** It is an efficient and desirable device to secure greater economy in operating railway equipments.

It reads in "coasting minutes," delivering a printed voucher-slip to the motorman at the end of each run. This voucher-slip shows the degree of economy which the motorman has exercised on every run. By a system of ranking or rewards, the railway company may make a practical and monetary inducement to the men for **economical operation,** and thus greatly reduce the amount of power ordinarily used in the propulsion of electric cars. Its purpose is to make a motorman substitute brains for sheer muscle.

These instruments are manufactured by the Railway Improvement Company, of New York, and are offered for sale by the Westinghouse Electric & Manufacturing Company for use with equipments of its manufacture.

SHIPPING

The manufacturer and the Company are not responsible for breakage in transit. All instruments are carefully packed by experienced men, and in the event of breakage en route customers should make a claim immediately on the carriers.

The manufacturer and the Company disclaim responsibility under any circumstances for direct or indirect damage or expenses arising from defective material or workmanship, or from accident or other unforeseen circumstances.

In ordering Coasting Recorders the line voltage, type of controller and motor and brakes should be specified.

GUARANTEE

All instruments are carefully tested before leaving the manufacturers' works, and are sent out in perfect

RICO COASTING TIME RECORDERS—Continued

working order and condition. The manufacturer therefore gives to purchasers of instruments the following guarantee:

If within a year from the date of purchase any defect is discovered in any instrument in respect to material or workmanship, the manufacturer undertakes to make good the defect at their own expense, provided that notice is given as soon as the defect is discovered and that the instrument is immediately forwarded to the manufacturer's works, transportation paid. Responsibility is in all cases limited to the cost of making good the defect. This guarantee does not apply to defects caused by wear and tear, accident, misuse, or neglect.

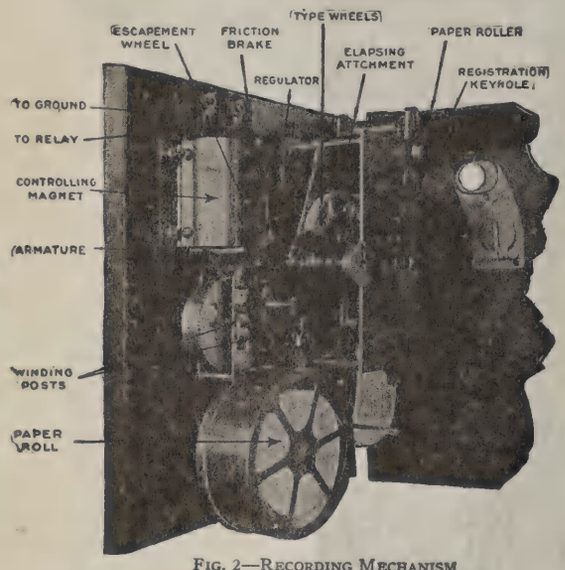


FIG. 2—RECORDING MECHANISM

ADVANTAGE OF COASTING

This device provides an accurate and consistent means of obtaining a record of the amount of coasting secured in the operation of electric railway equipments. The energy input to a car is utilized to overcome the resistor losses in starting, to overcome the losses in the motors and wiring, to impart velocity to the car, and to overcome friction. By far the larger part of the energy for a service with frequent stops is that required to impart velocity to the car. The momentum thus imparted to a car will keep it in motion for a considerable time if the power is shut off. Although coasting to a standstill is not practicable for the accomplishment of reasonable schedule service, improvement in economy of current consumption can be effected by the nearest permissible approach to the above condition. The greater the amount of coasting on any given schedule, the less total energy expended for its accomplishment.

It has long been admitted that a large part of the total electrical energy is wasted daily on nearly every railroad in the country through the variable handling of cars by motormen, and it is remarkable that this great loss has continued for years without steps having been taken to correct it.

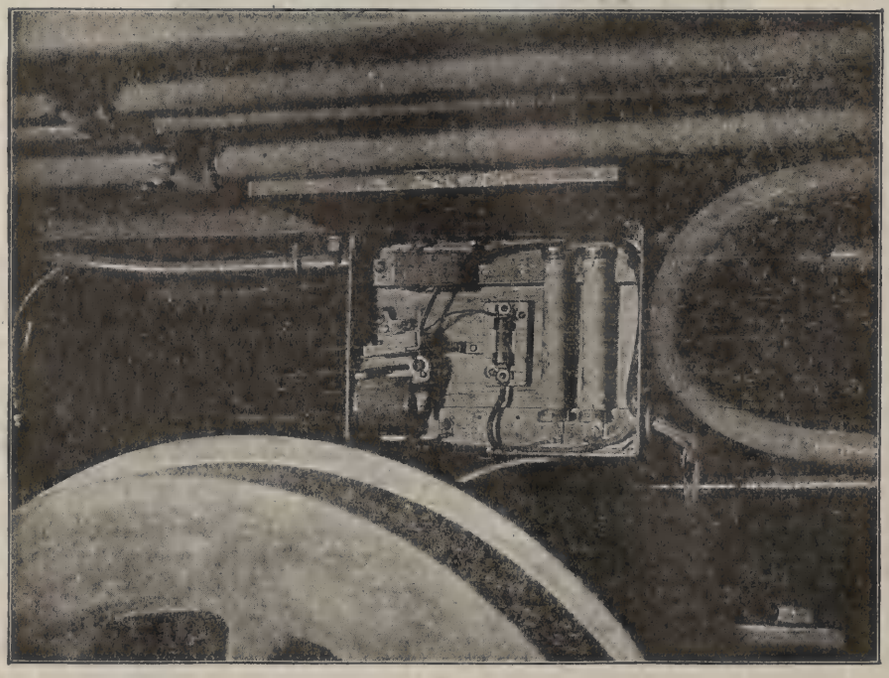


FIG. 3—RELAY INSTALLED UNDER CAR

RICO COASTING TIME RECORDERS—Continued

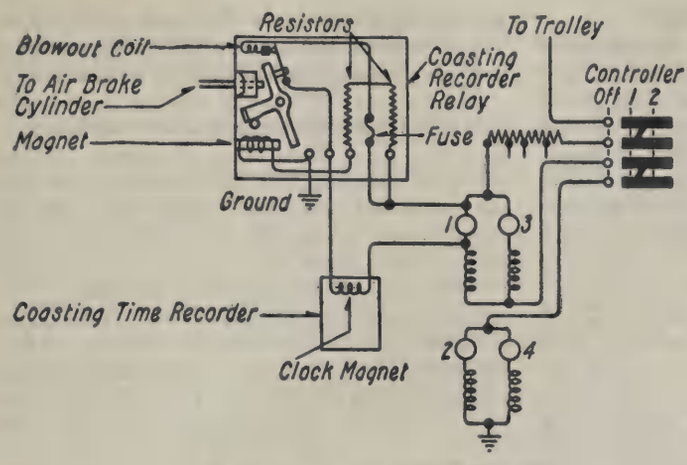


FIG. 4—SCHEMATIC DIAGRAM

The Railway Improvement Company's Coasting Time Recorders have proven in service that they effectually eliminate most of this loss.

The usual procedure in car operation is commonly about as follows:

An inexperienced man is given a brief period of instruction and then placed in charge of an electric car or train without a definite check to determine what degree of economy he actualy exercises. The motorman often becomes careless and falls into a perfectly human "habit" of operation without regard to the power he is using or to abuse of the equipment.

The Coasting Recorder is a simple and reliable automatic device which effectively puts an automatic and impartial check upon each man at all times. It records in coasting minutes, and its object and method of operation are readily understood by the motorman, who soon becomes not only on the alert in its use but enthusiastic in the support of operation which is increasing his efficiency and actually his earning power. The Coasting Recorder is an efficient guide for the motorman to operate properly. It provides a continuous check on his operation for each trip.

DESCRIPTION OF INSTRUMENT

The Coasting Recorder consists of a recording mechanism as shown in Fig. 2 and an electric relay. One recorder and one relay are necessary for each car or each multiple-unit train. The recording mechanism consists of a specially-designed recording instrument somewhat similar to those in use for factory time keeping. The printing mechanism is controlled and driven by a double-spring marine-movement clock, especially designed to withstand excessive vibration and climatic changes. This clock movement is directly geared to the recording mechanism and both are mounted on a solid cast-steel frame and enclosed in a steel case. Each motorman is given a registration key, bearing his badge number. With this key he registers at the beginning and end of the trip.

An examination of the schematic diagram, Fig. 4, shows that the current can reach the controlling magnet on the clock movement only when the traction motors are running as generators; the back e.m.f. or generated voltage of the motors when coasting furnishes energy for the clock magnet. The magnet and brake attachment is so arranged that it can be adjusted to meet any operating condition.

The electric relay is so arranged that when the controller is "on" no current can get through to the clock magnet from the traction motors. When the brakes are applied the clock circuit is opened. Consequently a motorman must have the car moving without power or brakes on in order to operate the clock.

With this type of relay it is impossible for a motorman to "coast to a standstill" and obtain a fictitious record, as the energy which operates the clock magnet ceases when the motor stops.

The relay is enclosed in a substantial steel case, and locked or sealed as desired.

On straight air-brake cars the relay is installed at any convenient place, but where hand brakes are used exclusively the relay is installed under the car.

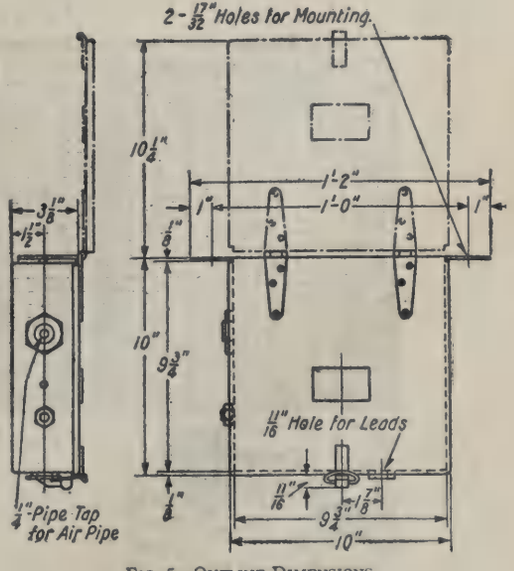


FIG. 5—OUTLINE DIMENSIONS

Dimensions given are for reference only.

OPERATING ECONOMIES

There are three elements which directly affect coasting, namely: acceleration, retardation, and running time. Records from tests made under actual operating conditions show that there is a marked difference between motormen in power consumption, an inefficient operator using as much as 81.8 per cent more power than the efficient, while to the casual observer the only difference in the operation of the two motormen is the more even starting and stopping of the car by the efficient man.

There is also a marked difference in the peaks of current used by operators, as well as in the total power used with the same running time and the same stops. For example:

An efficient operator uses 16.4 ampere-hours against 30.8 ampere-hours of the inefficient operator. The kilowatts per car mile of the efficient operator are 2.087 as compared with 3.800 of the inefficient man.

Fig. 6 shows the effect of coasting on the peak load of a substation supplying a metered line operating fifty cars. The number of car miles are also shown by hours in order to obtain a comparison with the station load, which is plotted by hours, with the corresponding percentage of coasting and total kilowatt-hour power consumption. It is evident from reference to this chart that the peaks on the several curves correspond generally. This shows in a case of the actual service on a metered line that the relation between coasting and power consumption is directly proportional. Thus, when a motorman increases his coasting one per cent and main-

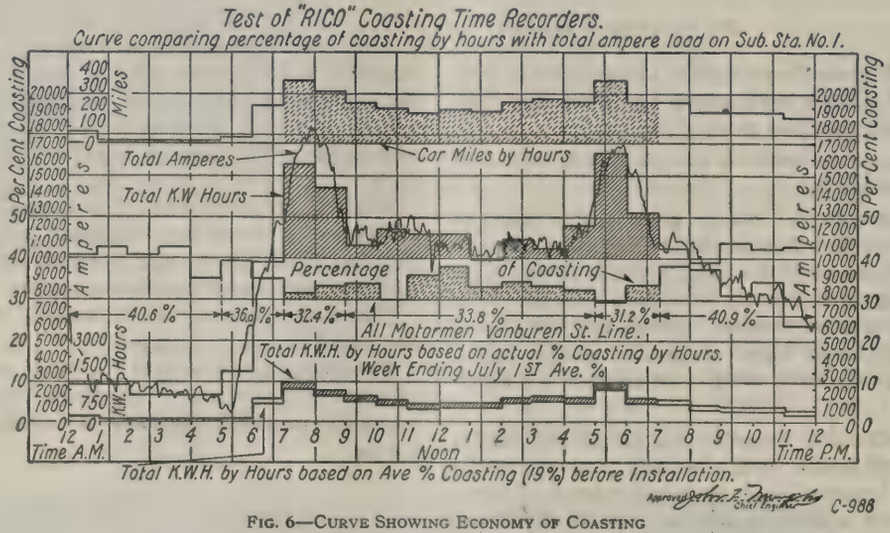
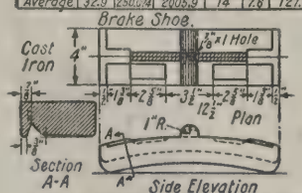


FIG. 6—CURVE SHOWING ECONOMY OF COASTING

Brake Shoe Test.

Showing Wear per 1000 Car Miles, Average Life of Shoes, Quality of Casting, Etc - Test Entire Van Buren St. Line Equipped with Rico Coasting Time Recorders.

No.	Car No.	Total Days on Car	Total Trips Made	Total Car Miles	Bad Cstgs in Set	% Bad Cstg.	Weight of Old Shoe per Set	Loss in Weight per Set-8 Total Car Miles	Loss in Weight per Set-8 One Car Mile	Lbs. per 1000 C.M.	Remarks	Pounds Lost per 1000 Miles (Lbs 10 20 30 40 50 60 70 80 90)
1	733	14	160	1280	0	0	148.50	44.86	.0350	35.0	Not Worn Much	
2	729	20	179	1432	2	25.	138.33	54.51	.0378	37.8	6-Badly Worn	
3	701	18	191	1528	0	0	142.00	51.36	.0336	33.6	Not Worn Much	
4	723	17	195	1560	0	0	140.45	52.71	.0338	33.8	Uniformly Worn	
5	720	17	205	1640	2	25.	133.60	59.76	.0364	36.4	3-Worn Out	
6	746	25	208	1664	0	0	143.20	50.16	.0345	30.5	1-Badly Worn	
7	720	19	220	1760	0	0	139.50	53.86	.0306	30.6	1- " "	
8	739	25	226	1808	0	0	128.50	64.86	.0359	35.9	Uniformly Worn	
9	743	21	231	1848	0	0	128.00	65.36	.0352	35.2	4-Badly Worn	
10	722	19	237	1896	1	12.5	126.48	66.88	.0352	35.2	2- " "	
11	717	29	247	1976	0	0	127.44	65.97	.0334	33.4	3- " "	
12	735	24	252	2016	0	0	132.00	61.36	.0306	30.6	1- " "	
13	714	22	262	2096	0	0	128.48	64.88	.0309	30.9	4-Worn Out	
14	707	25	269	2152	0	0	117.50	75.86	.0352	35.2	Uniformly Worn	
15	703	21	271	2168	0	0	129.53	63.83	.0294	29.4	" "	
16	708	21	272	2176	0	0	118.00	75.36	.0346	34.6	Worn Out	
17	744	20	272	2176	1	12.5	127.48	70.88	.0363	36.3	Uniformly Worn	
18	702	24	278	2224	2	25.	122.88	70.48	.0316	31.6	" "	
19	749	26	298	2384	0	0	122.96	70.40	.0295	29.5	" "	
20	718	28	311	2488	3	37.5	109.96	83.44	.0334	33.4	" "	
21	705	29	327	2616	0	0	129.25	64.11	.0245	24.5	" "	
22	711	32	328	2624	3	37.5	110.82	82.74	.0315	31.5	1-Worn Out 7-Uniform	
23	745	32	328	2924	0	0	120.00	73.36	.0229	27.9	Uniformly Worn	
Average		32.9	250.04	2005.9	14	7.8	127.83	64.65	.0322	32.2		



Used on Van Buren Street Line and Kedzie Ave. Line.

Average Saving Based on Van Buren St. before Installation = 45.1 %
" " " " Kedzie Ave. " " 35.7 %
" " " " Van Buren & Kedzie " " 40.8 %

Chicago Railways Co.
Engineering Department
Drawn By
Checked by
Approved by Chief Engr.
Date 7-22-19 Drwg. No. C-988

FIG. 7—SAVING OF BRAKE SHOES BY COASTING

RICO COASTING TIME RECORDERS—Continued

tains the same schedule running time, he has reduced the power consumption one per cent.

ECONOMY IN BRAKE SHOE WEAR

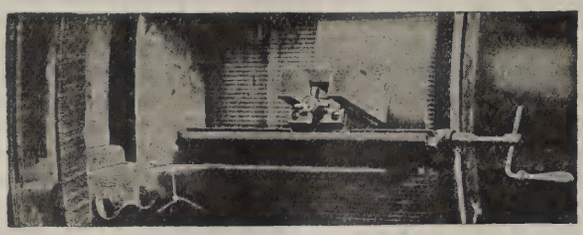
In order to obtain the maximum coasting a motorman must necessarily accelerate properly. The most efficient operator secures a minimum dissipation of energy by the brake shoes, which he usually obtains in practice by the stopping of a car with one application of the air and eliminates the "pinching of brakes" or "fanning of air", commonly practiced by many motormen.

Through the use of the Coasting Recorder more uniform as well as less total wear on brake shoes is effected, with the resultant maintenance saving. From test it has been found under ordinary conditions that a brake shoe loses in weight on the average from six to eight pounds per 1000 car miles. This loss has been reduced on an average of 40 per cent, and in some cases more, after applying the Coasting Recorder to the equipment.

Additional savings, both direct and indirect, are obtained through more alert and efficient operation. The direct savings are maintenance items, including wheels, car body, and other details of equipment, while the indirect are due to the continuous check and record of the motorman's operations which result in material improvement in his all-around efficiency.

For complete description of the apparatus, refer to the Operating and Engineering Data Book of the Railway Improvement Company, 165 Broadway, New York City.

COMMUTATOR TRUING DEVICE



This device is intended for truing a commutator that has been roughened in service. It is a simple and satisfactory device that does not require any auxiliary motor or driving power.

It is similar to a slide rest of a small engine lathe, being arranged to mount on any of our standard forms of brushholder brackets after the brushholders are removed. The brushholder bracket is braced at the outer end by wooden blocks or similar means to prevent vibration.

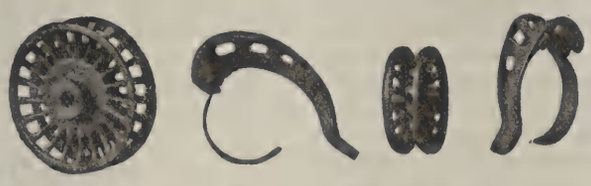
Instead of a regular cutting or lathe tool a piece of carborundum stone is employed, as this will true the commutator and leave it smooth with a minimum removal of copper. The stone is clamped on and moved back and forth across the face of the commutator by a screw feed rotated by hand, the armature being rotated at the same time at normal speed. Pressure of the stone against the commutator is obtained by a cross screw feed.

The parts of the device are accurately machined and fitted to get an accurate and true surface on the commutator. They are of sufficient size to secure requisite rigidity and at the same time the device is light enough to be easily portable from one machine or station to another.

		Each—Approx. Wt.—Lbs.		
Style No.	For Commutator Face—Inches	Net	Shipping	List Price
218053	Up to 18	50	60	$285 00
218054	18 to 30	50	60	315 00
218055	30 to 36	50	60	340 00

Order by Style Number

NUTTALL RAILWAY AND INDUSTRIAL TROLLEYS



SLEET WHEELS AND SCRAPERS

The Nuttall Company manufactures overhead trolleys, of two types—Pole Trolleys and Pantagraphs for electric railway, mine and industrial haulage. Their function is to collect and conduct current from trolley wire to car or locomotive and the application of one or the other depends upon operating speed, overhead construction and current to be collected.

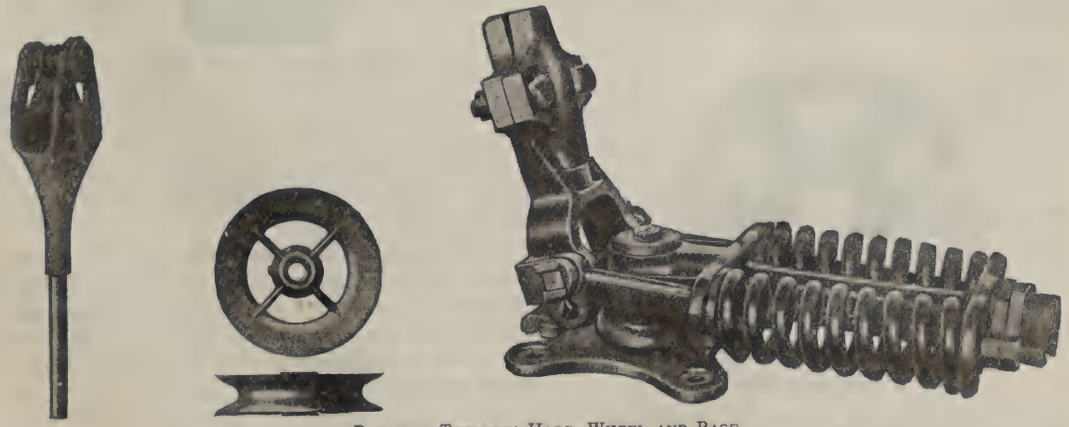
Pole Trolleys—A simple contact, capable of collecting current from the wire at any speed is provided by any of the 15 types of bronze wheels, running in harps, secured to steel poles. The force necessary to hold the wheel firmly against the wire is applied to the pole by springs in the trolley base. A pole socket on a horizontal bearing allows the pole position to change as required by variations in height of wire, and a swivel on a vertical bearing allows it to follow changes in alignment.

The prime mechanical requisite in a trolley base is sensitiveness; that is, ability to conform instantly to abrupt vertical or lateral variations in the trolley wire. The main springs and the resiliency of the pole accommodate vertical variations, and almost frictionless swivelling movement compensates for changes in wire alignment.

All pole trolleys are the same in general principle and the only differences are mechanical, to suit a trolley to each class of service.

Pantagraphs—This design meets the demand for a trolley which will stay on the wire under any conditions except the most extreme and abnormal. Poor overhead work or track may throw the most perfect wheel trolley from the wire, but does not affect the pantagraph and it is suited to highest speed service, collecting currents of 1600 to 3000 amperes during acceleration, 400 to 800 continuously and the high voltages used in traction service.

Its contact shoe is held against the wire by extension springs and lowered by compressed air under control of the motorman, or vice versa. Contact is made by a roller or by one or two sliding shoes, depending upon service conditions. Its frame-work is seamless steel tubing, and its principal castings malleable iron. Trolleys of every description are made for all railway, mine and mill haulage requirements.



RAILWAY TROLLEY; HARP, WHEEL AND BASE

NUTTALL RAILWAY GEARS

The first cut tooth gearing was manufactured for electric railway motors. As its use became general for this class of service, the advantages were recognized by industrial gear users and while the transition has been slower in this field, there are now very few industrial applications where cut gearing is not in general use.

The rapid development and improvements in the construction of electric railway motors, to meet the increasingly severe conditions of traction service have demanded similar developments and improvements in the gearing. Designs have been changed, heat treatment evolved, the quality of the steel improved—all through co-operative research and experiment on the part of the motor manufacturers, the gear cutters and the steel makers.

And keeping pace with all these developments have been the improvements in gear cutting machinery. New designs, new methods, new ideas have combined for the more economical production of better gearing. The turning, boring, cutting—every operation is done by improved machinery.

A heat treating department equipped with modern heating furnaces, electric pyrometers, proper quenching baths and Brinell and scleroscope hardness testing machines guarantees gearing of the proper grade for any particular application and guarantees a uniformity of product.

Spur Gears

The spur type of gearing has an undesirable feature inherent in that type of gear tooth, viz. vibration with attendant noise and deterioration of a great variety of parts of equipment with consequent increased maintenance expense. As long as there have been electric railroads, spur gear vibration has been quite generally accepted as an ill, which was a fundamental parasite and must be tolerated.

A Split Spur Gear

Even though great advances in accuracy of manufacture and improvements in methods of heat treatment and better quality of materials have been obtained, these are merely detail improvements and have failed to reach the fundamental cause of vibration inherent in the spur gearing.

Helical Gears

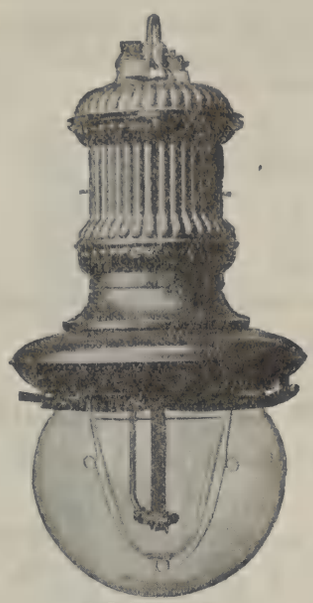
The action of this type of gear is best realized by thinking of it as if it were made up of a number of thin spur gears with the teeth of each successive gear element advanced thru a small angle relative to its neighbor. It then becomes clear that only one tooth of one narrow gear enters into contact with the corresponding tooth of the single narrow pinion at any given time.

A Helical Pinion and Gear

This action of the helical gearing insures smooth operation and practically eliminates the excessive vibration and noise found in the spur type of gearing.

The absence of shock and vibration in helical gearing results in longer life for these gears. From actual service tests, the maintenance of equipment was reduced as much as 25 to 50 per cent by the use of helical gears; and the life of the gears themselves was increased 200 to 300 per cent.

TYPE H FLAME-CARBON ARC LAMPS



D.C. Multiple

Applications—For factories, warehouses, mills, and other large industrial plants where the intensity of illumination should be uniform over the working surface, as well as for street, park, and boulevard lighting, these lamps give excellent and efficient illumination. Their exceptionally substantial construction and wide light distribution make them the best lamps to use in outdoor construction work, in quarries, in railroad yards, etc. Their intense illumination at low cost also makes them very desirable for display lighting in front of stores or theatres, or for the lighting of public squares.

Equipped with yellow-light carbons, which can be furnished instead of white-light carbons without additional cost, the lamps produce a light of great intensity and high penetrating power for the smoky and dusty interiors of foundries, train sheds, steel mills, and similar places. For marine work, on docks, etc., this yellow light is particularly desirable to penetrate fogs.

Carbons—A homogeneous, impregnated carbon, 7/8 by 14 inches, is used in these lamps. An average life of approximately 130 hours per trim is obtained.

PERFORMANCE

A. C. series lamps—When the standard lamp is adjusted for 10 amperes and 53 volts at terminals, the approximate performance on a 60-cycle circuit will be as follows:

Arc voltage	47.5
Lamp power factor	84%
Lamp watts	445
Electrical efficiency of lamp	91%

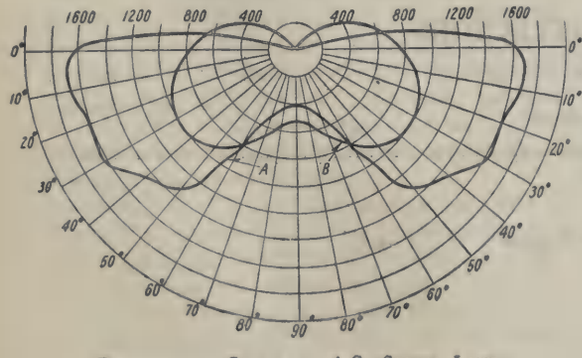
A. C. multiple lamps—When adjusted for 10-amperes and 48 volts at the arc, the approximate performance of the 110-volt, 60-cycle standard lamp operated on a 110-volt circuit will be as follows:

Lamp power factor	60.5%
Lamp watts	500
Electrical efficiency	86%

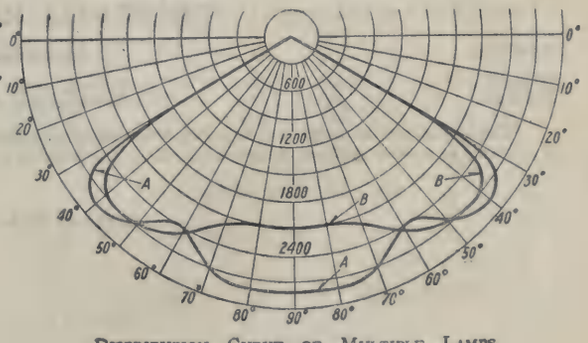
Performance of lamps of other ratings will be furnished on request.

Operation on other circuits—Standard 10-ampere lamps may be operated on series circuits of lower current value by using an auto-transformer with each lamp. The transformer may be placed in the lamp or mounted separately. The externally mounted transformer is entirely weather-proof and is arranged for mounting directly above the lamp. In case the secondary accidentally open-circuits, the auto-transformer will operate continuously without injury to the windings.

D. C. lamps—Performance is given in table of style numbers and price list.



Distribution Curve of A.C. Series Lamp



Distribution Curve of Multiple Lamps with Industrial Reflector

TYPE H FLAME-CARBON ARC LAMPS—Continued

A. C. SERIES LAMPS

Style number includes lamp complete with one set of carbons and glassware. In ordering, state whether white-light or yellow-light carbons are desired, and also the kind of glassware wanted. Also indicate voltage variation; i. e., maximum and minimum circuit voltage.

Style No.	Frequency Cycles	Current Amperes	Amperes At Arc	Fig. No.	Dimension A, Inches	Approx. Wt., Lb. Net With Glassware	Approx. Wt., Lb. Shipping, Without Glassware	List Price
217636	60	10*	9.5	1	31¾	53	96	
219431	60	6.6 or 7.5†	10.	1	36½	68	120	On
221089	50	10	9.5	1	36½	68	120	Request
221088	25	10	9.5	1	38	78	133	

*The external auto-transformer listed below can be supplied for use with this lamp on 6.6 or 7.5-ampere circuits.
†Auto-transformers are contained in these lamps.
Information on lamps for other frequencies will be furnished on request.

AUTO-CURRENT TRANSFORMERS FOR A.C. SERIES LAMPS

Style number covers auto-transformer with taps for operating one 10-ampere lamp on either 6.6 or 7.5-ampere, 60-cycle circuit.

Style No.	Frequency Cycle	Current Amperes	Amps. at Arc	Fig. No.	Net Weight	Shipping Weight	List Price
107516	60	6.6 or 7.5	10	2	14	30	On Request

A. C. MULTIPLE LAMPS

Style No.	Frequency Cycles	Normal Terminal Voltage	Range of Adjustment Volts	Amps. at Arc	Approx. Amps. at Terminals	Fig. No.	Dimension A, Inches	Approx. Wt., Lb. Net With Glassware	Approx. Wt., Lb. Shipping Without Glassware	List Price
219430	60	110	100 to 125	10	7 to 7.5	3	36½	65	125	
217637	60	220	200 to 250	10	3.5 to 4	3	36½	70	132	On
217638	50	110	100 to 125	10	7 to 7.5	3	36½	65	125	Request
217639	50	220	200 to 250	10	3.5 to 4	3	36½	70	132	
217640	25	110	100 to 125	10	7.5 to 8	3	38	78	140	

D. C. MULTIPLE LAMP

Style No.	Current Amperes	Voltage Range	No. of Lamps in Series	Normal Terminal Voltage Per Lamp	Approx. Arc Voltage	Fig. No.	Dimension A Inches	Approx. Wt., Lb. Net With Glassware	Approx. Wt., Lb. Shipping Without Glassware	List Price
217641	6.5	100 to 125	1	110	70	1	31¾	49	92	On Request

*D. C. MULTIPLE-SERIES LAMPS

221136	10	100 to 125	2	55	40	1	31¾	53	96	On
221134	6.5	200 to 250	2	110	70	1	31¾	53	96	Request

INDUSTRIAL REFLECTORS

Style No.	Description	List Price
202748	Reflector only	On Request
202749	Reflector with spacers	

*The multiple-series lamps have no substantial resistor and therefore cannot be used on circuits of higher voltage than listed. If one lamp in a series goes out of service, the other ceases to burn.

METALLIC-FLAME SERIES ARC LAMPS

TYPES B AND C—FOR DIRECT-CURRENT CIRCUITS

TYPE B LAMP

TYPE C LAMP

Westinghouse metallic flame arc lamps represent the most advanced development in direct-current arc lamp practice for the lighting of large areas. The distribution of the light is ideal for street illumination or for railway shops and yards and other areas where high voltage is not prohibited. Its intense, white color, resembling daylight, makes it particularly desirable for such service. These series lamps can be operated only on constant direct current, obtained either by means of rectifier constant-current regulators or directly from constant-current arc generators of the proper current rating.

In the Westinghouse lamps the vapors produced by the metallic oxides of which the electrodes are composed, are not permitted to come in contact with any solid substance in the lamp chamber, and therefore do not deposit as soot. The construction is such that air currents pass down over the inner surface of the globe and down along the electrodes then out through a chimney. These air currents serve to carry off the vapors and soot and also to steady the arc so that it does not run up the side of the upper (negative) electrode.

Distribution of Light—The negative electrode is on top, so that most of the light is thrown downward. A corrugated enameled reflector is provided in the type C lamp to utilize the small part of the light emitted above the horizontal, and the globe is so designed that reflections from it are in a downward direction. The reflector is attached to the case and comes off with it when the lamp is opened. It is not necessary to loosen the reflector screws. In the type B lamp a globe containing an opaque reflector in the upper half can be furnished. The type B lamp does not have a metal reflector. In both types the lower electrode is stationary and the upper electrode feeds, maintaining the arc always within ½ inch of the same position.

Accessories—For information concerning glassware, electrodes, etc., see pages covering "Arc Lamp Accessories."

For further information see circular on "Mercury Rectifier Arc Lighting Systems," which will be sent to anyone on request.

Prices—Style number includes lamp complete with globe and one set of electrodes, and with globe screen when desired.

Style No.	Type	Current	Watts	List Price
162498	C	6.6	449	
162497	C	4.0	272	Prices on
126199	B	6.6	449	Request
126200	B	4.0	272	

Approximate Weight

Net, with glassware—Type B, 42 lb.; type C, 45 lb.

Shipping, without glassware—Type B, 65 lb.; type C, 68 lb.

METALLIC-FLAME SERIES ARC LAMPS—Continued

ELECTRODES

For Westinghouse Metallic Flame Series Arc Lamps

Prices on request

UPPER OR NEGATIVE

Upper or Negative

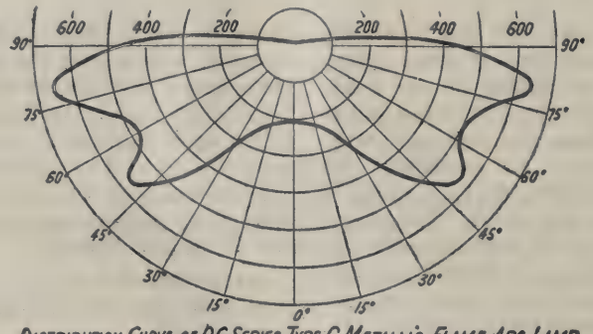
Style No.	Length	Amperes of Circuit	Shipping Weight, Lbs. Per 1000
146648	12″	4	
146649	16″	4	550
145368	16″	6.6	

Lower — Positive

LOWER OR POSITIVE

Style No.	Length	Amperes of Circuit	Shipping Weight, Lbs. Per 1000
92721	...	4	..
127909	...	6.6	85

Order by Style Number



DISTRIBUTION CURVE OF D.C. SERIES TYPE C. METALLIC FLAME ARC LAMP

Clear Glass Globe Standard Y Electrode

Amperes 4

Terminal Volts.... 68	*M.L.H.C.P. 495*	*M.S.C.P. 250*
Arc Volts..... 66	*M.L.H.C.P. per Watt 1.82*	*M.S.C.P. per Watt .92*
Terminal Watts 272	*Watt per M.L.H.C.P. .55*	*Watts per M.S.C.P. 1.09*

Note: Lamp was burned 36 hours before test was made.

WESTINGHOUSE COOPER-HEWITT RECTIFIER CONSTANT-CURRENT REGULATING TRANSFORMERS

50-Light Outfit Complete

Application—The Westinghouse Cooper-Hewitt rectifier outfits described herein are designed to permit the operation of direct-current series arc lighting systems from single-phase alternating-current circuits. By the use of these outfits, the advantages gained from alternating-current distribution at any commercial frequency are combined with the superior illuminating qualities of direct-current arc lamps. The outfits are applicable to any type of direct-current series arc lamps but are especially adapted for use with the Westinghouse metallic flame arc lamps. They are used in connection with the control panels described on other pages of this catalogue.

Ratings and Style Numbers

Style number and list price include regulating transformer with oil bulb single-throw control panel and lightning arresters. For style numbers of bulbs see below.

2200 Volts

No. Lights	Cap. Amps.	Style No. 25-Cycle	Style No. 60-Cycle	List Price
25	4	106701	106697	†
35	4	106702	106698	†
50	4	106703	106699	†
75	4	106704	106700	†
100	4	.....	138141	†
25	6.6	.....	106705	†
35	6.6	.....	106706	†
50	6.6	106711	106707	†
75	6.6	106712	106708	†

†Prices furnished on request.

COOPER-HEWITT RECTIFIER BULBS

Style number and list price cover bulb complete ready to be connected into the circuit.

Style No.	Description	Prices Furnished
95504-E	For all outfits	On Request

Approximate weight of one bulb packed in crate is 20 pounds.
Approximate weight of two bulbs packed in crate is 25 pounds.

APPROXIMATE WEIGHTS AND OUTLINE DIMENSIONS

Cycles	Capacity in Lights	Weights Without Oil		Gals. Oil*	Greatest Width Including Valve	Overall Dimensions			Height to Center Line of Terminals
		Net	Gross			Width of Top Including Lugs	Height	Diameter of Tank	
4-Ampere Rectifier Outfits									
25	25	3400	4400	320	4′- 6⅛″	4′- 0¾″	8′- 1½″	3′-6½″	5′- 6⅞″
	35	4500	5700	535	5′- 4¾″	5′- 1″	9′-3⅛″	4′-	5′- 9¾″
	50	5000	6400	535	5′- 3 1/16″	4′-11⅝″	9′-3″	5′-4½″	5′- 9⅝″
	75	6400	8100	680	5′-10¾″	5′- 3¾″	10′-1¼″	4′-9″	6′- 3¼″
60	25	2800	3700	350	4′- 6⅛″	4′- 0¾″	8′-1½″	3′-6½″	5′- 7″
	35	2950	3900	335	4′- 6⅛″	4′- 0¾″	8′-1⅜″	3′-6½″	5′- 6⅞″
	50	3100	4100	335	4′- 6⅛″	4′- 0¾″	8′-1⅜″	3′-6½″	5′- 6⅞″
	75	4500	5800	535	5′- 3 1/16″	4′-11⅝″	9′-3″	4′-4½″	5′- 9⅝″
	100	6400	7800	625	5′- 9″	4′-11⅜″	8′-4⅞″	4′-9½″	5′-11″
6.6-Ampere Rectifier Outfits									
25	50	8100	10300	750	6′-2¾″	5′- 6½″	10′-6″	5′-0½″	6′- 3″
	75	8400	10900	730	6′-2¾″	5′- 6½″	10′-6″	5′-0½″	6′- 3″
60	25	3000	3900	335	4′-7⅜″	4′- 3¼″	8′-1⅜″	3′-6½″	5′- 6⅞″
	35	3200	4200	320	4′-7⅜″	4′- 3¼″	8′-1⅜″	3′-6½″	5′- 6⅞″
	50	4500	5900	525	5′-3 1/16″	4′-11⅝″	9′-3″	4′-4½″	5′- 9⅝″
	75	5700	7400	700	5′-9¾″	5′- 3¾″	10′-1 1/16″	4′-9″	6′- 3⅜″

*Oil weighs approximately 7½ pounds per gallon net.
Note—The above dimensions are for reference only. For official dimensions apply to the nearest district office of this company

CONTROL PANELS FOR COOPER-HEWITT RECTIFIER CONSTANT-CURRENT REGULATING TRANSFORMERS

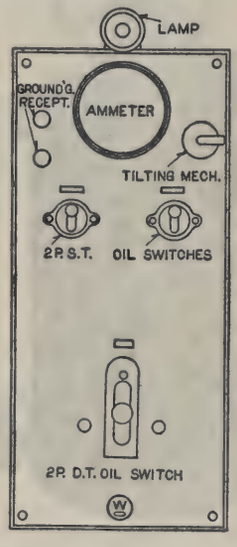
The panel consists of a single slab of marble having the apparatus mounted thereon, bolted to a tubular iron frame which is, in turn, bolted to the floor. The total height of the panel from the floor is 6 feet 4⅜ inches.

Marble—The marble slab is of black marine finish, 48 inches high, 1½ inches thick, with the front edges beveled ⅜-inch. It is bolted at the four corners to lugs on the frame. The switches and meters are mounted directly on the marble.

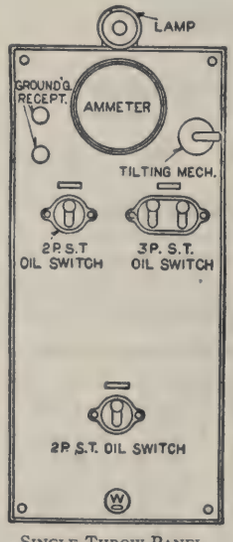
Frame—The type J frame is supplied with these panels. This frame is made from 1¼-inch gas pipe uprights which are screwed into foot-nuts adapted for bolting to the floor. Each upright is supplied with a gas-pipe rod and foot-nut for bracing the panel to the floor or to the wall, as may be desired.

FOR 25, 35, AND 50 ARC LAMPS
Schedule of Apparatus

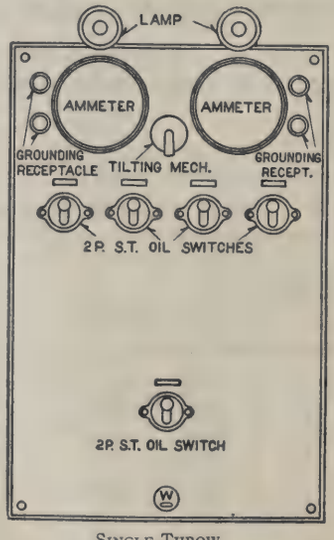
One type SL direct-current high-tension ammeter.
One two-pole type I oil switch for arc circuit.
One two-pole type I switch for starting.
One series incandescent lamp and bracket.
One two-pole single-throw primary oil switch for constant-potential circuit.
Two enclosed fuse blocks and fuses for constant-potential circuit.
One tilting handle for rectifier.
Two testing receptacles and necessary plugs.
One bell-ringing relay.



FOR 75 AND 100 ARC LAMPS



SINGLE-THROW PANEL 75-LIGHT



SINGLE-THROW 100-LIGHT

Schedule of Apparatus

75-Light	100-Light	
1	2	Type SL (Type TL for 75-Light) direct-current high-tension ammeters.
1	2	Two-pole type I oil switches for arc circuits.
1	..	Three-pole two-handle special type I oil switches for starting.
..	2	Two-pole type I oil switches for starting.
1	1	Series incandescent lamps and brackets.
*1	*1	Two-pole single-throw primary oil switch for constant-potential circuit.
2	2	Enclosed fuse blocks and fuses for constant-potential circuit.
1	1	Tilting handle for rectifier.
2	4	Testing receptacles and necessary plugs.
1	2	Bell-ringing relays.

*On double-throw panels the primary oil switch is double-throw.

ARC LAMP ACCESSORIES

The globes, bulbs, reflectors and other sundries listed in this section are especially designed for use with the arc lamps manufactured by the Westinghouse Electric & Manufacturing Company. The variety of designs listed enables the user to select that design which suits his particular conditions of service, there being a design suited to any one of the services for which the arc lamps may be used.

A variety of grades of glassware is listed in order to enable the user to select that grade best suited to his uses.

Clear Glass is recommended where the high intrinsic brilliancy is not objectionable, as it gives the highest illuminating efficiency. It can be used satisfactorily with most street-lighting systems and with interior lighting where the lamps are hung high.

Opal glass absorbs some of the superfluous violet rays of the light without seriously decreasing the illuminating efficiency. Globes of this glass eliminate to a considerable extent the glare which accompanies the clear glass, producing a pleasant, diffused light well adapted to street and interior lighting. This glass is distinguished by a pure milky color running evenly throughout its thickness.

Alabaster glass is composed of a thin film of opal glass overlaid with a clear glass. This reduces the illuminating efficiency somewhat, but the quality of light is much improved. Globes of this glass are recommended for use where a soft mellow light is desired. The globe acts as a secondary source of light, appearing pearl white of low intrinsic brilliancy. There is an entire absence of glare and shadows.

Opalescent glass is a similar grade to alabaster, but not quite so dense.

Alba glass is a crystal base uniformly permeated with innumerable minute, opaque, white particles. These deflect transmitted light rays into myriads of paths, producing a very even diffusion of light throughout the entire volume of glass. Alba globes have good diffusion and small absorption. They soften the light with a comparatively small loss and do not cause the distortion of the true color of the light source.

When used as a reflector, alba glass transmits enough light for excellent ceiling illumination, but deflects the larger proportion below the horizontal.

Marbo glass is a semi-opaque glass with diffusing properties. While not so efficient as clear glass, it gives a softer light, practically free from glare.

Monox glass is similar to alba glass but is of somewhat greater density and uniformity.

GLASSWARE—Prices on Request

Used With Lamp Style No.	Style No. Glassware	Description	Fig. No.	Approx. Wt. Lb. Net Each	Approx. Wt. Lb. Shipping per Pack.
For Westinghouse Enclosed Carbon Arc Lamps					
Alternating-Current Series					
		Outer Globes			
30062 36000 36001 50403-A	27034	Clear	1	5	115
	30059	Opal	1	5	115
	30060	Light, alabaster	1	5	115
50404-A	38919	Clear, open b't'm	2	3 11/16	115
		Inner Bulbs			
36000 36001 36002 36003 50403-A 50404-A 50405-A 50406-A	35286-A	Clear	14	11/16	60
	35287-A	Opalescent	14	11/16	60
30062 30063	27035	Clear	13	11/16	60
	30061	Opalescent	13	11/16	60
Alternating-Current Multiple					
		Outer Globes			
36006 36007 92248-A 92250-A	37962	Clear	3	4	115
	40649	Opal	3	4	115
		Inner Bulbs			
36006 36007 36045 36046 92248-A 92249-A 92250-A 92251-A	35286-A	Clear	14	11/16	60
	35287-A	Opalescent	14	11/16	60
Direct-Current Multiple and Series					
		Outer Globes			
36047 36053 59523	37962	Clear	3	4	115
	40649	Opal	3	4	115
Direct-Current Multiple and Series					
		Inner Bulbs			
36047 36048 36053 36054 59523 59524 59525	35289-A	Clear	15	1/16	60
	35290-A	Opal	15	1/16	60
Direct-Current Multiple Series					
		Outer Globes			
36049 103689	27034	Clear	1	5	115
	30059	Opal	1	5	115
	30060	Light alabaster	1	5	115
		Inner Bulbs			
36049 36050 103689 103691	35289-A	Clear	15	1/16	60
	35290-A	Opal	15	1/16	60
Direct-Current Multiple Mill Type					
		Outer Globes			
85784 104790	37962	Clear	3	4	115
	40649	Opal	3	4	115
		Inner Bulbs			
85756 85784 104789 104790	74645	Clear	16	1/16	60
	74646	Opalescent	16	1/16	60
Manhattan Type					
		Outer Globes			
601, 601-A 602, 602-A 603, 603-A 653, 653-A	301	Clear	4	4	115
	301	Alabaster	4	4	115
		Inner Bulbs			
601, 601-A 602, 602-A 603, 603-A 653, 653-A	12	Clear	17	1/16	60
	12	Alabaster	17	1/16	60

ARC LAMP ACCESSORIES—Continued

GLASSWARE—Continued

Prices on Request

For Westinghouse Flame-Carbon Arc Lamps

Westinghouse-Stave Type (Single-Globes)

Used With Lamp Style No.	Style No. Glassware	Description	Fig. No.	Approx. Wt. Lb. Net Each	Approx. Wt. Lb. Shipping per Pack.
169257-A 169258 169338-A	162221 162222	Clear Slightly opalescent	9 9	2½ 2½	80 80
169465-A 169581 173158	170060	Alba	9	2½	80

Type H Lamps—Outer Globes

Used With Lamp Style No.	Style No. Glassware	Description	Fig. No.	Approx. Wt. Lb. Net Each	Approx. Wt. Lb. Shipping per Pack.
183580-A 183583-A 183584-A 183585-A 183586-A 183589-A 185697-A 189020-A 189925-A 189628-A 189629-A 190003-A 191103-A 193673-A 195807-A 195916-A 217636 217637 217638 217639 217640 217641 219430 219431 221086 221087 221088 221089 221090 221133 221134 221135 221136	185918-A	Spherical,clear	10	5½	135
	185919-A	Spherical,slightly opalescent	10	5½	135
	185920-A	Spherical,alba	10	5½	135
	185921-A	Spherical,marbo	10	5½	135
	186320-A	Acorn type, clear	11	5½	135
	186321-A	Acorn type,slightly opalescent	11	5½	135
	186322-A	Acorn type, alba	11	5½	135
	186323-A	Acorn type, marbo	11	5¼	135

Type H—Inner Globes

Used With Lamp Style No.	Style No. Glassware	Description	Fig. No.	Approx. Wt. Lb. Net Each	Approx. Wt. Lb. Shipping per Pack.
183583-A 183584-A 183585-A 183586-A 183589-A 217636 217637 217638 217639 217640 219430 219431 221086 221087 221088 221089	190294-B	Clear	18	2	120
	190295-B	Slightly opalescent	18	2	120
	190296-B	Marbo	18	2	120
	190297-B	Alba	18	2	120
183580-A 185697-A 189020-A 189025-A 189628-A 189629-A 193673-A 190003-A 191103-A 193941-A 195807-A 195916-A 198734 198735 201858 210612 217641 221090 221133 221134 221135 221136	185138-B	Clear	19	2	80
	185139-B	Slightly opalescent	19	2	80
	185140-B	Marbo	10	2	80
	185141-B	Alba	19	2	80

For Westinghouse Metallic Flame Arc Lamps

Globes

Type A

Used With Lamp Style No.	Style No. Glassware	Description	Fig. No.	Approx. Wt. Lb. Net Each	Approx. Wt. Lb. Shipping per Pack.
99342	66095	Clear	5	3⅜	60
	200522	Clear with hole in bottom	5	3⅜	60
	142760	Alba	5	3⅜	60

Type B

Used With Lamp Style No.	Style No. Glassware	Description	Fig. No.	Approx. Wt. Lb. Net Each	Approx. Wt. Lb. Shipping per Pack.
126199-A 126200-A	133411	Clear,Reflecting	6	3	100
	142081	Alba	7	3	100
134250 134251					

Type C

Used With Lamp Style No.	Style No. Glassware	Description	Fig. No.	Approx. Wt. Lb. Net Each	Approx. Wt. Lb. Shipping per Pack.
162497-A	202877	Clear	8	4⅝	110
162498-A	202879	Alba	8	4⅝	110

For Luxsolite Fixtures

Globes

Used With Lamp Style No.	Style No. Glassware	Description	Fig. No.	Approx. Wt. Lb. Net Each	Approx. Wt. Lb. Shipping per Pack.
220841 220842 220843 220844 220845 220846	220258	Clear	20	3½	100
	220259	Alba	20	3½	100
	220260	Marbo	20	3½	100

Holophane Refractors

Used With Lamp Style No.	Style No. Glassware	Description	Fig. No.	Approx. Wt. Lb. Net Each	Approx. Wt. Lb. Shipping per Pack.
225351 225352 225353	220785	8½" Bowl	21	6½	80
	258665	6½" Bowl	..	...	80
	252212	8½" Skirted Band	22	...	80
225354 225355	244366	8½" Band	23	...	70

OUTLINE DIMENSIONS

Outer Globes

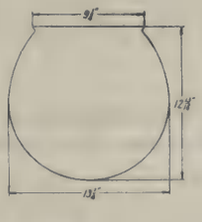


FIG. 1

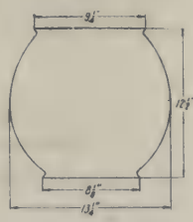


FIG. 2

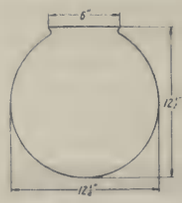


FIG. 3

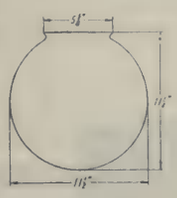


FIG. 4

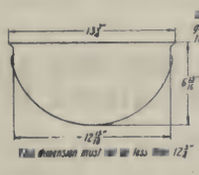


FIG. 5

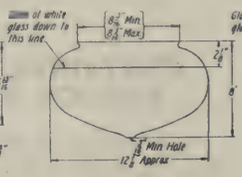


FIG. 6

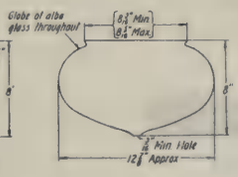


FIG. 7

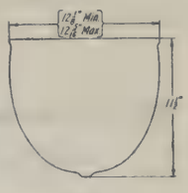


FIG. 8

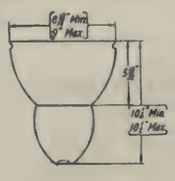


FIG. 9

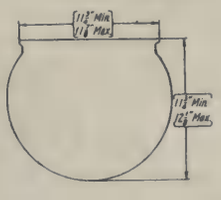


FIG. 10

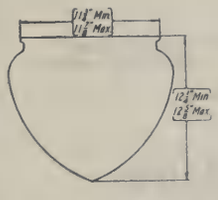


FIG. 11

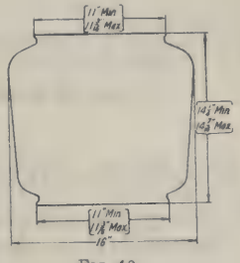


FIG. 12

Inner Bulbs

FIG. 13

FIG. 14

FIG. 15

FIG. 16

FIG. 17

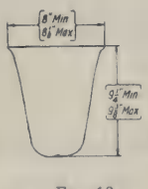


FIG. 18

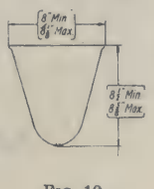


FIG. 19

Luxsolite Globes and Refractors

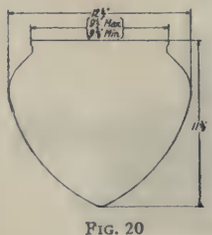


FIG. 20

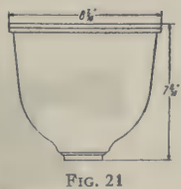


FIG. 21

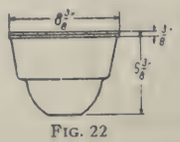


FIG. 22

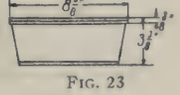


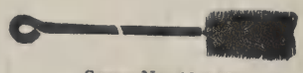
FIG. 23

These dimensions are for reference only. For official dimensions apply to nearest district office.

BRUSHES

STYLE No. 187299

STYLE No. 57968



STYLE No. 104162

Style No.	Description
57968	Inner globe brush.
104162	Chimney tube brush for metallic flame lamp
187299	Condensing chamber brush for flame-carbon lamp

Prices on Request

MAGNESIA CONSUMERS

For Westinghouse-Stave and Type H Flame-Carbon Arc Lamps

Style No. 177455-B consists of one set of magnesia consumer material made up in a wire gauze holder ready for insertion in any of the Westinghouse-Stave or type H flame-carbon arc lamps. Price on request.

CARBONS

For Westinghouse Enclosed Arc Lamps

Columbia carbons are carried in stock. In ordering state the diameter and length of carbon with description, i. e., cored or solid. Prices on request.

For Westinghouse Flame-Carbon Arc Lamps

Columbia carbons are carried in stock. In ordering be sure to state **style number** of lamp, **size,** of carbons, **color** of light and whether for alternating-current or direct-current lamps. Prices on request.

CONTAINER BOX FOR HIGH-TENSION RECTIFIER BULB

Style number of bulb box does not cover lifting strap which should be ordered as follows:

Style No.	Description
156452	Container box complete except lifting strap.

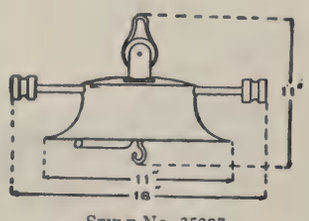
Lifting Straps

	Rating of Rectifier	
99553.....	25-light, 4-amp., 60-cycle 35-light, 4-amp., 60-cycle 50-light, 4-amp., 60-cycle 25-light, 4-amp., 25-cycle 25-light, 6.6-amp., 60-cycle 35-light, 6.6-amp., 60-cycle	Prices on Request
99596.....	75-light, 4-amp., 60-cycle 35-light, 4-amp., 25-cycle 50-light, 4-amp., 25-cycle 50-light, 6.6-amp., 60-cycle	Prices on Request
106568.....	75-light, 4-amp., 25-cycle 75-light, 6.6-amp., 60-cycle 50-light, 6.6-amp., 25-cycle 75-light, 6.6-amp., 25-cycle	Prices on Request
107482.....	100-light, 4-amp., 60-cycle..	Prices on Request
107483.....	100-light, 6.6-amp., 60-cycle	

ABSOLUTE CUT-OUT ARC LAMP HANGERS

For A. C. and D. C. Series Lamps

Price on request



STYLE No. 35297
Weight, 17 pounds, net.
Weight, 35 pounds, packed

STYLE No. 35297

MAZDA STREET LIGHTING

General

The development of the Mazda C lamp made possible the economical use of incandescent lamps with comparatively inexpensive fixtures for practically any candle-power rating.

The result of this development was a great decrease in the cost of illumination. Old carbon arc lamps of both the open and enclosed types can be replaced at a great saving in cost of operation. New installations can be made in many places where the value of the illumination does not warrant the cost of an arc lamp system, or the expense of its maintenance. The availability of lamps in all sizes makes possible the use of these lamps for a variety of locations impossible to an arc lamp system. The use of these lamps on alternating current simplifies the distribution, inasmuch as converting apparatus to furnish direct current is unnecessary.

To replace arc lamps, or provide illumination for large areas, on the series circuits commonly in use, the Luxsolite fixture has been developed. Street hoods are recommended for any of the smaller sized lamps where a low first cost is essential. Ornamental posts are available for all sizes of lamps. Safety coils for the operation of these lamps, where it would not otherwise be practicable to operate the high-voltage series circuits, are listed herein.

Series Distribution

Street lighting lamps, both arc and incandescent, are usually operated in series, because of the necessity of their being all turned "on" and "off" at stated intervals. By so operating, the comparatively light loads over a wide area, the highest efficiency in distribution may be obtained. By using a comparatively high current in the lamp, advantage is taken of the line wire capacity, which is necessarily made heavy enough to stand mechanical strains. A lamp of 100 candlepower has approximately 20 per cent higher efficiency than the 110-volt lamp of equivalent output in illumination. The most commonly used current rating is 6.6 amperes. Lamps are regularly made for 7.5 amperes or other currents, and can be furnished with control apparatus on special order.

Series Control Systems

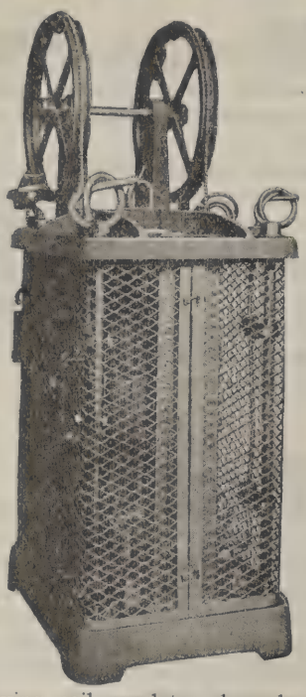
The moving-coil regulator, with control panel, operated in a station should be used to regulate series circuits wherever possible, because it can maintain closer regulation in the series circuit than any other device. This close regulation is very important for under normal conditions, the lamp renewals in approximately two years will pay for a regulator with control panel, an over-current of only 3 per cent continuously will cut the life of a series lamp in half; therefore double the renewal cost per year.

Adjuster-socket systems are recommended where excessive lengths of line wire must be run from a station to the district to be lighted, or where the voltage of the series circuit is less than 600 and the films in the series sockets are likely not to puncture, because of the voltage being too low.

The reactance-coil regulator should only be used where the installation of the control apparatus must be made on a pole. A saving in first cost of equipment on installations of from 5 to 10 kilowatts in size sometimes makes this system desirable.

MOVING-COIL REGULATORS AND CONTROL PANELS

STATION TYPE



The moving coil regulator depends upon the electrical repulsion existing between the primary and secondary coils of the transformer under load to produce and maintain a constant current in the secondary or lamp circuit. The regulator can be adjusted to maintain its rated secondary current under the normal conditions of load, primary voltage and frequency, regardless of the number of lamps in the circuit. The coils consist of a number of concentric sections and are known and described as ventilated coils. The individual sections consist of two layers, having one side of each conductor directly exposed to the air. No taping is used except for the protection of leads. The coils are insulated from the metal parts entirely by micarta tubes made from paper treated with Bakelite. These coils are most rugged and durable, withstanding heavy strains and overloads to the best advantage, and by reason of their light, weight making possible a very high sensitiveness in regulation.

The rating and performance of these regulators is based on average load conditions, consisting of an incandescent load in unity power factor and a line having 5 per cent ohmic and 10 per cent reactive drop. Their rating in kilowatts at the terminals of the regulator with unity power factor would be 9 per cent above the standard rating; the corresponding increase of power factor would amount to 6 per cent.

Enclosed carbon arc lamps may be operated from these regulators when equipped with a dash pot. A Westinghouse 6.6-ampere or 7.5-ampere enclosed carbon arc lamp, adjusted in accordance with the specifications, requires .62 or .70 kilovolt-amperes respectively of rated regulator capacity for its operation.

The efficiency of these regulators at full load varies from 90 to 96 per cent for the various sizes. The power factor similarly varies from 83 to 86%.

The regulator will maintain the secondary current within 2 per cent of its normal rating in the 4, 8 and 12-kilowatt sizes, or within 1 per cent on the larger sizes.

Circuits—The 34, 50, and 68-kilovolt-ampere sizes are arranged to operate two inter-connected circuits. To keep the load voltage to a minimum, each circuit should be of approximately ½ the capacity of the regulator. Two circuits may be operated from any regulator by the use of a two-circuit panel.

Taps — Primary taps are arranged for 2400, 2200 and 2000 volts. Secondary taps are provided for 80 and 90 per cent. of full load.

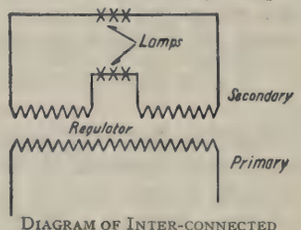


DIAGRAM OF INTER-CONNECTED SECONDARY CIRCUITS

Automatic operation with a time switch is successful, if the load is such that the coil separation is not more than 2 inches. With light loads, auxiliary blocks or catches should be installed for reducing the movement of the secondary coil towards the primary coil when the power is interrupted.

Control Panels

Control panels of black-marine-finished slate mounted on pipe frame work are furnished.

The standard panel for single-circuit, constant-current regulators, is 16 inches by 36 inches and has mounted on it:

(a) One four-pole single-throw type I non-automatic oil circuit-breaker, which, with one operation, connects both the primary and secondary coils to their respective circuits.

(b) One alternating-current high-voltage type SR ammeter.

(c) One double-pole fuse block, (2 single-pole fuse blocks on high-capacity).

(d) Four enclosed fuses (two extra ones) mounted on the back and connected in the primary circuit. Where the working voltage of the regulator to be controlled exceeds 4,000 volts, a current transformer (type KA) for the ammeter, which is connected in the secondary circuit, is furnished complete with mounting brackets.

Sub-panels for watthour meters can be supplied for any of the standard panels. These sub-panels are black-marine-finished slate, 16 inches high, mounted on the same frame as the standard panel and directly under it. Apparatus mounted thereon consists of

(a) One type C watthour meter.
(b) One voltage transformer.
(c) One current transformer.
(d) One double-pole fuse block with four fuses, (two extra) for the voltage transformer.

REGULATING TRANSFORMERS FOR 2200-VOLTS 60-CYCLE PRIMARY AND 6.6 AMPERES SECONDARY CIRCUITS

Transformers for Other Voltages Frequencies or Currents can be Furnished on Order

Capacity Kva.	Approx. Weight Lbs. Net	Shipping	Style No.	List Price
4	480	725	200599	$520 00
■	685	985	200602	600 00
12	850	1200	200605	700 00
17	1000	1350	200608	800 00
24	1250	1650	200611	950 00
34	1350	1750	200614	1200 00
*50	1800	2200	236673	1500 00
*68	2200	2600	236674	1800 00

For ■ transformer equipped with dash pot, add $15.00 to list price.

*A current transformer is required for an ammeter in the secondary circuits.

REGULATOR CONTROL PANELS

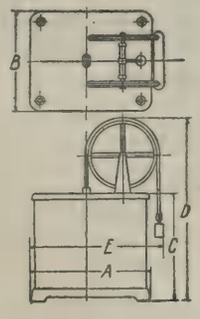
Order panels by description, giving style number of regulator to be controlled.

Description	Approx. Shipping Weight, Lb.	List Price
Single-circuit, single-throw (1 switch) panel for 4, 8, 12, 17 and 24-kva. regulators	300	$125 00
Single-circuit, single-throw (2 switches) panel for 4, 8, 12, 17 and 24-kva. regulators	350	150 00
Two-circuit, single-throw (3 switches) panel for 34, 50 and 68-kva. regulators	450	200 00

Description	Approx. Shipping Weight Lb.	List Price
Sub-panel for any standard panel complete with necessary watthour meter, current, voltage transformers fuse blocks, and fuses	150	$150 00
Double-throw panels, add to above two-switch and three-switch single throw panels		50 00
Current transformer and mounting bracket for ■ panel when operated on regulators of higher voltage than 4000 volts		50 00

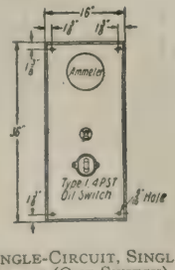
OUTLINE DIMENSIONS

Moving Coil Regulators



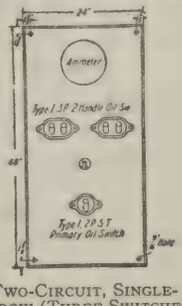
Kva. 25-Cycles	Kva. 60-Cycles	Dimensions, Inches A	B	C	D	E
....	4	21⅝	17	30½	50	29¼
3	8	23	18	33⅜	55⅛	31⅝
4.75	12	25⅛	20	33¾	55⅛	32⅝
7	17	26	21	35⅛	57⅜	33
10	24	28¾	26	25⅜	58	34½
14	34	32½	29	34⅞	55½	36¾
20	50	34¼	30	36¼	60	40¼
28	..	36	32	36⅛	63¾	42
.....	68	36	32	41⅛	65¾	42

CONTROL PANELS

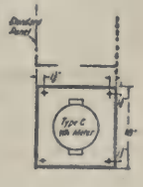


Single-Circuit, Single-Throw (One Switch) Control Panel

Single-Circuit, Single Throw (Two Switches) Control Panel



Two-Circuit, Single-Throw (Three Switches) Control Panel



Sub Panel

One-Switch Panel is 1¼ inches thick and has ¼ inch bevel; Two-Switch and Three-Switch Panels are 1½ inches and have ⅜-inch bevel.

Width of sub-panel is 16 or 24 inches and thickness 1¼ or 1½ inches to match control panel.

These dimensions are for reference only. For official dimensions apply to the nearest district office.

THE ADJUSTER SOCKET SYSTEMS

The adjuster socket system consists of a simple series of lamps connected across the secondary terminals of a constant-potential transformer. A reactance coil is connected in shunt across the terminals of each lamp and operates to maintain the continuity of the circuit and the normal voltage on the remaining lamps in case any lamp burns out or is removed. While it is possible to connect the lamps in series directly across the main, it is always advisable to provide a transformer having taps for a close adjustment of the voltage required.

The transformers listed below are provided with taps to enable any voltage to be obtained within 1 per cent of that required by the circuit. All taps are brought to terminal blocks inside the transformer case and no solder connections need to be made in changing these taps.

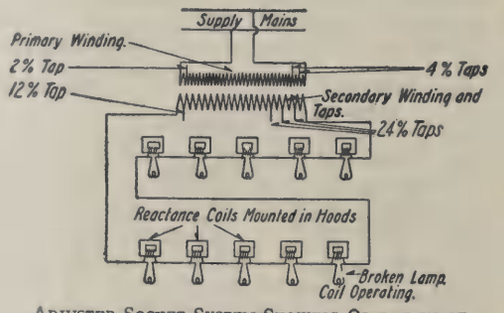
Regulation—As the lamps go out and the reactance coils take their place in the circuit, the current will never rise over 2 per cent above normal, this point being reached with from 10 to 15 per cent of the lamps out.

TRANSFORMERS FOR ADJUSTER SOCKET SYSTEM

For 2200-Volt 60-Cycle Primary, 6.6-Ampere Secondary

Transformers for other voltages frequencies and currents can be furnished on order.

TRANSFORMER FOR ADJUSTER SOCKET SYSTEM



ADJUSTER SOCKET SYSTEM SHOWING OPERATION OF REACTANCE COILS TO REPLACE LAMPS

Secondary Voltage Min.	Secondary Voltage Max.	Gallons Oil	Style No. Hangers	Approx. Shipping Wt. Lb.	Transformer Style No.	List Price
87	160	1-½	109712	98	219131	$100 00
137	250	1-¾	109712	121	219132	110 00
215	395	2	109712	158	219133	130 00
338	625	3-½	109713	230	219134	160 00
435	800	4-½	109713	256	219135	190 00
620	1140	6-¾	109713	355	242015	230 00
823	1500	9-¾	109713	450	219136	325 00
1250	2300	14	109733	570	219137	370 00

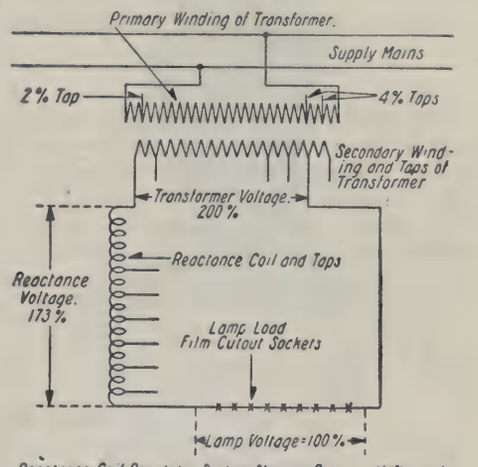
These transformers are for use in connection with the hoods listed on a following page.

Order by Style Number

REACTANCE COIL REGULATOR OUTFITS FOR MAZDA STREET SERIES LAMPS

The reactance coil regulator herein described is particularly useful on circuits which are remote from stations where apparatus can be housed. The outfits are especially designed for service where pole mounting and operation with a time switch is desirable. This simplifies the circuit construction and thus reduces the expense of serving outlying towns which may have constant potential feeder service for residence lighting, but for street lighting have nothing available except multiple lamps or long special series circuits from larger existing installations. They are used with the inexpensive and well-known film cutout street hoods, no change being required in these devices.

The particular advantages of this system of control are: (1) Low cost of installation and apparatus. (2) Simplicity of wiring and operation. (3) Protection of circuit against grounds.



Reactance Coil Regulator System Showing Relative Voltages for 50% Power Factor

Construction

The standard adjuster socket transformers with taps, having a range of from 55% to 100% of maximum voltage rating are regularly used with reactance coils to make up these reactance coil regulators. These transformers are thoroughly described under the adjuster socket system. By reason of their tap arrangement, it is possible to adjust the current to within less than 1% of any required value.

The reactance coils used in connection with this system are separately mounted, thus making it possible to adjust the taps conveniently, and obtain any desired power factor and consequent protection within the range of the apparatus.

Operation

This system keeps the current in the series lamp circuit from rising abnormally by the use of a reactance in series with the lamp. If one lamp goes out, the impedance of the circuit is diminished by a much lower percentage because of this constant fixed reactance in series with the lamp. Consequently the larger the proportional value of reactance to lamp resistance, the closer will be the regulation with a large percentage of lamps out. Other conditions being equal, a 50% power factor regulator will, therefore, hold the current much closer to normal with a given percentage of lamps out than an 80% power factor regulator. A regulator with 30% power factor would be even better in this respect. The relative cost of the complete regulator decreases as the power factor increases for a given load.

The efficiency of these regulators is relatively high, there being but comparatively small loss in the reactance coil, and transformer. At full load these efficiencies will be between 90 and 95% for the various sizes.

The regulation as explained above, depends altogether upon the power factor, it being understood that Mazda "C" lamps are inherently self-regulating to a certain extent, because their resistance increases with the increase in current in the lamps, which causes the temperature rise.

NORMAL POWER FACTOR

Outage	50%	80%	100%	
10	2.1	4.5	6	% current increase above normal.
20	4.2	10	13.7	
30	6.2	16	23.5	
Short Circuit	16	63	....	

In ordering reactance coil regulators, state the maximum kilowatts in lamp load for which the regulator is desired, the power factor rating desired, and give style number of the transformer and reactance to be used.

The smallest unit is mounted in a cast-iron gum-filled case with all leads brought out of case. The larger units are mounted in oil-insulated-transformer parts with a terminal board for changing connections, and only two leads are brought out. Taps are provided for voltages down to about 25% of the maximum.

The kilovoltamperes of the reactance coil to give 50% or 80% power factor is respectively 173% and 75% of the lamp load carried by the complete reactance coil regulator. Taps are provided to enable the operator to maintain approximately 50% or 80% power factor respectively throughout the range of the adjustable transformer with which the reactance coil is used.

REACTANCE-COIL REGULATOR OUTFITS

For 60-Cycle 6.6-Ampere Series Film-Cutout Circuits

Style number of transformer includes transformer mounted in weatherproof case without oil, fuse blocks, or hanger irons. Style number of reactance coil includes the coil only.

List price of complete outfit includes transformer, reactance coil, one pair hanger irons for transformer, one pair of hanger irons for reactance coil,* two fuse blocks (Style No. 29865 or 147190—for description of fuse blocks see pages on "Transformer Fuse Blocks"), and necessary oil* for both transformer and reactance coil.

When ordering, specify, by style number and description, all the items included in the list price as shown above.

Max. KW. Mazda Lamps	Transformers: Range of Volts	Transformers: Style No.	Transformers: Style No. Hanger Irons	Transformers: Gal. Oil	Reactance Coil: Required Volts	Reactance Coil: Style No.	Reactance Coil: Style No. Hanger Irons	Reactance Coil: Gal. Oil	Total Shipping Weight	List Price
Rated on 80% Power Factor										
2.10	215–395	219133	109712	2	236	240793	*	*	275	$225 00
3.30	338–625	219134	109713	3½	375	240793	*	*	360	250 00
4.20	435–800	219135	109713	4½	480	240793	*	*	400	275 00
6.00	620–1140	242015	109713	6¾	685	240794	109713	8	760	420 00
7.50	823–1500	219136	109713	9¾	900	240794	109713	8	860	450 00
12.00	1250–2300	219137	109733	14	1385	246447	109713	11½	1220	620 00
16.00	1650–3000	246446	.....	....	1800	246447	109713	11½	1560	750 00
Rated on 50% Power Factor										
1.30	215–395	219133	109712	2	340	240793	*	*	275	225 00
2.00	338–625	219134	109713	3½	540	240793	*	*	360	250 00
2.50	435–800	219135	109713	4½	690	240794	*	*	400	375 00
3.75	620–1140	242015	109713	6¾	980	240794	109713	8	760	420 00
5.00	823–1500	219136	109713	9¾	1290	240794	109713	8	860	450 00
7.50	1250–2300	219137	109733	14	2000	246447	109713	11½	1220	620 00
10.00	1650–3000	246446	.....	....	2600	246447	109713	11½	1560	750 00

Prices for other capacities and frequencies furnished on request.

REACTANCE COILS

For 60-Cycle 6.6-Ampere Series Film-Cutout Circuits

For use in Connection with Adjuster-Socket Transformers Listed on A Previous Page to Make-Up Reactance-Coil Regulator Outfits as Listed Above.

Style number includes reactance coil only. **List price** includes reactance coil, one pair of hanger irons and the necessary oil. **When ordering,** specify, by style number and description, all items included in the list price.

Maximum Kva.	Maximum Volts	Gallons Oil	Approx. Shipping Wt., Lb.	Style No. Hanger Irons	Style No. Coil	List Price
4.0	600	*	116	*	240793	$100 00
8.5	1290	8	350	109713	240794	200 00
17.2	2600	11½	530	109713	246447	300 00

*Style No. 240793 is gum filled and is mounted by lag screws—no oil or hanger irons required.

Order by Style Number

TYPE CI LUXSOLITE FIXTURES

Application

The Type CI (cast iron) Luxsolite Fixtures are used with Westinghouse Mazda C Lamps in the same manner as former types of Luxsolite fixtures for the lighting of residential streets, parks, and other large outdoor spaces. Their very rugged construction makes them especially useful for the hard service required of street-lighting fixtures—the cast iron case cannot be dented. For districts requiring an extraordinarily sturdy and compact unit the cast iron fixture, by reason of its additional ruggedness and weight, is especially valuable.

The overall weight of the Type C Luxsolite Fixtures has been kept well under that of the standard enclosed arc lamps formerly used, so that no difficulty may be experienced in the use of the same line equipment with the new fixtures.

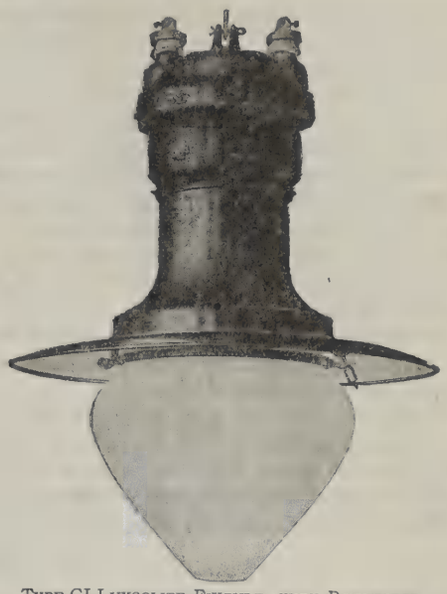
Construction

Case—Cast iron, galvanized, and finished with black asphaltum paint, can suffer no deterioration in any climate. Installations made in the most severe climatic conditions have given four years' service without showing any appreciable deterioration.

The cases are very convenient to disassemble, sherardized bolts being used. Binding posts have been provided to meet with the best standards of construction.

Auto-Transformer—To secure the full advantage of the high efficiency in the Mazda C lamp a larger current is necessary than is usually available in commercial series circuits. To obtain this current a special auto-transformer of the core type has been designed for use in series circuits. The standard winding is for 6.6-ampere circuits, with a tap provided for 7.5-ampere circuits, the latter giving approximately the same performance. Windings for other current ratings may be obtained on order. Taps are provided on the standard 1000-candle-power auto-transformer to take care of 600-candle-power 20-ampere lamps, and on the standard 600-candle-power auto-transformer to take care of 400-candle-power 15-ampere lamps.

TYPE CI LUXSOLITE FIXTURE, WITH REFLECTOR AND SOLLUX DIFFUSER



TYPE CI LUXSOLITE FIXTURE, WITH REFLECTOR AND LARGE GLOBE

The insulation of the auto-transformer consists of micarta, and the whole auto-transformer is thoroughly impregnated in bakelite after completion; this gives the auto-transformer excellent heat-resisting properties. The operating temperature of the lamp is high and if the auto-transformer is quite close to it the necessity for its careful insulation as to heat resisting value cannot be overlooked.

Film-Cutout and Multiple Circuits—The Type CI Luxsolite Fixture is also supplied with film-cutout sockets or multiple sockets.

Reflector—A reflector is regularly used and is supplied with the standard fixture, but can be omitted if desired.

Glassware similar to that used with other types of Luxsolite fixtures is regularly provided. The large Luxsolite globe used as a standard with the original Luxsolite design is regularly furnished. In some cases a smaller globe, such as the **Sollux diffusing globe** (Fig. 2), may be used to advantage, particularly if the candle-power of the lamp is relatively low. The Sollux diffusing globe takes the same holder as the 8½-inch Holophane refractor.

A **refractor** of the skirted type is recommended where distribution of the nature given by refracting glassware is of advantage. The **skirted refractor**

TYPE CI LUXSOLITE FIXTURES—Continued

gives a good distribution of the light close to the horizontal angles and at the same time throws sufficient light on the street beneath the lamp to prevent the dim appearance produced by using the bowl-type refractor. The diffusing skirt cuts off the direct rays of the high intensity filaments, which are exposed when used with the band-type refractor. The skirted refractor thus gives the advantages of both the bowl-type and band-type refractor with comparatively little reduction in candle-power at angles close to the horizontal, or in the overall efficiency of the complete unit.

The **refractor support** consists of a casting with rugged hinge and catch. The globe bail is an electro-galvanized steel band painted black.

Ventilation for the lamp is readily secured with the diffuser and refractor by the opening at the bottom and an outlet under the edge of the top casting. An additional outlet under the reflector gives excellent ventilation when the large globe is used.

TYPE CI LUXSOLITE FIXTURE, WITH REFLECTOR AND SKIRTED REFRACTOR

PRICES

Style number and list price includes fixture complete with 6.6—7.5-ampere primary auto-transformer, series (Regent) film-cutout socket, or large Edison-base multiple socket, as described, complete with reflector and glassware.

Glassware	Approximate Weight Complete With Glassware and Reflector: Net	Shipping	Style No.	List Price
With 400-Candle-Power Auto-Transformer				
Luxsolite Globe	35	43	272258	$28 35
Sollux Diffuser	33	41	272259	27 30
Skirted Refractor	38	46	272260	30 80
Bowl Refractor	39	47	272261	32 20
Band Refractor	36	44	272262	32 20
With 600-Candle-Power Auto-Transformer				
Luxsolite Globe	37	45	272263	30 45
Sollux Diffuser	35	43	272264	29 40
Skirted Refractor	40	48	272265	32 90
Bowl Refractor	41	49	272266	34 30
Band Refractor	38	46	272267	34 30
With 1000-Candle-Power Auto-Transformer				
Luxsolite Globe	41	49	272268	33 35
Sollux Diffuser	39	47	272269	32 30
Skirted Refractor	44	52	272270	35 80
Bowl Refractor	45	53	272271	37 20
Band Refractor	42	50	272272	37 20
With Series (Regent) Film-Cutout Socket for Lamps of 50 to 600 Candle-Power				
Luxsolite Globe	28	36	272253	21 10
Sollux Diffuser	26	34	272254	20 05
Skirted Refractor	31	39	272255	23 55
Bowl Refractor	32	40	272256	24 95
Band Refractor	29	37	272257	24 95
With Multiple Mogul Socket for Lamps of 300 to 500 Watts				
Luxsolite Globe	28	36	272273	20 25
Sollux Diffuser	26	34	272274	19 20
Skirted Refractor	31	39	272275	22 70
Bowl Refractor	32	40	272276	24 10
Band Refractor	29	37	272277	24 10

Order by Style Number

SAFETY COILS

For Indoor and Outdoor Service on Series A. C. Circuits

FIG. 1—REAR VIEW OF TYPE SK (OIL-INSULATED-TYPE) SHOWING METHOD OF ATTACHING HANGER IRONS

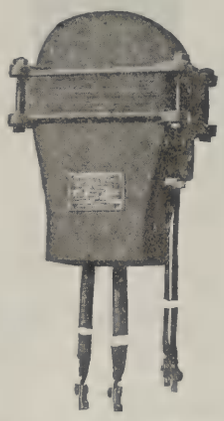


FIG. 2—TYPE MA (DRY-TYPE) (½ AND 1 KVA.)

It is often desirable to make an installation of lamps where the potential of the series arc or incandescent circuit—the only circuit available—is too high for the application in question and the cost of running a multiple circuit from the central station would be prohibitive.

For such a proposition, Westinghouse safety coils are the economical solution. They are especially useful on installations as follows:

1—Where a series lighting system is desirable but high potentials are impracticable:

a. On side streets or alleys where to run the main series circuit would require a new pole line. The comparatively low-voltage safety-coil circuit can often be run on an existing telephone pole-lines.

b. On bridges and in subways where the high potential of the regular series circuit is prohibitive.

c. For lighting of fire-alarm, police, and letter boxes, where high potentials so near the ground would be dangerous.

2—Where a few lamps are wanted in a building and a multiple circuit is not available.

3—Where large lamps of high current must be operated from high-voltage series circuits such as white-way post and pendant fixtures on mast arms having long loops.

Operation

The primary of these coils is connected in the regular series circuit, the secondary then supplying the lower-potential series circuit. Regular series lighting fixtures (such as those with film cut-outs) should be used, except where the secondary load voltage does not exceed 200 in which case the puncturing of films is unreliable and multiple sockets may be used.

Safety coils of 2 kilowatt and less may be operated continuously on open circuit without injury; those of larger size will operate two hours without injury.

Construction

These safety coils are series transformers insulated for high voltages (being tested for 20,000 volts for one minute between windings and between windings and iron.

In Terne-plate Case—The safety coils of 500 watts or less are of the core type construction with a case of terne-plate, gum filled consisting of heavy sheet steel thoroughly tinned. For manhole service, outlets of a heavy pipe are provided, so tinned that a joint with lead covered cable may be wiped to them. Small feet or mounting straps for supporting the transformer in the base of the hole are conveniently arranged. For overhead service, the leads are brought out through the bottom in porcelain bushings and a strap is provided on the side for mounting on a pole.

Type MA (Dry-Type)—The 1 and 2 kilowatt capacities of these coils are built for air cooling, being of the same form of construction as the Westinghouse standard type MA current transformers. The magnetic circuit, with laminations exposed to the air, is clamped between cast-iron end-caps which protect the windings, the leads extending downwards through suitable bushings in the bottom end-cap. The coils are impregnated with an insulating compound which thoroughly seals up joints between the laminations and end-caps.

Type SK (Oil-Insulated Type)—The larger capacities of these coils are oil-insulated and have the same form of construction as the type SK distributing transformers (see catalogue on "Distributing Transformers").

SAFETY COILS—Continued

FIG. 4

FIG. 5

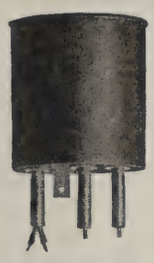


FIG. 3

SAFETY COILS

Style number and list price includes safety coil and (for the oil insulated) the necessary oil and hanger irons for pole mounting.

For 6.6-Amperes Circuits Line Voltage of 6600

Capacity Kva.	Fig. No.	Secondary Amperes	Maximum Secondary Volts	Approx. Wt., Lb. Net	Approx. Wt., Lb. Shipping	Style Hanger Irons	Gal. Oil	Style No.	List Price
In Terne-Plate Case (Gum Filled)									
.075	3	6.6	11	18	38	....	....	242382	$22 00
.450	3	6.6	68	28	48	....	....	242384	33 00
.230	3	15	15.3	20	40	....	....	242376	25 00
.310	3	20	15.5	28	48	....	....	242378	31 00
.518	3	20	25.9	30	50	....	....	242380	35 00
.075	4	6.6	11	18	38	....	....	242381	22 00
.450	4	6.6	68	28	48	....	....	242383	33 00
.230	4	15	15.3	20	40	....	....	242375	25 00
.310	4	20	15.5	28	48	....	....	242377	31 00
.518	4	20	25.9	30	50	....	....	242379	35 00
.075	5	6.6	11	18	38	....	....	245648	22 00
.450	5	6.6	68	28	48	....	....	245649	33 00
.230	5	15	15.3	20	40	....	....	245645	25 00
.310	5	20	15.5	28	48	....	....	245646	31 00
.518	5	20	25.9	30	50	....	....	245647	35 00
Type MA (Dry Type)									
1.00	2	6.6	152	56	65	....	....	249428	59 40
2.00	2	6.6	304	93	110	....	....	249430	86 50
Type SK (Oil Insulated)									
5.0	1	6.6	760	230	333	109713	8	249433	220 00
10.0	1	6.6	1520	346	508	109713	11½	249435	282 00

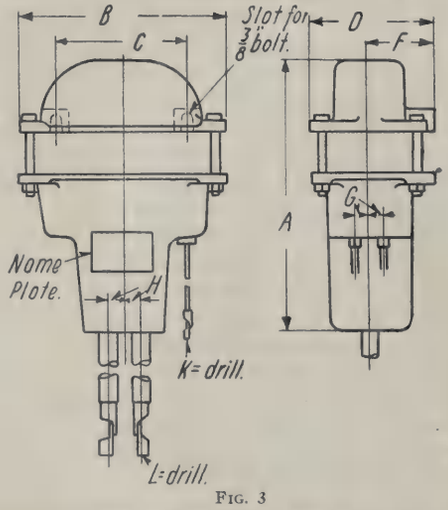


FIG. 3

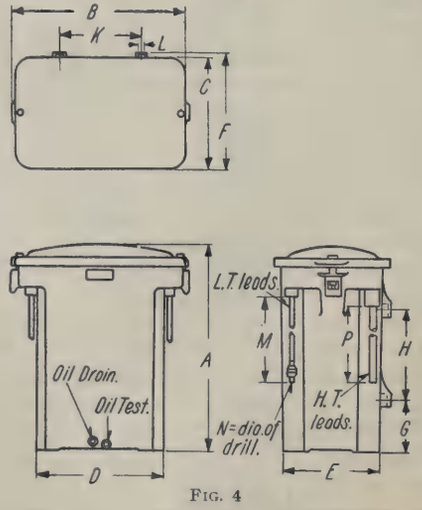
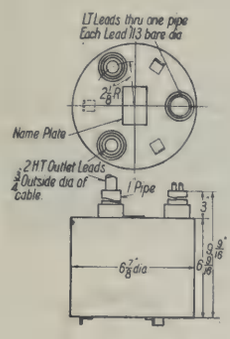


FIG. 4

Style No.	Kva.	Fig. No.	Dimensions in Inches Corresponding to Letters Given in Outline Views												
			A	B	C	D	E	F	G	H	K	L	M	N	P
249427	½	3	14 3/32	9 13/16	6 1/8	5 13/16	—	3 1/8	5/8	3/4	5/32	1/4	—	—	—
249428	1	3	15 13/16	9 13/16	6 1/8	5 13/16	—	3 1/8	5/8	3/4	5/32	1/4	—	—	—
249429	1½	3	14 3/4	11 1/4	7 7/8	7 13/16	—	4 1/2	3/4	3/4	5/32	1/4	—	—	—
249430	2	3	15 1/2	11 1/4	7 7/8	7 13/16	—	4 1/2	3/4	3/4	5/32	1/4	—	—	—
249431	3	4	21 3/16	18 3/16	11 3/4	12 1/2	9 7/8	12 1/8	5 5/8	10	8 1/2	9/16	16	.168	24
249432	4	4	21 3/8	18 3/8	11 3/4	12 1/2	9 7/8	12 1/8	5 5/8	10	8 1/2	9/16	16	.168	24
249433	5	4	23 1/8	19 3/4	12 5/8	14 1/4	10 7/8	13	6 1/8	10	9	9/16	18	.168	24
249434	7½	4	23 1/8	19 3/4	12 5/8	14 1/4	10 7/8	13	6 1/8	10	9	9/16	18	.168	24
249435	10	4	25 1/2	22 3/8	14 7/8	15 3/4	12 7/8	15 1/4	3 3/8	16	11	9/16	21	.168	24

SAFETY COILS—Continued

OUTLINE DIMENSIONS



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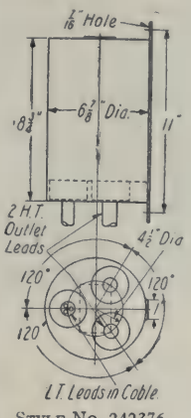

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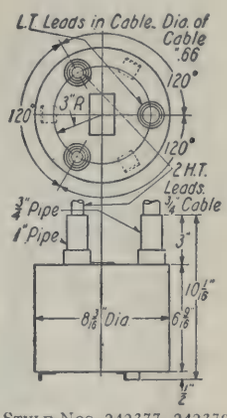
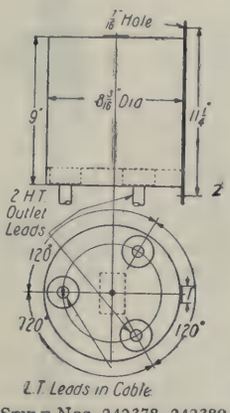
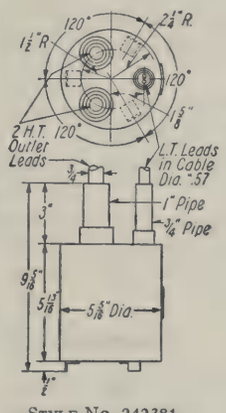


STYLE NOS. 242377, 242379 AND 242383



STYLE NOS. 242378, 242380 AND 242384



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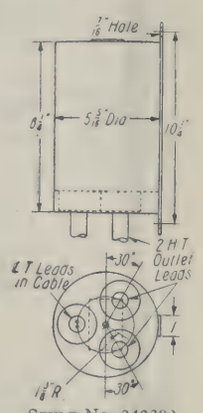

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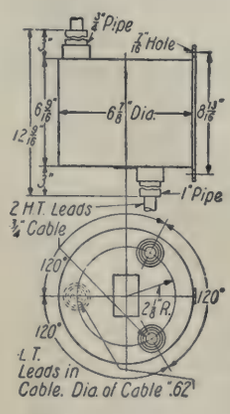
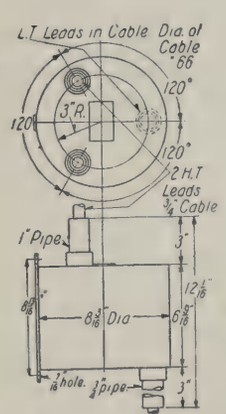
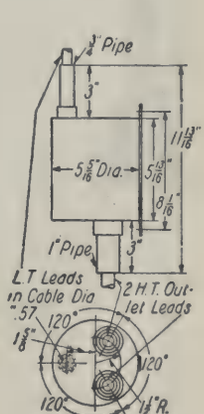


STYLE NO. 245645



STYLE NOS. 245646, 245647, AND 245649



STYLE NO. 245648

These dimensions are for reference only. For official dimensions apply to the nearest district office.

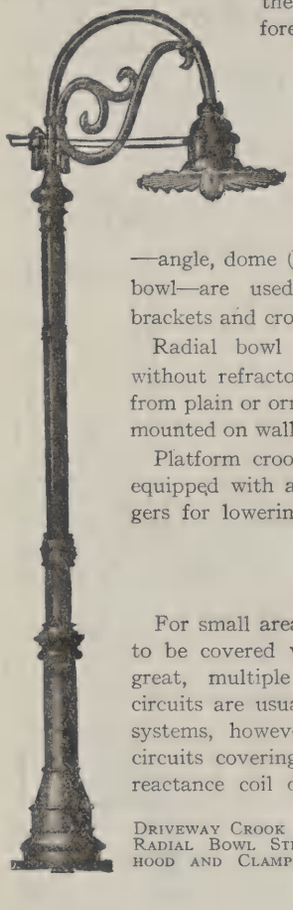
PROTECTIVE LIGHTING

Although it has been the practice for many years with large industrial plants to provide sufficient illumination on the grounds adjacent to mills and factories to prevent accidents, the application of lighting facilities on an extensive scale for protective purposes is essential during times of war. The following principles should be observed in planning protective lighting systems:

(1) An object is made visible by the light which comes from it and not by the light which comes from the lamp. The light, therefore, must be directed on the object, or

(2) An object may be discerned in silhouette, as, for instance, a man in dark clothing may be seen when he is between the observer's eye and a brightly illuminated back ground.

(3) Glare must be eliminated for the guard who patrols the premises. Bare lamps should never be used. They should be provided with reflectors or diffusing glassware or both and so mounted on poles or buildings that they are well above the ordinary angle of vision. Reflectors serve the dual purpose of eliminating glare and directing the light where it is most needed.



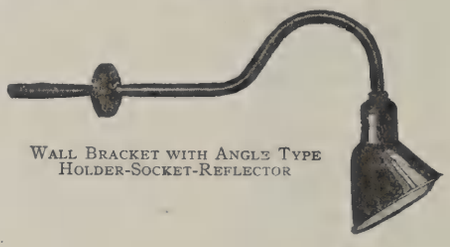
DRIVEWAY CROOK WITH RADIAL BOWL STREET-HOOD AND CLAMP-ARM.

Fixtures for Protective Lighting

The various types of industrial lighting reflectors in porcelain enamel finish —angle, dome (distributing type) and bowl—are used with Cutter pipe brackets and crooks.

Radial bowl streethoods with or without refractors may be suspended from plain or ornamental brackets and mounted on walls or poles.

Platform crooks or pipe standards, equipped with automatic cutout hangers for lowering the fixtures to the ground, are especially adapted to yard lighting.



WALL BRACKET WITH ANGLE TYPE HOLDER-SOCKET-REFLECTOR

Flood-lighting projectors are used most successfully for construction work at night and for illuminating objects a considerable distance away.

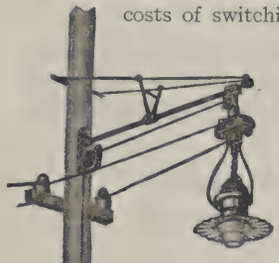
Distribution Systems

For small areas, where the distance to be covered with the wires is not great, multiple lamps on 110-volt circuits are usually employed. Series systems, however, may be used for circuits covering larger distances. A reactance coil or two-winding transformer is installed in each fixture and thus a considerable saving in wire is effected without the necessity of a regulating transformer.

Additional information regarding Distributing Apparatus for both interior and outside lighting will be furnished upon request.

RAILWAY-YARD LIGHTING

Good illumination is an important factor in railway switching, storage and loading yards. Decreases in the number of accidents and in the costs of switching and loading are arguments in favor of modern lighting systems.



Automatic Cut-out Hanger with Streethood.

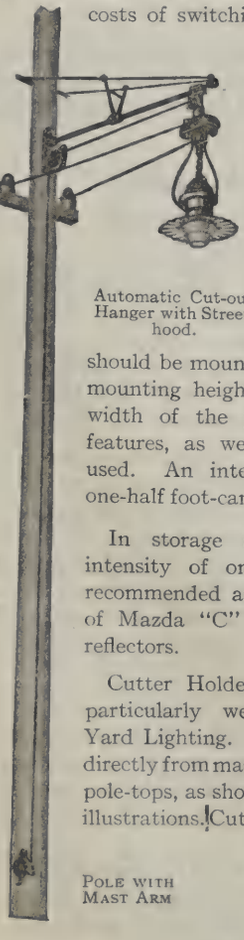
The small clearance between cars in switching yards usually necessitates mast-arm fixtures or the suspension of lamps on cables between poles set at the sides. Lamps should be mounted high to prevent glare; mounting heights vary according to the width of the yards and their general features, as well as the sizes of lamps used. An intensity of one-quarter to one-half foot-candle produces good results.

In storage and loading yards, an intensity of one-fourth candlepower is recommended and is secured by the use of Mazda "C" lamps with Dome type reflectors.

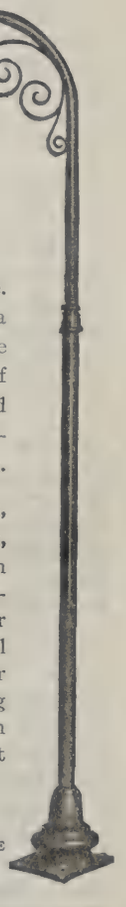
Cutter Holder - Socket - Reflectors are particularly well adapted to Railway Yard Lighting. They may be suspended directly from mast-arms, poles, brackets and pole-tops, as shown in the accompanying illustrations. Cutter Holder-Socket Reflectors are combinations of Holder-Sockets and One-Piece Porcelain Enameled Steel Reflectors. They are easy to wire and install, are weather and fume proof and are easily cleaned.

The average illumination of railway yards may be increased from 30 to 60 per cent by keeping the reflectors clean. Cutter Automatic Cut-Out Hangers facilitate cleaning reflectors and renewing lamps at minimum expense. The cost of these devices is saved in a short time by the reduction in maintenance expense. The initial high efficiency of a railway yard lighting system is assured continuously by the use of Cutter Holder-Socket-Reflectors and Cut-Out Hangers.

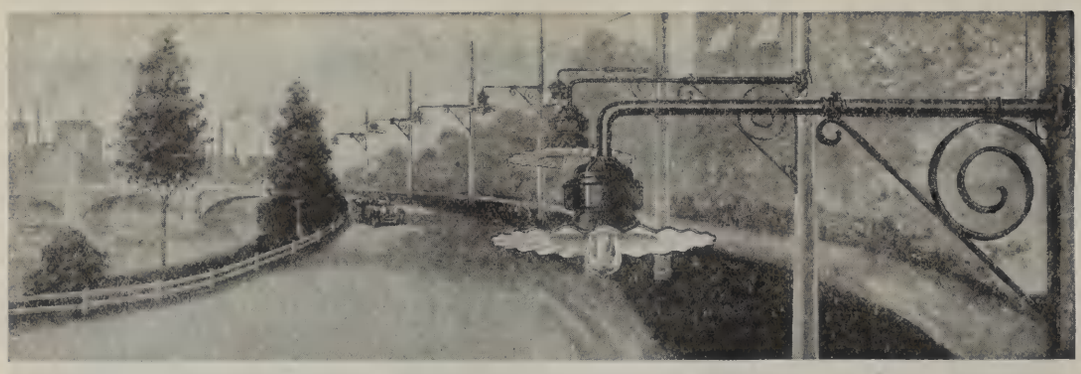
In switching yards and round houses, where smoke and fumes are excessive, Cutter Vapor-Proof Fixtures listed on page 14 are recommended. Flood Lighting Projectors, Streethoods and other Cutter products are adapted to special railway yard lighting requirements. Our engineering service is available for solving complicated problems and assisting in the selection of the proper equipment for each particular requirement.



Pole with Mast Arm



Platform Crook with Dome Type Holder-Socket Reflector



Modern Street Lighting Systems with Cutter Streethoods

THE methods employed for operating street-lighting systems may be divided into two classes: Multiple and Series Operation.

Multiple Systems are usually operated at 110 or 220 volts, and the power is supplied from a constant-potential transformer. The multiple system of operation has been generally used for small installations where the distance traversed by the line wires is not sufficiently great to warrant the expense of installing regulating equipment for series lamps.

The Series System, using one conductor to traverse the lighted area, as compared with two conductors for the multiple system, has been adopted generally for large installations of incandescent street lighting fixtures. Series Mazda "C" lamps are used.

The series system is usually more economical in first cost, but for very small installations where the series system would require additional regulating apparatus, it may be found more economical to install multiple lamps, although certain variations of the series system described below are particularly applicable to small installations.

Methods of Operation of Series Distribution Systems

There are several methods of using series Mazda "C" lamps in Cutter Streethoods and any one of the following may be considered for each particular installation:

(1). The constant-current straight series system using the Cutter Regent Film Socket with each lamp. (See next page.) In the event of a lamp failing, the perfectly calibrated film in the Regent Socket punctures, thus re-establishing the circuit instantly. The system is operated through a regulating transformer which takes care of the difference in the load and maintains the current practically constant. This method is suitable for all series systems for operating lamps ranging from 40 to 600 candlepower.

(2). The constant-potential series system using an individual two-winding (or so-called series multiple) transformer placed on the pole from which the service wires lead to the fixture. The transformers are connected in series and each one delivers the amount of current required for the lamp at a voltage equal to that of only one lamp. Multiple Streethoods are used. The system may be operated either from constant-potential mains or in series with other lamps using film sockets and supplied through a regulating transformer. This method is particularly applicable to small installations of series lamps of 400 candlepower rating or larger, and has the special feature of providing a low potential in the wires leading from the transformer to the lamp.

(3). The constant-potential series system using a multiple socket and reactance coil with each lamp. This system requires no regulating apparatus at the central station. When a lamp fails, there is sufficient reactance inserted in the line to maintain the current practically constant. This method is used on systems for operating series lamps of 250 candlepower rating and smaller, and is found most economical on circuits of less than 2 kilowatt capacity. Cutter Adjuster-Socket Streethoods are used.

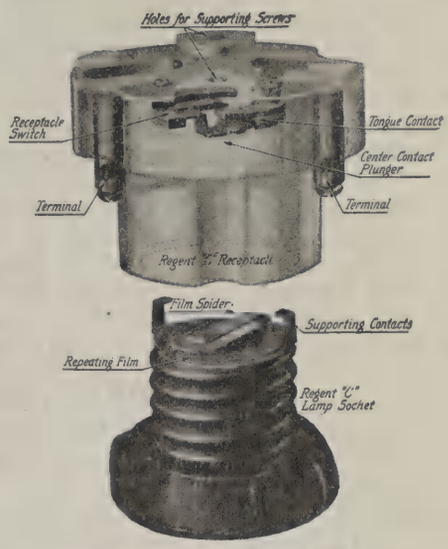
Local conditions govern the selection of the method of operation of a distribution system. If data are given on the number and size of lamps, plan of streets, central-station equipment and methods of distribution now used, our Engineering Department will make recommendations for the most efficient and suitable method of distribution.

Straight Series System with Regulating Transformer and Cutter Regent Film Socket

In a straight series lighting system, the constant-current transformer which regulates the voltage to compensate for burned out lamps may be considered the heart of the sytem while the *Regent Film Socket is the safety valve.*

When a lamp burns out, there is a momentary rise in potential across the terminals of the lamps and the dielectric film in the socket must puncture to re-establish the circuit. If the dielectric strength of the film is too great, the rise of the voltage may not be sufficient to puncture the film, or it may hold the circuit open until the voltage has increased to a point that will produce violent surges in the line. These surges are damaging to Mazda "C" lamps, because the filament must be kept so near the melting point that a line surge of any consequence destroys the lamp.

The film used in the Regent Socket punctures uniformly and accurately at rated voltage. It is enclosed in the socket and protected against climatic conditions which might prevent this accuracy. The film cannot creep out as a result of vibration of the fixture and lamp. The film holder is so designed that it is impossible to use any substitute for the regular film.



Phantom View of Regent "C" Receptacle with View of Lamp Socket. Showing Repeating Film.

Regent Film Sockets have been thoroughly tried out by the users of the country. Hundreds of thousands are in service under all climatic conditions. Approximately 30,000 have been installed in the city of Chicago alone, where they are used in Cutter pendants and in ornamental posts for Mazda "C" lamps.

To the many well known advantages of the Regent Socket, improvements have been added to make the Regent "C" Socket, illustrated above, the ideal "safety valve" socket.

Regent "C" Film Sockets Solve Outage Problems

Cigarette wrappers, matches or anything will do with the ordinary film socket, until something has gone wrong, all the lamps are *burned out* or the circuit is open and the trouble cannot be located. Outage penalties eat into the profits and accidents occur because of darkness. No such condition can arise with the *repeating film.* Lift the spring spider, turn the film a fraction of an inch, close it and screw in a new lamp. Insert the socket in the receptacle and the lamp is ready for operation. The saving in cost of film renewals alone will pay for the socket in a short time.

Advantages of Regent "C" Film Sockets

Use Regent "C" Sockets with Cutter pendants, streethoods, posts and other fixtures with straight series lamps. The following advantages are obtained:

(1) The repeating film saves trouble and time, and decreases the expense of renewals.
(2) Only the calibrated film can be used with Regent "C" Sockets.
(3) Large contact surface and uniform pressure insure accuracy in film puncture.
(4) Fool-proof construction insures the proper use of the film and socket.
(5) The film is enclosed in the socket, protecting it against climatic conditions which might prevent accuracy in film puncture.
(6) There are no live metal parts exposed back of the socket; this construction eliminates danger from corrosion and short circuits.
(7) The intense heat of Mazda "C" lamps cannot affect the operation of the film.
(8) The lamp socket is easily inserted in the receptacle; a slight turn locks it in place.
(9) Lamps may be renewed easily by hand or with lamp-changer from the ground.
(10) Lamps may be inserted in the lamp socket shells at the storeroom and carried in this manner by the linemen to the places where renewals are made.
(11) The Regent "C" Socket is smaller and better insulated than other designs.

Construction of Cutter Series Streethoods

The design of Cutter Streethoods is the result of many years of experience in the development of street-lighting equipment. Every detail in their construction has been planned so they can be easily installed and wired. They give efficient and long service.

Copper heels on Cutter Streethood Reflectors insure maximum life because they prevent chipping of the enamel from contact with screw or clip supports. When enamel is chipped away by screws or similar supports, the metal body of the reflector is exposed to the air; rust sets in and spreads rapidly over the surface of the reflector, reducing the efficiency and greatly shortening the life.

Cutter Streethood Reflector. Showing Copper Heel and Beaded Edge.

The beaded edge on Cutter Streethood Reflectors is another feature which guarantees maximum life of the reflector. The edge of the steel reflector body is turned over and a smooth bead is formed. The three coats of enamel on the exterior of the reflector as well as the three coats on the interior are lapped over the beaded edge, forming a protective covering that is extremely durable.

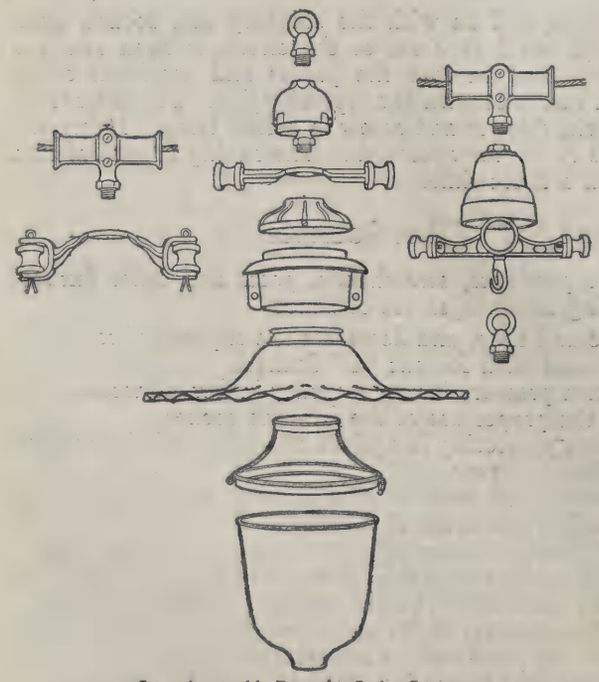
Advantages of Cutter Streethoods

(1) *Interchangeable Parts* permit combinations suited to every individual requirement.

(2) *Cast Iron Canopies* are threaded for ¾-inch pipe or for 1¼-inch pipe. The ¾-inch canopy also fits all styles of center suspension fittings. Iron parts of Cutter Streethood Bodies are electro-galvanized and painted black.

(3) *Porcelain Heads* are designed to give ample insulation for the Regent "C" Series Film Socket and are arranged for either inner or outer wiring. When outer wiring is used the wires may be tied to holes in the rim of the Porcelain Head, making the use of a cross arm unnecessary. Durable wiring connections are easily and quickly made.

(4) *Standard 4-inch Copper Heel* on all reflectors insures maximum life of the reflector. The enamel is not damaged by the supporting screws. When reflectors are fastened by any other means, the enamel is easily chipped and corrosion begins. The rust will quickly spread to other parts, making it necessary to replace the reflector, which is a large part of the cost of the fixture.

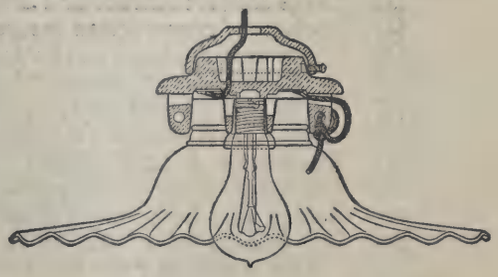


Interchangeable Parts for Series Center Suspension Streethoods.

(5) *Radial Bowl Reflectors* shed rain, sleet and snow, thus relieving the fixtures of undue strain during inclement weather. They are artistic in appearance and afford ideal light distribution.

(6) *"Sol-lux" Diffusers and Holophane Refractors* are supported on hinges so that the lamps may be replaced easily, and the glassware may be cleaned frequently, at low expense. This is essential to obtain maximum efficiency in light distribution.

(7) *Regent "C" Film Sockets* eliminate many troubles of series street-lighting systems. The saving in lamp renewals alone will quickly pay for the complete fixture.



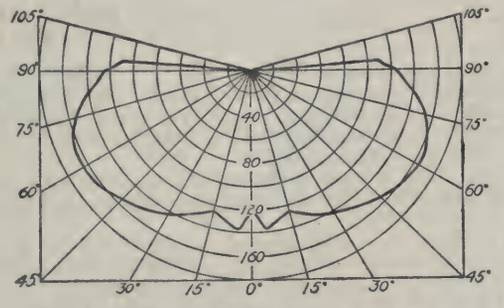
Method of Wiring Cutter Series Streethoods

Efficient Illumination with Cutter Series Streethoods

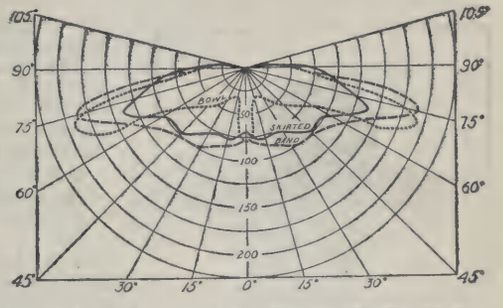
The first consideration in the selection of every street-lighting fixture is the amount of light required; that is, the size of lamp. The next consideration is the manner in which the light should be distributed. These determine one or two styles of Streethood Reflectors. The third consideration, that of the method of installation, will enable the customer to select the one best suited to his requirements. Cutter Streethood Bodies and the brackets for supporting them are listed separately. The size of lamp is given for each Streethood Body, which enables the selection of the one best suited to the lighting needs. The Streethood Body may then be offered in combination with several styles of brackets and center-suspension parts. Thus a complete fixture may be assembled to suit any condition.

To facilitate proper selection of Streethood Bodies typical distribution curves for Mazda "C" lamps with each reflector are shown below.

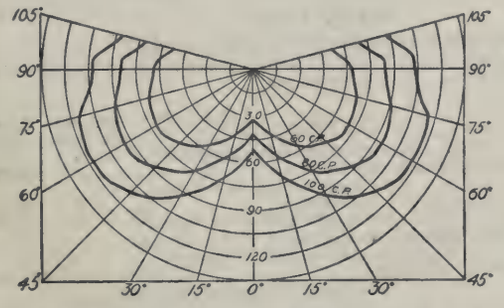
Distribution Curves



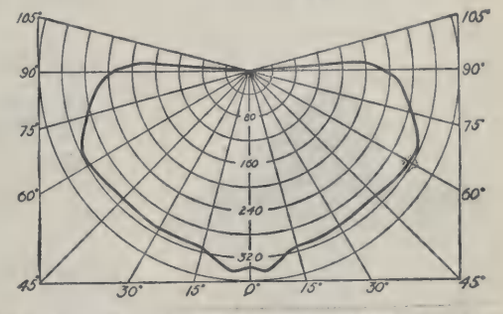
Distribution Curve for 100 Candlepower Mazda "C" Lamp with 18-inch Radial Bowl Reflector.



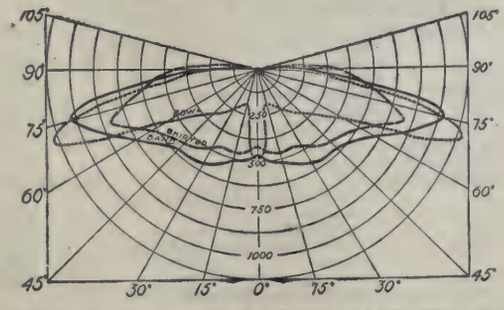
Distribution Curves for 100 Candlepower Mazda "C" Lamp with 18-inch Radial Bowl Reflector and 6½-inch Holophane Bowl Refractor, with Band Refractor and Skirted Refractor.



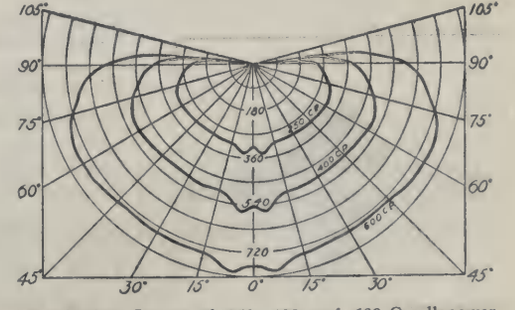
Distribution Curves for 20-inch Flat Radial Reflector with 60, 80 and 100 Candlepower Mazda "C" Lamp.



Distribution Curve for 250 Candlepower Mazda "C" Lamp and 20-inch Radial Bowl Reflector with Extension.



Distribution Curves of 600 Candlepower Mazda "C" Lamp with 18-inch Radial Bowl Reflector and 8½-inch Bowl, Band and Skirted Refractors.

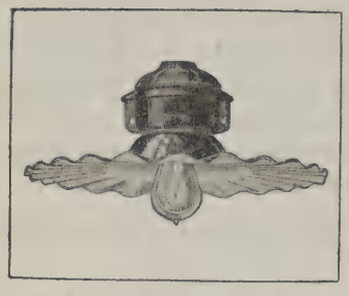


Distribution Curves of 250, 400 and 600 Candlepower Mazda "C" Lamps with 18-inch Radial Bowl Reflectors and "Sol-lux" Diffusers.

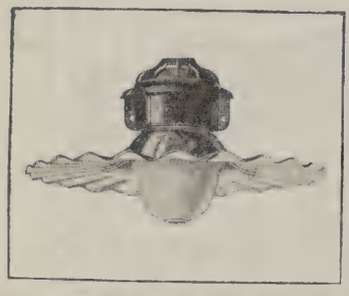
Cutter Series Streethood Bodies

For 40, 60, 80 and 100 C. P. Series Mazda "C" Lamps

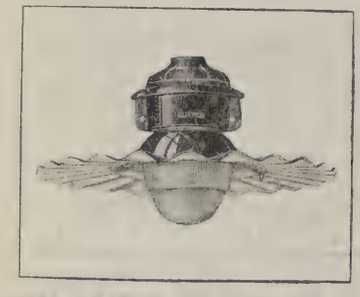
Schedule A—Standard Package Quantity 10



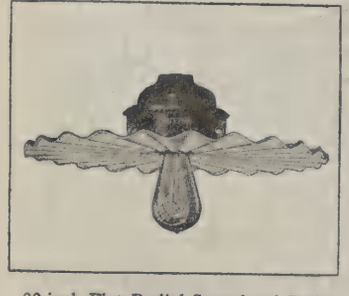
18-inch Radial Bowl Streethood Body. Trade No. W27101



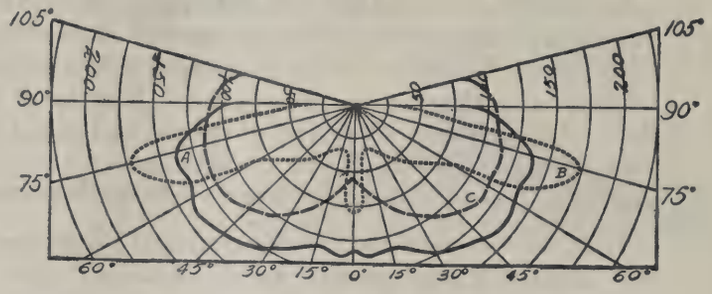
18-inch Radial Bowl Streethood Body with 6½-inch Holophane Bowl Refractor. Trade No. W27103



18-inch Radial Bowl Streethood Body with 6½-inch Holophane Skirted Refractor. Trade No. W27105



20-inch Flat Radial Streethood Body. Trade No. W27109



Distribution Curves of 100 C. P. Mazda "C" Lamp with A—18-inch Radial Bowl Reflector. B—Same with 6½-inch Holophane Bowl Refractor. C—20-inch Flat Radial Reflector.

A Cutter Series Streethood Body consists of a porcelain insulator head with Regent "C" Film Socket and iron canopy and a reflector with or without refractor as listed.

The porcelain head contains the Regent "C" Film Socket and is equipped with galvanized iron canopy painted black. The canopy is threaded for ¾-inch pipe for fastening to brackets or for center suspension fittings, or, the Streethood body will be furnished with canopy threaded for 1¼-inch pipe as listed below.

Line wires leading to the Streethood are tied securely in the outer rim of the porcelain head and lead in to the socket terminals through holes provided therefor.

Reflectors are made of deep drawing steel and surfaced with three coats of highest grade porcelain enamel, reflective white underneath, green on top. The reflector is attached to the porcelain head by means of two stationary lugs and a heavy set screw with lock-nut engaging a 4-inch copper heel which protects the enamel from chipping. Reflectors and Refractors furnished with the Streethood Bodies listed on this page are designed for use with 40, 60, 80 and 100 C. P. Series Mazda "C" Lamps.

PRICE LIST

Schedule A—Standard Package Quantity 10

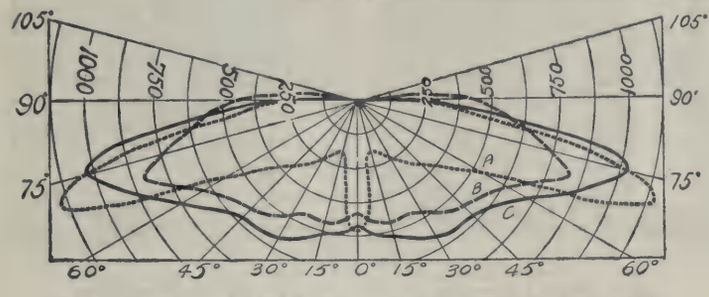
Prices below cover Streethood Bodies for 40, 60, 80 and 100 C. P. Series Mazda "C" Lamps, but do not include lamps or wiring.

Trade No. For ¾-in. Pipe	Trade No. For 1¼-in. Pipe	Description		Ship. Wt. lbs. each	Price each
		With 18-inch Radial Bowl Reflector			
W27101	W27102	**Complete Unit**		12	$7.00
W27141	W27142	Unit Consists of	Porcelain Head with Socket and Canopy	8	4.25
W27143	W27143		18-inch Radial Bowl Reflector	4	2.75
		With 18-inch Radial Bowl Reflector and 6½-inch Holophane Bowl Refractor			
W27103	W27104	**Complete Unit**		17	$11.50
W27141	W27142	Unit Consists of	Porcelain Head with Socket and Canopy	8	4.25
W27143	W27143		18-inch Radial Bowl Reflector	4	2.75
W27166	W27166		6½-inch Holophane Bowl Refractor	3½	3.00
W27146	W27146		Hinged Refractor Holder	1½	1.50
		With 18-inch Radial Bowl Reflector and 6½-inch Holophane Skirted Refractor			
W27105	W27106	**Complete Unit**		17	$11.50
W27141	W27142	Unit Consists of	Porcelain Head with Socket and Canopy	8	4.25
W27143	W27143		18-inch Radial Bowl Reflector	4	2.75
W27167	W27167		6½-inch Holophane Skirted Refractor	3½	3.00
W27146	W27146		Hinged Refractor Holder	1½	1.50
		With 18-inch Radial Bowl Reflector and 6½-inch Holophane Band Refractor			
W27107	W27108	**Complete Unit**		16	$11.50
W27141	W27142	Unit Consists of	Porcelain Head with Socket and Canopy	8	4.25
W27143	W27143		18-inch Radial Bowl Reflector	4	2.75
W27168	W27168		6½-inch Holophane Band Refractor	2½	3.00
W27146	W27146		Hinged Refractor Holder	1½	1.50
		With 20-inch Flat Radial Reflector			
W27109	W27110	**Complete Unit**		13	$10.00
W27141	W27142	Unit Consists of	Porcelain Head with Socket and Canopy	8	4.25
W27162	W27162		20-inch Flat Radial Reflector	5	2.25

Cutter Series Streethood Bodies

For 250, 400 and 600 C. P. Series Mazda "C" Lamps

Schedule A—Standard Package Quantity 10



Distribution Curves for 600 Candlepower Mazda "C" Lamp with 18-inch Radial Bowl Reflector and A — 8½-inch Bowl Refractor. B — 8½-inch Skirted Refractor. C — 8½-inch Band Refractor.

A Cutter Series Streethood Body consists of a porcelain insulator head with Regent "C" Film Socket and iron canopy and a reflector with or without refractor as listed.

The porcelain head contains the Regent "C" Film Socket and is equipped with galvanized iron canopy painted black. The canopy is threaded for ¾-inch pipe for fastening to brackets or for center suspension fittings; or, the Streethood will be furnished with canopy threaded for 1¼-inch pipe as listed below.

Line wires leading to the Streethood are tied securely in the outer rim of the porcelain head and lead in to the socket terminals through holes provided therefor.

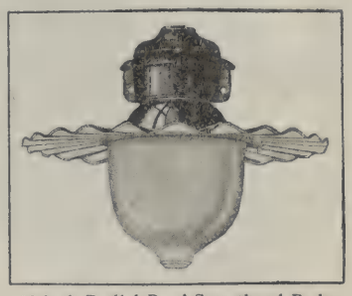
Reflectors are made of deep drawing steel and surfaced with three coats of highest grade porcelain enamel, reflective white underneath, green on top. The reflector is attached to the porcelain head by means of two stationary lugs and a heavy set screw with lock-nut engaging a 4-inch copper heel which protects the enamel from chipping. Reflectors and Refractors furnished with the Streethood Bodies listed on this page are designed for use with 250, 400 and 600 C. P. Series Mazda "C" Lamps.

PRICE LIST

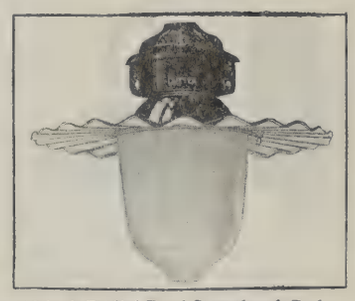
Schedule A—Standard Package Quantity 10

Prices below cover Streethoods for use with 250, 400 and 600 C. P. Series Mazda "C" Lamps, but do not include lamps or wiring.

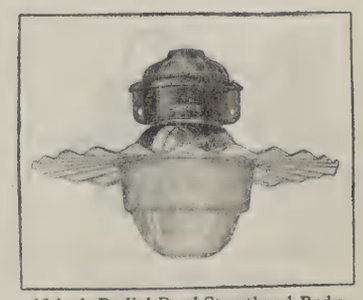
Trade No. For ¾-in. Pipe	Trade No. For 1¼-in. Pipe	Description	Ship. Wt. lbs. each	Price each
		With 18-inch Radial Bowl Reflector and 8½-inch Holophane Bowl Refractor		
W27111	**W27112**	**Complete Unit**	23	**$14.50**
W27141	W27142	Porcelain Head with Socket and Canopy	8	4.25
W27143	W27143	Unit 18-inch Radial Bowl Reflector	4	2.75
W27169	W27169	Consists of 8½-inch Holophane Bowl Refractor	9½	6.00
W27145	W27145	Hinged Refractor Holder	1½	1.50
		With 18-inch Radial Bowl Reflector and 8½-inch Holophane Skirted Refractor		
W27113	**W27114**	**Complete Unit**	22	**$14.50**
W27141	W27142	Porcelain Head with Socket and Canopy	[illegible]	4.25
W27143	W27143	Unit 18-inch Radial Bowl Reflector	4	2.75
W27170	W27170	Consists of 8½-inch Holophane Skirted Refractor	8½	6.00
W27145	W27145	Hinged Refractor Holder	1½	1.50
		With 18-inch Radial Bowl Reflector and 8½-inch Holophane Band Refractor		
W27115	**W27116**	**Complete Unit**	19	**$14.50**
W27141	W27142	Porcelain Head with Socket and Canopy	8	4 25
W27143	W27143	Unit 18-inch Radial Bowl Reflector	4	2.75
W27171	W27171	Consists of 8½-inch Holophane Band Refractor	5½	6.00
W27145	W27145	Hinged Refractor Holder	1½	1.50
		With 18-inch Radial Bowl Reflector and "Sol-lux" Diffuser		
W27117	**W27118**	**Complete Unit**	18	**$11.50**
W27141	W27142	Porcelain Head with Socket and Canopy	[illegible]	4.25
W27143	W27143	Unit 18-inch Radial Bowl Reflector	4	2.75
W27172	W27172	Consists of "Sol-lux" Diffuser	4½	3.00
W27145	W27145	Hinged Refractor Holder	1½	1.50
		With 20-inch Radial Bowl Reflector with Extension for Bare Lamps		
W27119	**W27120**	**Complete Unit**	14	**$7.75**
W27141	W27142	Unit Porcelain Head with Socket and Canopy	8	4.25
W27144	**W27144**	Consists of 20-inch Radial Bowl Reflector with Extension	6	3.50



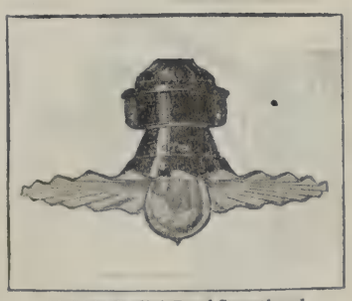
18-inch Radial Bowl Streethood Body with 8½-inch Holophane Bowl Refractor. Trade No. W27111.



18-inch Radial Bowl Streethood Body with 8½-inch "Sol-lux" Diffuser. Trade No. W27117.



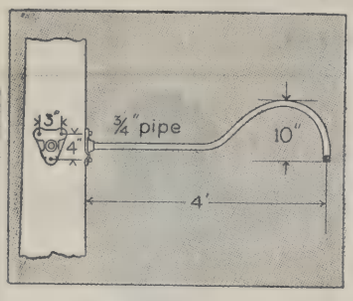
18-inch Radial Bowl Streethood Body with 8½-inch Holophane Skirted Refractor. Trade No. W27113.



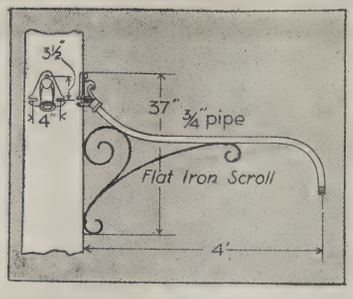
20-inch Radial Bowl Streethood Body with Extension. Trade No. W27119.

Cutter Streethood Brackets

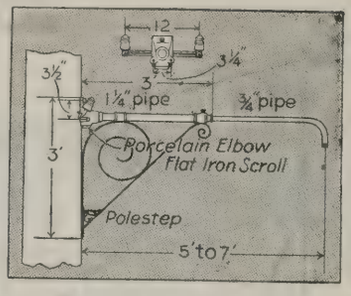
Schedule A—Standard Package Quantity 10



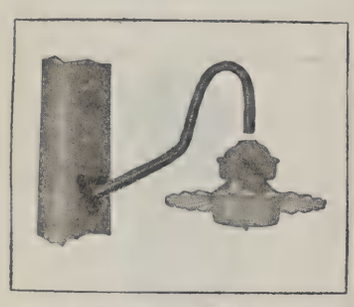
Style A Bracket.
(Approximate Dimensions.)



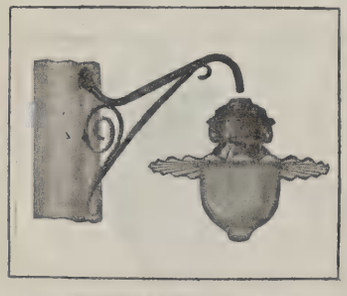
Majestic Medium Bracket.
(Approximate Dimensions.)



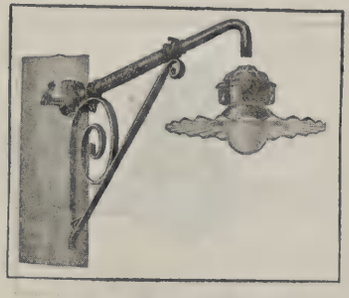
Boulevard Telescope Bracket.
(Approximate Dimensions.)



Style A Bracket. Trade No. W27173



Majestic Medium Bracket.
Trade No. W27175



Boulevard Telescope Bracket.
Trade No. W27176

A Complete Cutter Bracket Type Streethood consists of one of the Brackets shown and one of the Streethood Bodies listed on the preceding pages. Brackets listed on this page are for supporting Streethood Bodies with ¾-inch canopy. Simple Cross Arm with ¾-inch lock-nut (Trade No. W27194) will be furnished for spreading the wires above the Streethood Body for 40 cents list additional, when so ordered.

Style A Bracket

Consists of 4-foot gooseneck of ¾-inch pipe with heavy 3-hole grooved pole plate. Furnished with or without brace arm for guiding line wires from back of pole to Streethood Body.

Majestic Medium Bracket

A medium-weight bracket of the same style as the Majestic Bracket shown on the page opposite. Consists of ornamental grooved pole plate, 4-foot gooseneck (double bend) of ¾-inch pipe and wrought iron scroll. Shipped assembled complete as shown.

Boulevard Telescope Bracket

The ¾-inch pipe telescopes into the 1¼-inch pipe and allows for adjustments of 5 to 7 feet in reach from pole. This bracket has a heavy 3-hole cast iron pole plate with porcelain elbow for inner wiring and a cross-arm with glass insulators. The knurled set screw in the pipe joint and the pole step in the lower corner of the scroll are for the convenience of linemen when renewing lamps.

PRICE LIST

Schedule A—Standard Package Quantity 10

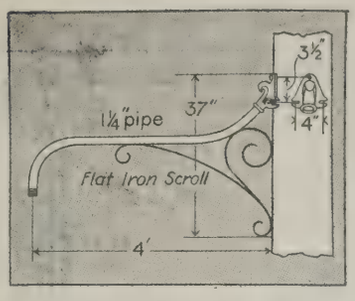
Prices below cover brackets only. Streethood Bodies to make complete Bracket Type Streethoods should be selected from the two preceding pages and ordered separately.

Trade No.	Description	Ship. Wt. lbs. each	Price each
	Style A Bracket		
W27173	**Complete Bracket**	7	**$1.75**
W27179	Bracket Consists of ¾-inch x 4-foot Gooseneck	4¾	1.35
W27180	Bracket Consists of Grooved Pole Plate	2¼	.40
	Style A Bracket with Brace Arm		
W27174	**Complete Bracket**	10	**$2.45**
W27179	Bracket Consists of ¾-inch x 4-foot Gooseneck	4¾	1.35
W27180	Bracket Consists of Grooved Pole Plate	2¼	.40
W27181	Bracket Consists of Brace Arm	3	.70
	Majestic Medium Bracket		
W27175	**Complete Bracket, Assembled**	18	**$3.25**
	Boulevard Telescope Bracket		
W27176	**Complete Bracket**	36	**$7.75**
W27147	Bracket Consists of Pole Plate with Cross Arm	9	1.75
W27148	Bracket Consists of Boulevard Bracket with Pole Step and Scroll Assembled	19	4.20
W27149	Bracket Consists of ¾-inch 5-foot Pipe Bend	6	1.50
W27150	Bracket Consists of 2 Pony Glass Insulators	1	.15

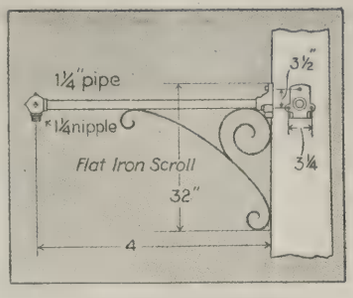
Galvanizing: When ordered in Standard Package Quantities or over, any of the brackets listed above will be furnished electro-galvanized and painted black, for 20% list additional. In less than Standard Package Quantities add 40%

Cutter Streethood Brackets

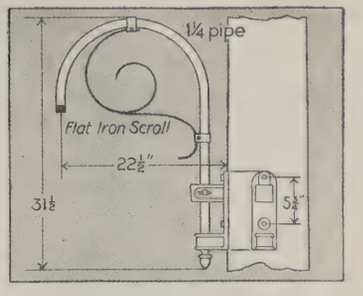
Schedule A—Standard Package Quantity 10



Majestic Senior Bracket.
(Dimensions approximate.)



Spartan Straight Arm Bracket.
(Dimensions approximate.)



Pole Crook.
(Dimensions approximate.)

A Complete Cutter Bracket Type Streethood consists of one of the brackets shown and one of the Streethood Bodies listed on the preceding pages. Brackets listed on this page are for supporting Streethood Bodies with 1¼-inch canopies. Simple Cross Arm with 1¼-inch locknut (Trade No. W27197) will be furnished for spreading the wires above the Streethood Body for 40 cents list additional, when so ordered.

Majestic Senior Bracket

Consists of double-bend gooseneck of 1¼-inch pipe with 3-hole grooved pole plate and wrought iron scroll assembled. Holds lamp 4 feet from pole.

Spartan Straight Arm Bracket

Consists of straight piece of 1¼-inch pipe with 3-hole pole plate, headpiece and wrought iron scroll assembled. Holds lamp 4 feet from pole. Furnished with 1¼-inch nipple.

Arcadian Junior Bracket

Similar to Spartan Straight Arm Bracket described above. Holds lamp 20 inches from pole. Furnished with 1¼-inch nipple.

Pole Crook

Made of 1¼-inch pipe with wrought iron scroll assembled. Clamps for attaching to pole are adjustable to compensate for the rake on trolley poles.

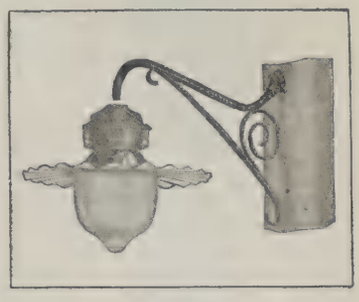
PRICE LIST

Schedule A—Standard Package Quantity 10

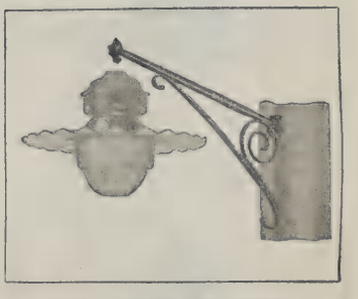
Prices below cover Brackets only. Streethood Bodies to make complete Bracket Type Streethoods should be selected from the two preceding pages and ordered separately.

Trade No.	Description	Ship. Wt. lbs. each	Price each
	Majestic Senior Bracket		
W27177	**Complete Bracket**	26	**$5.00**
	Spartan Straight Arm Bracket		
W27151	**Complete Bracket**	24	**$5.00**
W27152	Bracket — Spartan Straight Arm Bracket Assembled	23¾	4.80
W27198	Consists of — 1¼-inch Nipple	¼	.20
	Arcadian Junior Bracket		
W27178	**Complete Bracket**	14	**$4.00**
W27153	Bracket — Arcadian Junior Bracket Assembled	13¾	3.80
W27198	Consists of — 1¼-inch Nipple	¼	.20
	Pole Crook for Wooden Poles		
W27154	**Complete Bracket**	28	**$6.00**
W27155	Bracket — Crook with Scroll Assembled	20	4.50
W27156	Consists of — Pole Plate	[illegible]	1.50
	Pole Crook for 4-inch Iron Poles		
W27157	**Complete Bracket**	36	**$7.50**
W27155	Bracket — Crook with Scroll Assembled	20	4.50
W27158	Consists of — 2 Pipe Clamps for 4-inch Pipe	8	1.50
	Pole Crook for 5-inch Iron Poles		
W27159	**Complete Bracket**	38	**$7.70**
W27155	Bracket — Crook with Scroll Assembled	20	4.50
W27160	Consists of — 2 Pipe Clamps for 5-inch Pipe	9	1.60

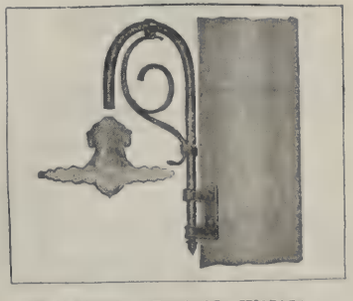
Galvanizing: When ordered in Standard Package Quantities or over, any of the brackets listed above will be furnished electro-galvanized and painted black, for 20% list additional. In less than Standard Package Quantities add 40%.



Majestic Senior Bracket.
Trade No. W27177



Spartan Straight Arm Bracket.
Trade No. W27151

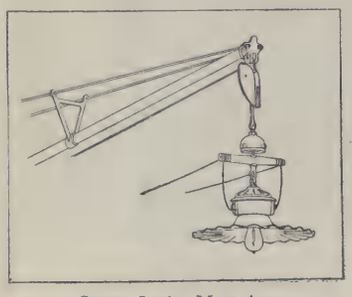


Pole Crook. Trade No. W27154

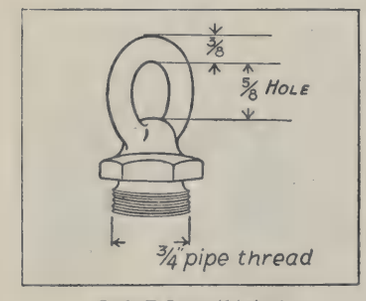
Cutter Series Suspension Streethoods

For 40, 60, 80 and 100 C. P. Series Mazda "C" Lamps

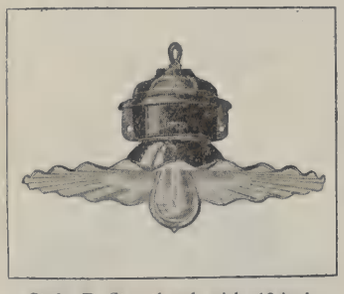
Schedule A—Standard Package Quantity 10



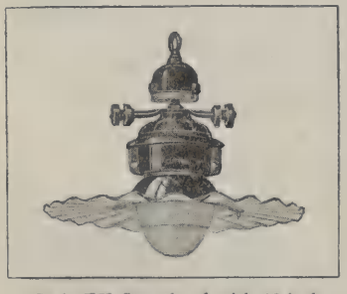
Cutter Junior Mast Arm.



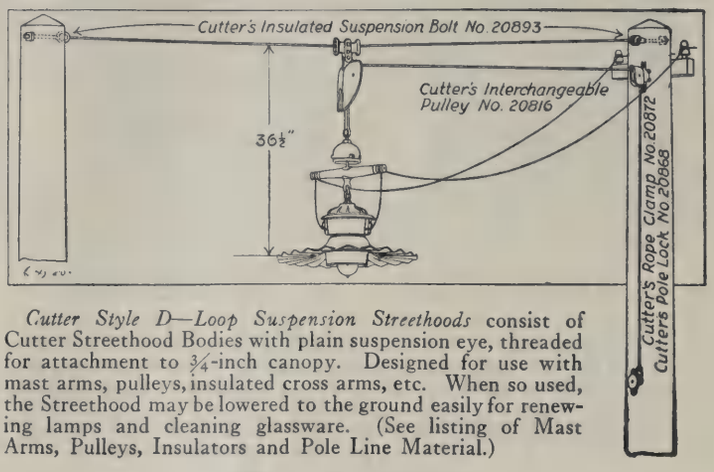
Style D Loop (½-size.)



Style D Streethood with 18-inch Radial Bowl Reflector. Trade No. W27121



Style EX Streethood with 18-inch Radial Bowl Reflector and 6½-inch Holophane Skirted Refractor. Trade No. EX W27123


Cutter's Insulated Suspension Bolt No. 20893
Cutter's Interchangeable Pulley No. 20816
36½"
Cutter's Rope Clamp No. 20872
Cutter's Pole Lock No. 20868

Cutter Style D—Loop Suspension Streethoods consist of Cutter Streethood Bodies with plain suspension eye, threaded for attachment to ¾-inch canopy. Designed for use with mast arms, pulleys, insulated cross arms, etc. When so used, the Streethood may be lowered to the ground easily for renewing lamps and cleaning glassware. (See listing of Mast Arms, Pulleys, Insulators and Pole Line Material.)

PRICE LIST

Schedule A—Standard Package Quantity 10

Prices below cover Streethoods for 40, 60, 80 and 100 C. P. Mazda "C" Lamps but do not include lamps or wiring.

Trade No.	Description	Ship. Wt. lbs. each	Price each
	With 18-inch Radial Bowl Reflector		
W27121	**Complete Streethood**	12½	**$7.15**
W27161	Style D Loop	½	.15
W27141	Streethood Consists of Porcelain Head with Socket and ¾-inch Canopy	8	4.25
W27143	Streethood Consists of 18-inch Radial Bowl Reflector	4	2.75
	With 18-inch Radial Bowl Reflector and 6½-inch Holophane Bowl Refractor		
W27122	**Complete Streethood**	17½	**$11.65**
W27161	Style D Loop	½	.15
W27141	Streethood Consists of Porcelain Head with Socket and ¾-inch Canopy	8	4.25
W27143	Streethood Consists of 18-inch Radial Bowl Reflector	4	2.75
W27166	Streethood Consists of 6½-inch Holophane Bowl Refractor	3½	3.00
W27146	Streethood Consists of Hinged Refractor Holder	1½	1.50
	With 18-inch Radial Bowl Reflector and 6½-inch Holophane Skirted Refractor		
W27123	**Complete Streethood**	17½	**$11.65**
W27146	Style D Loop	½	.15
W27141	Streethood Consists of Porcelain Head with Socket and ¾-inch Canopy	8	4.25
W27143	Streethood Consists of 18-inch Radial Bowl Reflector	4	2.75
W27167	Streethood Consists of 6½-inch Holophane Skirted Refractor	3½	3.00
W27146	Streethood Consists of Hinged Refractor Holder	1½	1.50
	With 18-inch Radial Bowl Reflector and 6½-inch Holophane Band Refractor		
W27124	**Complete Streethood**	16½	**$11.65**
W27161	Style D Loop	½	.15
W27141	Streethood Consists of Porcelain Head with Socket and ¾-inch Canopy	8	4.25
W27143	Streethood Consists of 18-inch Radial Bowl Reflector	4	2.75
W27168	Streethood Consists of 6½-inch Holophane Band Refractor	2½	3.00
W27146	Streethood Consists of Hinged Refractor Holder	1½	1.50
	With 20-inch Flat Radial Reflector		
W27125	**Complete Streethood**	13½	**$6.65**
W27161	Style D Loop	½	.15
W27141	Streethood Consists of Porcelain Head with Socket and ¾-inch Canopy	8	4.25
W27162	Streethood Consists of 20-inch Flat Radial Reflector	5	2.25

Cutter Styles DX, E and EX Streethoods

Style DX Streethood consists of Style D Streethood with simple cross arm No. W27186. Add prefix DX to trade number; 1½ lbs. to the shipping weight and 35 cents to list price of Style D Streethood selected.

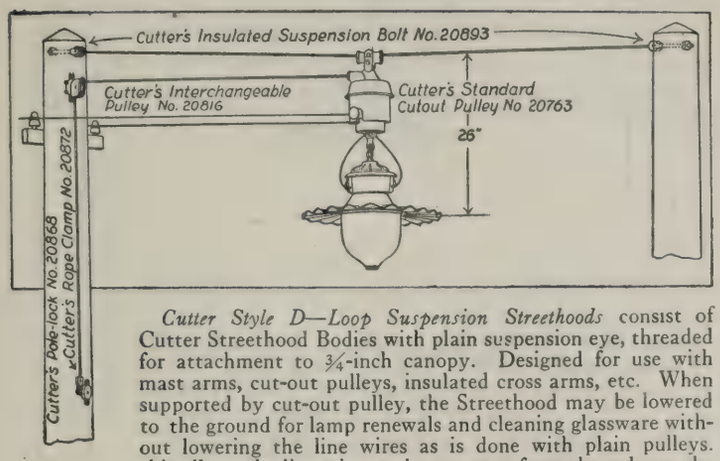
Style E Streethood consists of Style D Streethood with high voltage hood insulator No. W27163. Add prefix E to trade number; 2½ lbs. to the shipping weight and 90 cents to list price of Style D Streethood selected.

Style EX Streethood consists of Style D Streethood with high voltage hood insulator No. W27163 and simple cross arm No. W27186. Add prefix EX to trade number; 3¾ lbs. to the shipping weight and $1.35 to list price of Style D Streethood selected.

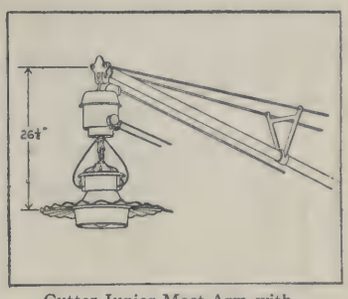
Cutter Series Suspension Streethoods

For 250, 400 and 600 C. P. Series Mazda "C" Lamps

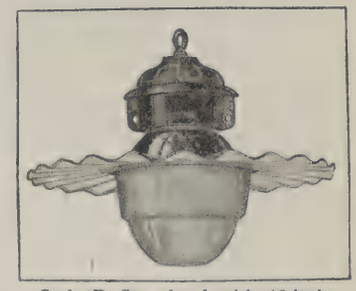
Schedule A—Standard Package Quantity 10


Cutter's Insulated Suspension Bolt No. 20893
Cutter's Interchangeable Pulley No. 20816
Cutter's Standard Cutout Pulley No 20763
26"
Cutter's Pole-lock No. 20868
Cutter's Rope Clamp No. 20872

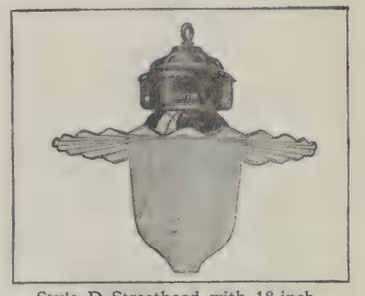
Cutter Style D—Loop Suspension Streethoods consist of Cutter Streethood Bodies with plain suspension eye, threaded for attachment to ¾-inch canopy. Designed for use with mast arms, cut-out pulleys, insulated cross arms, etc. When supported by cut-out pulley, the Streethood may be lowered to the ground for lamp renewals and cleaning glassware without lowering the line wires as is done with plain pulleys. this allows the line wires to be run taut from the pole to the pulley and provides absolute protection against accidents.



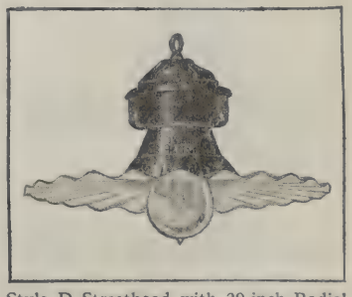
Cutter Junior Mast Arm with Standard Cut-Out Pulley.



Style D Streethood with 18-inch Radial Bowl Reflector and 8½-inch Holophane Skirted Refractor. Trade No. W27127



Style D Streethood with 18-inch Radial Bowl Reflector and "Sol-lux" Diffuser. Trade No. W27129



Style D Streethood with 20-inch Radial Bowl Reflector with Extension. Trade No. W27130

PRICE LIST

Schedule A—Standard Package Quantity 10

Prices below cover Streethoods for 250, 400 and 600 C. P. Series Mazda "C" Lamps, but do not include lamps or wiring.

Trade No.	Description	Shpg. wt. lbs. each	Price each
	With 18-inch Radial Bowl Reflector and 8½-inch Holophane Bowl Refractor		
W27126	**Complete Streethood**	23½	**$14.65**
W27161	Style D Loop	½	.15
W27141	Streethood Consists of: Porcelain Head with Socket and ¾-inch Canopy	8	4.25
W27143	18-inch Radial Bowl Reflector	4	2.75
W27169	8½-inch Holophane Bowl Refractor	9½	6.00
W27145	Hinged Refractor Holder	1½	1.50
	With 18-inch Radial Bowl Reflector and 8½-inch Holophane Skirted Refractor		
W27127	**Complete Streethood**	22½	**$14.65**
W27161	Style D Loop	½	.15
W27141	Streethood Consists of: Porcelain Head with Socket and ¾-inch Canopy	8	4.25
W27143	18-inch Radial Bowl Reflector	4	2.75
W27170	8½-inch Holophane Skirted Refractor	8½	6.00
W27145	Hinged Refractor Holder	1½	1.50
	With18-inch Radial Bowl Reflector and 8½-inch Holophane Band Refractor		
W27128	**Complete Streethood**	19½	**$14.65**
W27161	Style D Loop	½	.15
W27141	Streethood Consists of: Porcelain Head with Socket and ¾-inch Canopy	8	4.25
W27143	18-inch Radial Bowl Reflector	4	2.75
W27171	8½-inch Holophane Band Refractor	5½	6.00
W27145	Hinged Refractor Holder	1½	1.50
	With 18-inch Radial Bowl Reflector and "Sol-lux" Diffuser		
W27129	**Complete Streethood**	18½	**$11.65**
W27161	Style D Loop	½	.15
W27141	Streethood Consists of: Porcelain Head with Socket and ¾-inch Canopy	8	4.25
W27143	18-inch Radial Bowl Reflector	4	2.75
W27172	"Sol-lux" Diffuser	4½	3.00
W27145	Hinged Refractor Holder	1½	1.50
	With 20-inch Radial Bowl Reflector with Extension for Bare Lamps		
W27130	**Complete Streethood**	14½	**$7.90**
W27161	Style D Loop	½	.15
W27141	Streethood Consists of: Porcelain Head with Socket and ¾-inch Canopy	8	4.25
W27144	20-inch Radial Bowl Reflector with Extension	6	3.50

Cutter Styles DX, E and EX Streethoods

Style DX Streethood consists of Style D Streethood with simple cross arm No. W27186. Add prefix DX to trade number; 1½ lbs. to the shipping weight and 35 cents to list price of Style D Streethood selected.

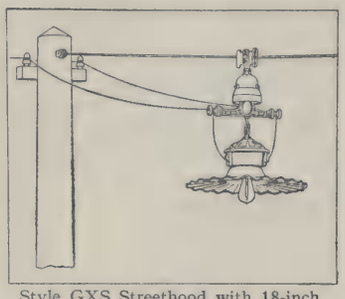
Style E Streethood consists of Style D Streethood with high voltage hood insulator No. W27163. Add prefix E to trade number; 2½ lbs. to the shipping weight and 90 cents to list price of Style D Streethood selected.

Style EX Streethood consists of Style D Streethood with high voltage hood insulator No. W27163 and simple cross arm No. W27186. Add prefix EX to trade number; 3¾ lbs. to the shipping weight and $1.35 to list price of Style D Streethood selected.

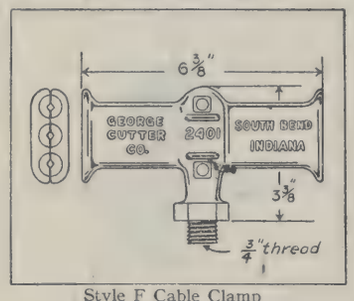
Cutter Series Suspension Streethoods

For 40, 60, 80 and 100 C. P. Series Mazda "C" Lamps

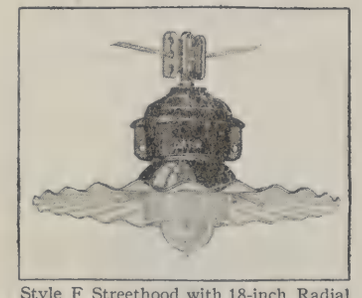
Schedule A—Standard Package Quantity 10



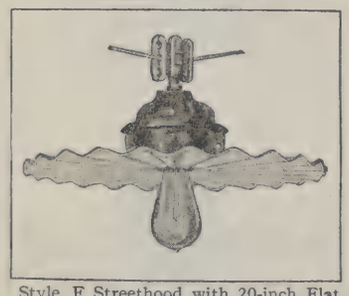
Style GXS Streethood with 18-inch Radial Bowl Reflector.



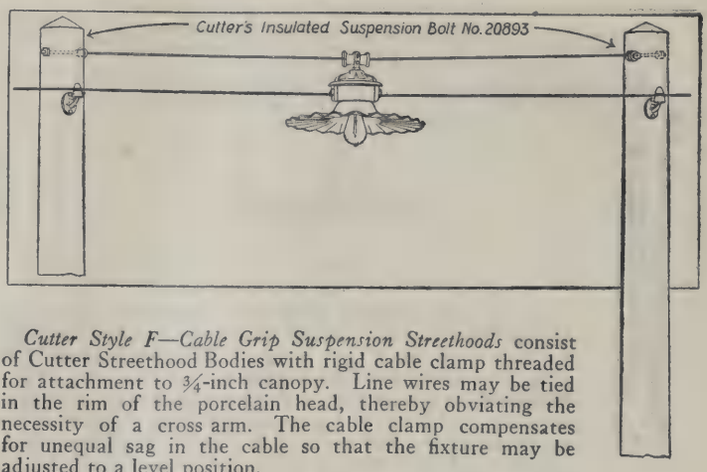
Style F Cable Clamp



Style F Streethood with 18-inch Radial Bowl Reflector and 6½-inch Holophane Band Refractor. Trade No. W27134



Style F Streethood with 20-inch Flat Radial Reflector. Trade No. W27135



Cutter Style F—Cable Grip Suspension Streethoods consist of Cutter Streethood Bodies with rigid cable clamp threaded for attachment to ¾-inch canopy. Line wires may be tied in the rim of the porcelain head, thereby obviating the necessity of a cross arm. The cable clamp compensates for unequal sag in the cable so that the fixture may be adjusted to a level position.

PRICE LIST

Schedule A—Standard Package Quantity 10

Prices below cover Streethoods for 40, 60, 80 and 100 C. P. Series Mazda "C" Lamps, but do not include lamps or wirings.

Trade No.	Description	Ship. Wt. lbs. each	Price each
	With 18-inch Radial Bowl Reflector		
W27131	**Complete Streethood**	14½	**$ 7.60**
W27164	Cable Clamp	2½	.60
W27141	Porcelain Head with Socket and ¾-inch Canopy	[illegible]	4.25
W27143	18-inch Radial Bowl Reflector	4	2.75
	With 18-inch Radial Bowl Reflector and 6½-inch Holophane Bowl Refractor		
W27132	**Complete Streethood**	19½	**$12.10**
W27164	Cable Clamp	2½	.60
W27141	Porcelain Head with Socket and ¾-inch Canopy	8	4.25
W27143	18-inch Radial Bowl Reflector	4	2.75
W27166	6½-inch Holophane Bowl Refractor	3½	3.00
W27146	Hinged Refractor Holder	1½	1.50
	With 18-inch Radial Bowl Reflector and 6½-inch Holophane Skirted Refractor		
W27133	**Complete Streethood**	19½	**$12.10**
W27164	Cable Clamp	2½	.60
W27141	Porcelain Head with Socket and ¾-inch Canopy	8	4.25
W27143	18-inch Radial Bowl Reflector	4	2.75
W27167	6½-inch Holophane Skirted Refractor	3½	3.00
W27146	Hinged Refractor Holder	1½	1.50
	With 18-inch Radial Bowl Reflector and 6½-inch Holophane Band Refractor		
W27134	**Complete Streethood**	18½	**$12.10**
W27164	Cable Clamp	2½	.60
W27141	Porcelain Head with Socket and ¾-inch Canopy	8	4.25
W27143	18-inch Radial Bowl Reflector	4	2.75
W27168	6½-inch Holophane Band Refractor	2½	3.00
W27146	Hinged Refractor Holder	1½	1.50
	With 20-inch Flat Radial Reflector		
W27135	**Complete Streethood**	15½	**$7.10**
W27164	Cable Clamp	2½	.60
W27141	Porcelain Head with Socket and ¾-inch Canopy	8	4.25
W27162	20-inch Flat Radial Reflector	5	2.25

Streethood consists of

Cutter Styles FX, G, GX and GXS Streethoods

Style FX Streethood consists of Style F Streethood with cable cross arm No. W27182. Add prefix FX to trade number; 2 lbs. to shipping weight, and 50 cents to list price of Style F Streethood selected.

Style G Streethood consists of Style F Streethood with high voltage hood insulator No. W27163. Add prefix G to trade number; 2½ lbs. to shipping weight, and 90 cents to list price of Style F Streethood selected.

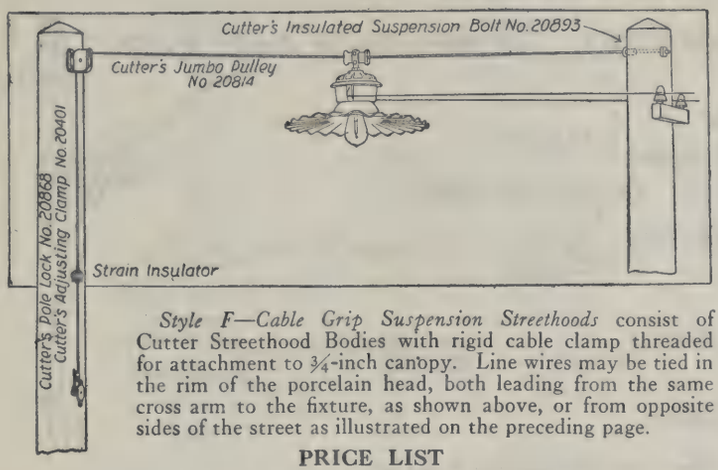
Style GX Streethood consists of Style F Streethood with cable cross arm No. W27182 and high voltage hood insulator No. W27163. Add prefix GX to trade number; 4½ lbs. to shipping weight, and $1.40 to list price of Style F Streethood selected.

Style GXS Streethood consists of Style F Streethood with Style D loop No. W27161 and Goliath cross arm No. W27165 to separate Cable Clamp from Streethood body. The fittings allow the Streethood body to swing free of the line wires attached to the cross arm and thereby find a level position regardless of the strain on the cross arm. When ordering add prefix GXS to trade number; 11 lbs. to the shipping weight, and $2.40 to list price of Style F Streethood selected.

Cutter Series Suspension Streethoods

For 250, 400 and 600 C. P. Series Mazda "C" Lamps

Schedule A—Standard Package Quantity 10


Cutter's Insulated Suspension Bolt No. 20893
Cutter's Jumbo Pulley No 20814
Cutter's Pole Lock No. 20868
Cutter's Adjusting Clamp No. 20401
Strain Insulator

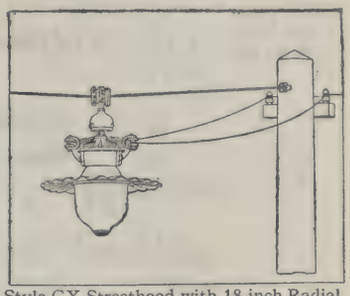
Style F—Cable Grip Suspension Streethoods consist of Cutter Streethood Bodies with rigid cable clamp threaded for attachment to ¾-inch canopy. Line wires may be tied in the rim of the porcelain head, both leading from the same cross arm to the fixture, as shown above, or from opposite sides of the street as illustrated on the preceding page.

PRICE LIST

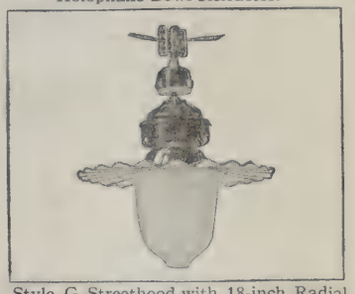
Schedule A—Standard Package Quantity 10

Prices below cover Streethoods for 250, 400 and 600 C. P. Series Mazda "C" Lamps, but do not include lamps or wiring.

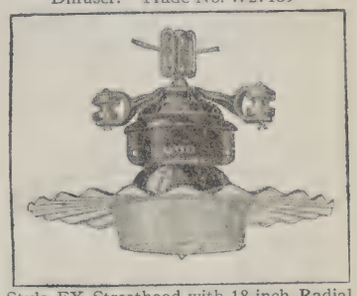
Trade No.	Description	Ship. Wt. lbs. each	Price each
	With 18-inch Radial Bowl Reflector and 8½-inch Holophane Bowl Refractor		
W27136	**Complete Streethood**	25½	**$15.10**
W27164	Cable Clamp	2½	.60
W27141	Porcelain Head with Socket and ¾-inch Canopy	8	4.25
W27143	18-inch Radial Bowl Reflector	4	2.75
W27169	8½-inch Holophane Bowl Refractor	9½	6.00
W27145	Hinged Refractor Holder	1½	1.50
	With 18-inch Radial Bowl Reflector and 8½-inch Holophane Skirted Refractor		
W27137	**Complete Streethood**	24½	**$15.10**
W27164	Cable Clamp	2½	.60
W27141	Porcelain Head with Socket and ¾-inch Canopy	8	4.25
W27143	18-inch Radial Bowl Reflector	4	2.75
W27170	8½-inch Holophane Skirted Refractor	8½	6.00
W27145	Hinged Refractor Holder	1½	1.50
	With 18-inch Radial Bowl Reflector and 8½-inch Holophane Band Refractor		
W27138	**Complete Streethood**	21½	**$15.10**
W27164	Cable Clamp	2½	.60
W27141	Porcelain Head with Socket and ¾-inch Canopy	8	4.25
W27143	18-inch Radial Bowl Reflector	4	2.75
W27171	8½-inch Holophane Band Refractor	5½	6.00
W27145	Hinged Refractor Holder	1½	1.50
	With 18-inch Radial Bowl Reflector and 8½-inch "Sol-lux" Diffuser		
W27139	**Complete Streethood**	20½	**$12.10**
W27164	Cable Clamp	2½	.60
W27141	Porcelain Head with Socket and ¾-inch Canopy	8	4.25
W27143	18-inch Radial Bowl Reflector	4	2.75
W27172	8½-inch "Sol-lux" Diffuser	4½	3.00
W27145	Hinged Refractor Holder	1½	1.50
	With 20-inch Radial Bowl Reflector with Extension for Bare Lamps		
W27140	**Complete Streethood**	16½	**$8.35**
W27164	Cable Clamp	2½	.60
W27141	Porcelain Head with Socket and ¾-inch Canopy	8	4.25
W27144	20-inch Radial Bowl Reflector with Extension	6	3.50



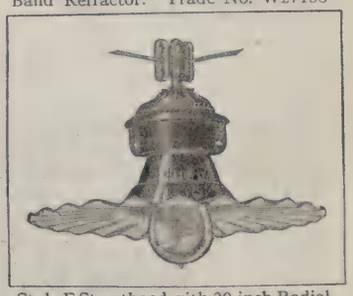
Style GX Streethood with 18-inch Radial Bowl Reflector and 8½-inch Holophane Bowl Refractor.



Style G Streethood with 18-inch Radial Bowl Reflector and 8½-inch "Sol-lux" Diffuser. Trade No. W27139



Style FX Streethood with 18-inch Radial Bowl Reflector and 8½-inch Holophane Band Refractor. Trade No. W27138



Style F Streethood with 20-inch Radial Bowl Reflector with Extension. Trade No. W27140

Cutter Styles FX, G, GX and GXS Streethoods

Style FX Streethood consists of Style F Streethood with cable cross arm No. W27182. Add prefix FX to trade number; 2 lbs. to shipping weight; and 50 cents to list price of Style F Streethood selected.

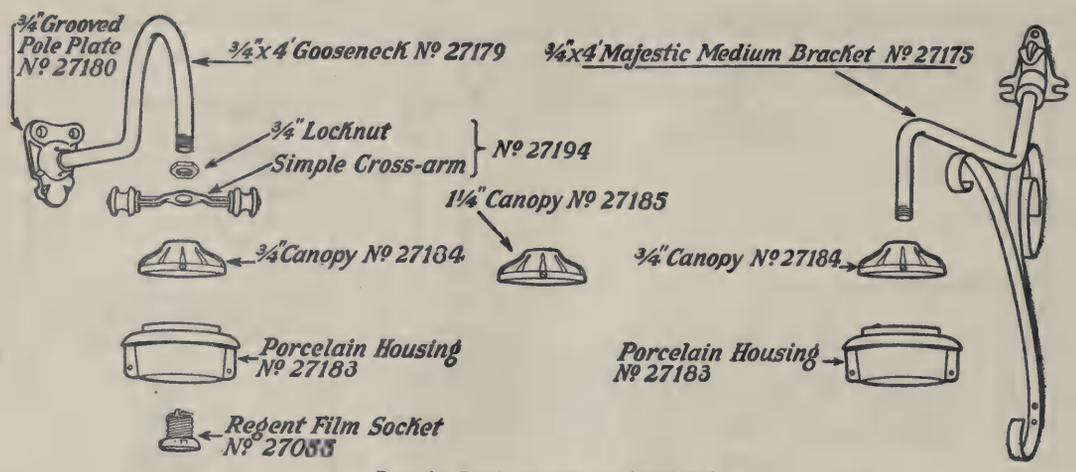
Style G Streethood consists of Style F Streethood with high voltage hood insulator No. W27163. Add prefix G to trade number; 2½ lbs. to shipping weight; and 90 cents to list price of Style F Streethood selected.

Style GX Streethood consists of Style F Streethood with cable cross arm No. W27182 and high voltage hood insulator No. W27163. Add prefix GX to trade number; 4½ lbs. to shipping weight; and $1.40 to list price of Style F Streethood selected.

Style GXS Streethood consists of Style F Streethood with Style D loop No. W27161 and Goliath cross arm No. W27165 to separate Cable Clamp from Streethood body. The fittings allow the Streethood body to swing free of the line wires attached to the cross arm and thereby find a level position regardless of the strain on the cross arm. When ordering add prefix GXS to trade number; 11 lbs. to the shipping weight; and $2.40 to list price of Style F Streethood selected.

Parts for Bracket Suspension Series Streethoods

Schedule A—Standard Package Quantity 10

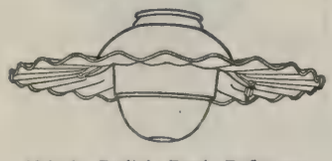


Parts for Bracket Suspension Streethoods.

20-inch Flat Radial Reflector for 40, 60, 80 and 100 C. P. Series Mazda "C" Lamps.

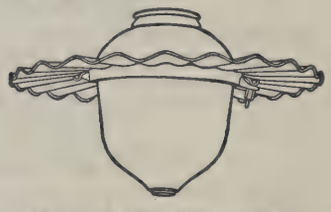
18-inch Radial Bowl Reflector for 40, 60, 80 and 100 C. P. Series Mazda "C" Lamps.

20-inch Radial Bowl Reflector with Extension for 250,400 and 600 C. P. Series Mazda "C" Lamps.



18-inch Radial Bowl Reflector with 6½-inch Holophane Skirted Refractor for 40, 60, 80 and 100 C.P. Series Mazda "C" Lamps.

18-inch Radial Bowl Reflector with 8½-inch Holophane Band Refractor for 250, 400 and 600 C.P. Series Mazda "C" Lamps.



18-inch Radial Bowl Reflector with 8½-inch Holophane Bowl Refractor for 250, 400 and 600 C.P. Series Mazda "C" Lamps.

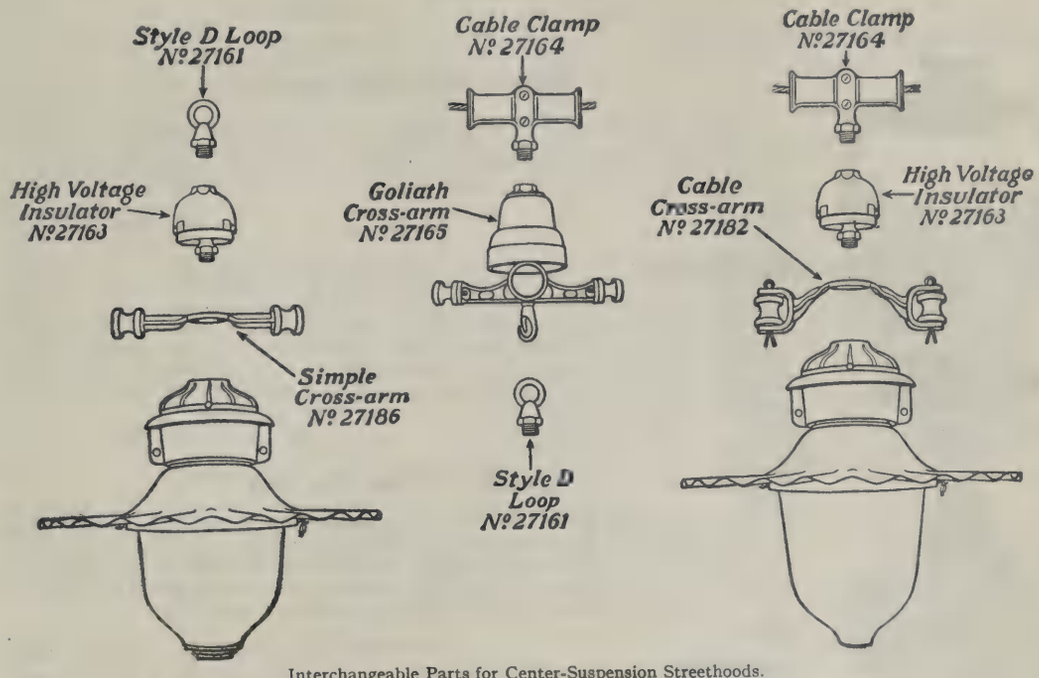
PRICE LIST

Schedule A—Standard Package Quantity 10

Trade No.	Description	Ship. Wt. lbs. each	Price each
W27141	Porcelain Head with Socket and ¾-inch Canopy	8	$4.25
W27142	Porcelain Head with Socket and 1¼-inch Canopy	8	4.25
W27183	Porcelain Head without Canopy	6	3.50
W27184	¾-inch Canopy only	2	.75
W27185	1¼-inch Canopy only	2	.75
W27055	Regent "C" Socket Part only	¼	.80
W27162	20-inch Flat Radial Reflector	5	2.25
W27143	18-inch Radial Bowl Reflector	4	2.75
W27144	20-inch Radial Bowl Reflector with Extension	6	3.50
W27166	6½-inch Holophane Bowl Refractor	3½	3.00
W27167	6½-inch Holophane Skirted Refractor	3½	3.00
W27168	6½-inch Holophane Band Refractor	2½	3.00
W27169	8½-inch Holophane Bowl Refractor	9½	6.00
W27170	8½-inch Holophane Skirted Refractor	8½	6.00
W27171	8½-inch Holophane Band Refractor	5½	6.00
W27172	8½-inch "Sol-lux" Diffuser	4½	3.00
W27146	6½-inch Hinged Refractor Holder	1½	1.50
W27145	8½-inch Hinged Refractor Holder	1½	1.50
W27194	Simple Cross Arm with Locknut for ¾-inch pipe	1½	.40
W27197	Simple Cross Arm with Locknut for 1¼-inch pipe	1½	.40

Parts for Center-Suspension Series Streethoods

Schedule A—Standard Package Quantity 10



Interchangeable Parts for Center-Suspension Streethoods.

The Streethood Bodies listed under "Cutter Series Streethood Bodies," are listed complete with center-suspension parts under "Cutter Series Suspension Streethoods." These suspension parts are entirely interchangeable. List of parts used to make up the various styles of Streethoods given below. Prices of Reflectors will be found on preceding page.

PRICE LIST

Schedule A—Standard Package Quantity 10

Trade No	Style	Description	Ship. Wt. lbs. each	Price each
W27161	D	**Style D Loop**	½	**$0.15**
W27187	DX	**Complete Fittings**	2	**.50**
W27161		Style D Loop	½	.15
W27186		Simple Cross Arm	1½	.35
W27188	E	**Complete Fittings**	3	**1.05**
W27161		Style D Loop	½	.15
W27163		High Voltage Insulator	2½	.90
W27189	EX	**Complete Fittings**	4½	**1.40**
W27161		Style D Loop	½	.15
W27163		High Voltage Insulator	2½	.90
W27186		Simple Cross Arm	1½	.35
W27164	F	**Cable Clamp**	2½	**.60**
W27190	FX	**Complete Fittings**	4½	**1.10**
W27164		Cable Clamp	2½	.60
W27182		Cable Cross Arm	2	.50
W27191	G	**Complete Fittings**	5	**1.50**
W27164		Cable Clamp	2½	.60
W27163		High Voltage Insulator	2½	.90
W27192	GX	**Complete Fittings**	7	**2.00**
W27164		Cable Clamp	2½	.60
W27163		High Voltage Insulator	2½	.90
W27182		Cable Cross Arm	2	.50
W27193	GXS	**Complete Fittings**	13½	**3.00**
W27164		Cable Clamp	2½	.60
W27165		Goliath Cross Arm	10½	2.25
W27161		Style D Loop	½	.15

Cutter Streethood Sockets

For Series Lamps

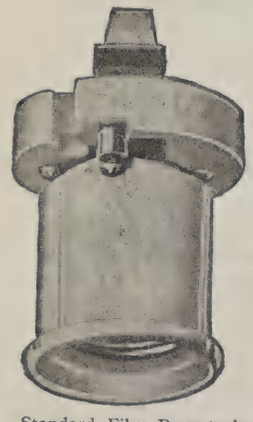
Schedule A

Regent "C" Film Socket with Hood Fork.

Regent "C" Film Sockets

Consist of the Regent "C" Film Sockets and Receptacles described in detail near the beginning of 7-A part IV. These sockets are for use with porcelain heads No. **W27195** and **W27196** listed below or with other styles of Streethoods which are arranged for standard hood forks.

Trade No.	Description	Std. Pkg.	Ship. Wt. lbs. each	Price each
W27050	Receptacle Mogul Base Socket and Film Holder	50	1½	**$1.80**
W27051	Same, with ¾-inch hood fork, rigid male nipple	50	1¾	**2.00**
W27052	Same with ¾-inch hood fork, female thread	50	1⅞	**2.00**
W27053	Same, with ⅜-inch hood fork, female thread	50	1¾	**2.00**
W27054	Same, with ⅜-inch low flange, female thread	50	1⅝	**2.00**
W27055	Lamp Socket only, with film holder	50	¼	**.80**
W27056	Package of 50 silk films, puncture voltage 200	500 films		**1.35**
W27057	Package of 50 impregnated silk films, puncture voltage 350	500 films		**1.35**

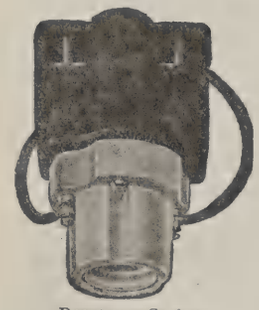


Standard Film Receptacle and Mogul Base Socket.

Standard Film Sockets

Have a porcelain receptacle with wire terminals and spring clips to hold the projecting fingers of the socket part. These fingers hold the dielectric film. The receptacle fits in the porcelain heads No. **W27195** and **W27196** or on the hood forks listed at the bottom of this page. Screws and nuts for holding the receptacle in place are included with the porcelain heads and hood forks.

Trade No.	Description	Std. Pkg.	Ship. Wt. lbs. each	Price each
W21462	Receptacle and Socket, Mogul Screw Base	50	1¼	**$1.80**
W21434	Receptacle only	100	½	**.80**
W20480	Socket part only, Mogul Screw Base	75	¾	**1.00**
W20481	Socket part only, Medium Screw Base	100	½	**.50**
W21451	Package of 15 films	500 films		**.60**



Reactance Socket.

Reactance Sockets

Consist of Cutter Mogul Screw Base Streethood Socket with special hood fork supporting a reactance coil connected in shunt with the lamp. These sockets are for use on series lighting systems, and when a lamp fails, the reactance coil compensates for the voltage drop through the lamp, thus maintaining constant current without the use of a regulator. In ordering, state voltage and amperes of circuit and voltage and candlepower rating of lamp. Furnished with ¾-inch male nipple.

Trade No. 3.5 or 4 Amps. 60 Cycles	Trade No. 6.6 Amps. 60 Cycles	Candle Power Lamp	Std. Pkg.	Ship. Wt. lbs. each	Price each
W20487	**W20491**	32	25	4	**$5.30**
W20488	**W20492**	40	25	5	**5.50**
W20489	**W20493**	60	25	6	**5.65**
W20490	**W20494**	80	25	7	**6.00**

Porcelain Head for Streethood, without Socket.

Porcelain Heads without Sockets

Consists of porcelain body to take either Regent "C" Film Socket No. **W27050** or Standard Film Socket No. **W21462** ventilated cast iron canopy tapped for ¾-inch or 1¼-inch pipe, and adapter ring to fit reflectors with 4-inch standard heel.

Trade No.	Description	Std. Pkg.	Ship. Wt. lbs. each	Price each
W27195	With ¾-inch Canopy, without socket	10	8	**$2.45**
W27196	With 1¼-inch Canopy, without socket	10	8	**2.45**

Hood Forks and Flanges

With screws and nuts for fastening sockets. Prices do not include sockets.

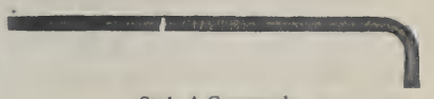
Trade No.	Description	Std. Pkg.	Ship. Wt. lbs. each	Price each
W21713	Hook Fork with ¾-inch rigid male nipple	100	⅜	**$0.30**
W21484	Hood Fork with ¾-inch female thread	100	½	**.20**
W21485	Hood Fork with ⅜-inch female thread	100	½	**.20**
W21486	Low Flange with ⅜-inch female thread	100	¼	**.20**

Parts for Cutter Brackets

Schedule A

Goosenecks

Trade No. Style A	Trade No. Style B	Length feet	Size of Pipe inches	Std. Pkg.	Wt. lbs. each	Price each
W21362	W21365	3	½	200	2⅞	$0.75
W21363	W21366	4	½	150	3⅞	1.00
W21364	W21367	5	½	125	4⅞	1.20
W21439	W21442	3	¾	150	3¾	1.10
W21440	W21443	4	¾	125	4¾	1.35
W21441	W21444	5	¾	100	5¾	1.50



Style A Gooseneck.

Style B Gooseneck.

Curved Pole Plates

Trade No.	Description	Std. Pkg.	Wt. lbs. each	Price each
W21487	Grooved, for ½-inch pipe..	400	1¼	$0.30
W27180	Grooved, for ¾-inch pipe..	400	2¼	.40

½-inch Grooved Pole Plate.

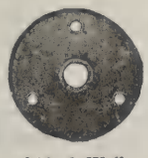
¾-inch Grooved Pole Plate.

Wall Flanges

Trade No.	Description	Std. Pkg.	Wt. lbs. each	Price each
W21488	Threaded for ½-inch pipe..	500	1	$0.30
W21489	To slip over ½-inch pipe...	500	1	.30
W21490	Threaded for ¾-inch pipe..	400	2	.30
W21491	To slip over ¾-inch pipe...	400	2	.40

Corner Plates

Trade No.	Description	Std. Pkg.	Wt. lbs. each	Price each
W21492	For ½-inch pipe.....	300	2½	$1.00
W21493	For ¾-inch pipe.....	200	2½	1.00



¾-inch Wall Flange.

Corner Plate.

Hood Insulator.

Hood Insulators

Trade No.	Description	Std. Pkg.	Wt. lbs. each	Price each
W21495	With ¾-inch stud below, tapped for ¾-inch pipe above.....	100	2½	$0.90

Angle Change Brace Arms

Made of cast iron with curved pole plate and fixed pins. May be used on front or back of pole.

Trade No.	Description	Std. Pkg.	Wt. lbs. each	Price each
W21498	With glass insulators....	150	6	$0.80

Angle Change Brace Arm.

Standard Iron Cross Arms

Made of cast iron with porcelain insulators. Has wire holes beneath. Tapped for either ½-inch or ¾-inch pipe above, ¾-inch nipple below. Complete with nipple.

Trade No.	Description	Std. Pkg.	Wt. lbs. each	Price each
W20532	For ½-inch pipe.....	150	3	$1.00
W27539	For ¾-inch pipe.....	150	3	1.00

Standard Iron Cross Arm.

Simple Cross Arms

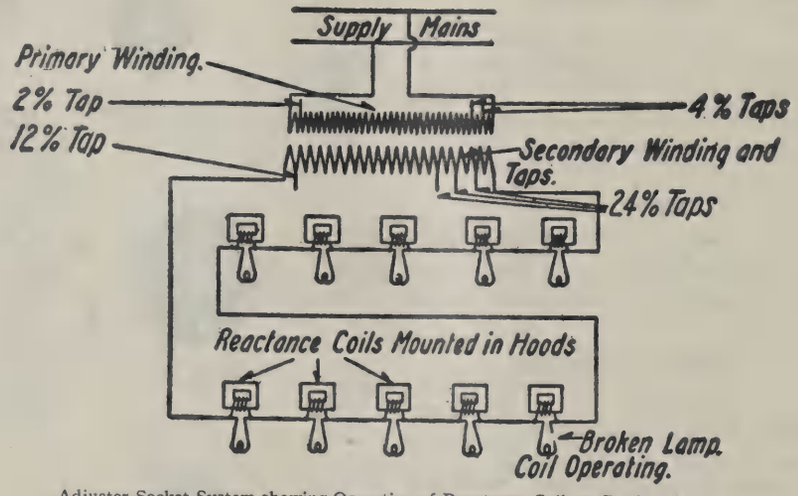
Trade No.	Description	Std. Pkg.	Wt. lbs. each	Price each
W27186	Without locknut.....	150	1½	$0.35
W27194	With ¾-inch locknut....	150	1½	.40
W27197	With 1¼-inch locknut....	150	1½	.40

Simple Cross Arm.

Adjuster-Socket Systems

The adjuster-socket system operates only on constant-potential circuits. It consists of a simple series of lamps connected across constant-potential alternating-current mains, or across the secondary terminals of a constant-potential transformer. A reactance coil is connected in shunt across the terminals of each lamp and operates in a well-known manner to maintain the continuity and normal voltage of the circuit in case of burnouts or lamp removals.

Reactance Coil—The reactance coil is one of the simplest and most economical devices ever developed for maintaining the continuity of a lamp circuit. It has an effective reactance voltage equivalent to the voltage of a burning lamp, but the loss of energy sustained by its use is only about 4 or 5 per cent of that taken by a lamp. Taking this loss into consideration, the adjuster-socket system has an efficiency of 95 or 96 per cent with all lamps burning. The coils are so designed that lamps of increased efficiency can be used without change. The drop created by the coil when a lamp is out is such that the current is not greatly altered until about 20 per cent of the lamps on the circuit are out. Lamps of larger candlepower may be used with the standard reactance coils so long as the voltage per lamp does not greatly exceed the voltage of the lamp for which the coil is listed.



Adjuster-Socket System showing Operation of Reactance Coils to Replace Lamps.

Number of Lamps—Since the lamps are operated in series from a constant-potential source of supply, all the lamps in one circuit must be of the same ampere capacity, though not necessarily of the same candlepower. The sum of the lamp voltages should equal the supply voltage. Consequently, it is necessary to use a definite number of lamps on a given supply voltage.

Flexibility—With the adjuster-socket system, a great flexibility is possible through the use of standard transformers providing several different ranges of voltages for lamp circuits. Where the supply circuit voltage differs from that for which the standard apparatus is listed, or where the number of lamps would be better served by a different range of voltages, special transformers adapted to the existing conditions must be secured.

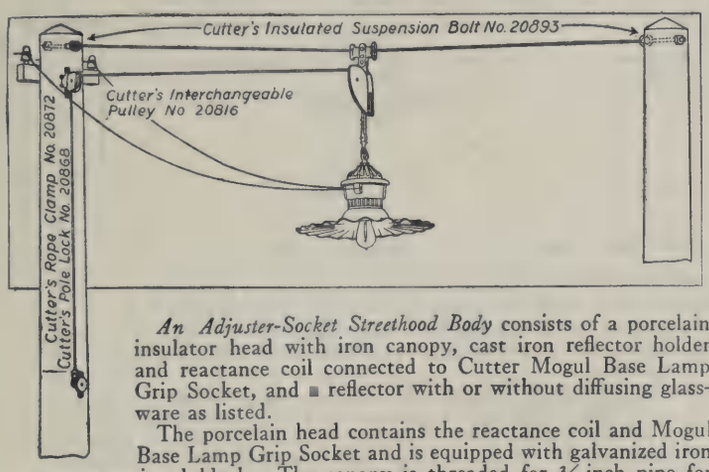
Transformers—On supply circuits up to 550 volts, it is possible to connect the lamps in series with a control switch, directly across the mains. On higher voltages, however, the supply mains should ordinarily be properly insulated from the lamp circuits by means of suitable transformers. Transformers for this purpose are regularly furnished for 2200-volt supply circuits. Transformers should be provided with weatherproof cast-iron cases suitable for indoor use, or for outdoor mounting on poles at a distance from the power station, at any advantageous point.

Voltage Variations—Taps should be provided in the primary winding by means of which any secondary voltage may be raised 2, 4, 6, 8 or 10 per cent, if operating on a 2200-volt circuit. By this arrangement any voltage within one per cent of that required by the circuit may be obtained.

Cutter Adjuster-Socket Streethood Bodies

For 40 and 60 C. P., 6.6 Ampere, 60 Cycle Series Mazda "C" Lamps

Schedule A—Standard Package Quantity 10


Cutter's Insulated Suspension Bolt No. 20893
Cutter's Interchangeable Pulley No. 20816
Cutter's Rope Clamp No. 20872
Cutter's Pole Lock No. 20868

An Adjuster-Socket Streethood Body consists of a porcelain insulator head with iron canopy, cast iron reflector holder and reactance coil connected to Cutter Mogul Base Lamp Grip Socket, and a reflector with or without diffusing glassware as listed.

The porcelain head contains the reactance coil and Mogul Base Lamp Grip Socket and is equipped with galvanized iron canopy painted black. The canopy is threaded for ¾-inch pipe for fastening to brackets or center suspension fittings, or for 1¼-inch pipe. The cast iron reflector holder is designed to give the proper relative position of reflector and lamp.

Reflectors are made of deep drawing steel and surfaced with three coats of highest grade porcelain enamel, reflective white underneath, green on top. The reflector is attached to the reflector holder by means of a 4-inch copper heel which protects the enamel from chipping.

Line wires leading to the Streethood are tied to holes in the outer rim of the porcelain, thus eliminating the use of a cross arm.

Brackets are listed separately under "Cutter Streethood Brackets;" center-suspension fittings, under "Parts for Center-Suspension Series Streethoods."

PRICE LIST

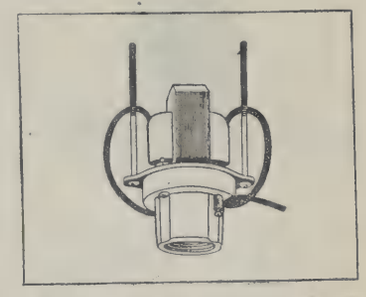
Schedule A—Standard Package Quantity 10

Prices below cover Streethood Bodies for 40 and 60 C. P., 6.6 Ampere, 60 Cycle Series Mazda "C" Lamps, but do not include lamps or wiring.

Trade No. For ¾-in. Pipe	Trade No. For 1¼-in. Pipe	Description	Ship. Wt. lbs. each	Price each
		With 18-inch Radial Bowl Reflector		
W27701	**W27702**	**Complete Unit**	18	**$14.00**
W27734	W27731	Unit Consists of: Porcelain Head with Reactance Socket, Canopy and Reflector Holder	14	11.25
W27143	W27143	Unit Consists of: 18-inch Radial Bowl Reflector	4	2.75
		With 18-inch Radial Bowl Reflector and 6½-inch Holophane Bowl Refractor		
W27703	**W27704**	**Complete Unit**	23	**$18.50**
W27734	W27731	Unit Consists of: Porcelain Head with Reactance Socket, Canopy and Reflector Holder	14	11.25
W27143	W27143	Unit Consists of: 18-inch Radial Bowl Reflector	4	2.75
W27166	W27166	Unit Consists of: 6½-in. Holophane Bowl Refractor	3½	3.00
W27146	W27146	Unit Consists of: Hinged Refractor Holder	1½	1.50
		With 18-inch Radial Bowl Reflector and 6½-inch Holophane Skirted Refractor		
W27705	**W27706**	**Complete Unit**	23	**$18.50**
W27734	W27731	Unit Consists of: Porcelain Head with Reactance Socket, Canopy and Reflector Holder	14	11.25
W27143	W27143	Unit Consists of: 18-inch Radial Bowl Reflector	4	2.75
W27167	W27167	Unit Consists of: 6½-inch Holophane Skirted Refractor	3½	3.00
W27146	W27146	Unit Consists of: Hinged Refractor Holder	1½	1.50
		With 18-inch Radial Bowl Reflector and 6½-inch Holophane Band Refractor		
W27707	**W27708**	**Complete Unit**	22	**$18.50**
W27734	W27731	Unit Consists of: Porcelain Head with Reactance Socket, Canopy and Reflector Holder	14	11.25
W27143	W27143	Unit Consists of: 18-inch Radial Bowl Reflector	4	2.75
W27168	W27168	Unit Consists of: 6½-in. Holophane Band Refractor	2½	3.00
W27146	W27146	Unit Consists of: Hinged Refractor Holder	1½	1.50
		With 20-inch Flat Radial Reflector		
W27709	**W27710**	**Complete Unit**	19	**$13.50**
W27734	W27731	Unit Consists of: Porcelain Head with Reactance Socket, Canopy and Reflector Holder	14	11.25
W27162	W27162	Unit Consists of: 20-inch Flat Radial Reflector	5	2.25

If Streethoods for use on 25-cycle circuits are wanted add to the above prices **$1.25** each, and to the shipping weights 1 lb.

20-inch Flat Radial Streethood Body. Trade No. W27709.



Reactance Coil for 40 and 60 C. P. Lamps, with Mogul Lamp Grip Socket.

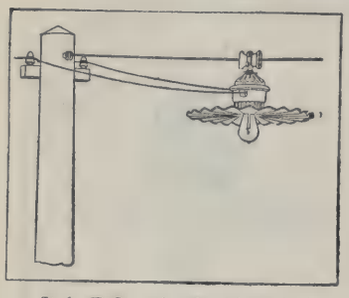
18-inch Radial Bowl Streethood Body with 6½-inch Holophane Bowl Refractor. Trade No. W27703.

18-inch Radial Bowl Streethood Body with 6½-inch Holophane Band Refractor. Trade No. W27707.

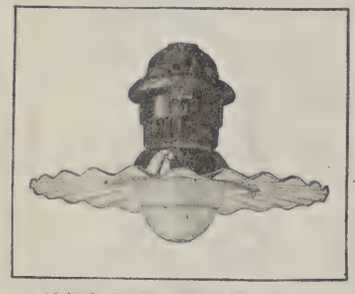
Cutter Adjuster-Socket Streethood Bodies

For 80 and 100 C. P., 6.6 Ampere, 60 Cycle Series Mazda "C" Lamps

Schedule A—Standard Package Quantity 10

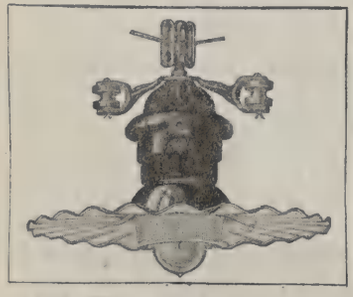


Style F Streethood with 20-inch Flat Radial Reflector.

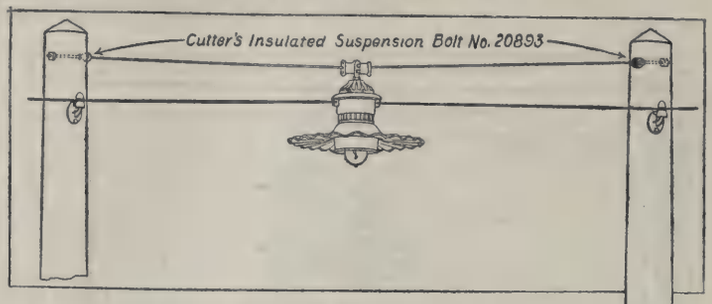


18-inch Radial Bowl Streethood Body with 6½-inch Holophane Skirted Refractor. Trade No. W27715.

Style EX Streethood with 18-inch Radial Bowl Reflector and 6½-inch Holophane Bowl Refractor. Trade No. W27713 with No. W27189 Fittings.



Style FX Streethood with 18-inch Radial Bowl Reflector and 6½-inch Holophane Band Refractor. Trade No. W27717 with No. W27190 Fittings.



An Adjuster-Socket Streethood Body consists of a porcelain insulator head with iron canopy, cast iron reflector holder and reactance coil connected to Cutter Mogul Base Lamp Grip Socket, and a reflector with or without diffusing glassware as listed.

The porcelain head contains the reactance coil and Mogul Base Lamp Grip Socket and is equipped with galvanized iron canopy painted black. The canopy is threaded for ¾-inch pipe for fastening to brackets or center suspension fittings, or for 1¼-inch pipe. The cast iron reflector holder is designed to give the proper relative position of reflector and lamp.

Reflectors are made of deep drawing steel and surfaced with three coats of highest grade porcelain enamel, reflective white underneath, green on top. The reflector is attached to the reflector holder by means of a 4-inch copper heel which protects the enamel from chipping.

Line wires leading to the Streethood are tied to holes in the outer rim of the porcelain, thus elimating the use of a cross arm.

Brackets are listed separately under "Cutter Streethood Brackets," center-suspension fittings under "Parts for Center-Suspension Series Streethoods."

PRICE LIST

Schedule A—Standard Package Quantity 10

Prices below cover Streethood Bodies for 80 and 100 C. P., 6.6 Ampere, 60 Cycle, Series Mazda "C" Lamps, but do not include lamps or wiring.

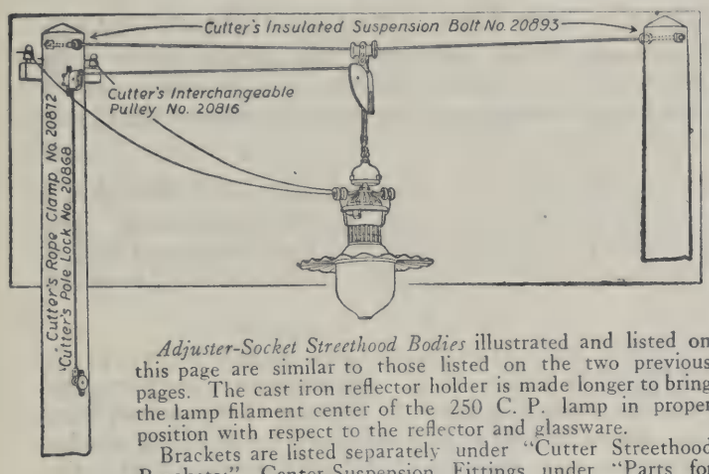
Trade No. For ¾-in. Pipe	Trade No. For 1¼-in. Pipe	Description	Ship. Wt. lbs. each	Price each
		With 18-inch Radial Bowl Reflector		
W27711	W27712	**Complete Unit**	19	**$15.10**
W27735	W27732	Unit Consists of: Porcelain Head with Reactance Socket, Canopy and Reflector Holder	15	12.35
W27143	W27143	Unit Consists of: 18-inch Radial Bowl Reflector	4	2.75
		With 18-inch Radial Bowl Reflector and 6½-inch Holophane Bowl Refractor		
W27713	W27714	**Complete Unit**	24	**$19.60**
W27735	W27732	Unit Consists of: Porcelain Head with Reactance Socket, Canopy and Reflector Holder	15	12.35
W27143	W27143	Unit Consists of: 18-inch Radial Bowl Reflector	4	2.75
W27166	W27166	Unit Consists of: 6½-in. Holophane Bowl Refractor	3½	3.00
W27146	W27146	Unit Consists of: Hinged Refractor Holder	1½	1.50
		With 18-inch Radial Bowl Reflector and 6½-inch Holophane Skirted Refractor		
W27715	W27716	**Complete Unit**	24	**$19.60**
W27735	W27732	Unit Consists of: Porcelain Head with Reactance Socket, Canopy and Reflector Holder	15	12.35
W27143	W27143	Unit Consists of: 18-inch Radial Bowl Reflector	4	2.75
W27167	W27167	Unit Consists of: 6½-inch Holophane Skirted Refractor	3½	3.00
W27146	W27146	Unit Consists of: Hinged Refractor Holder	1½	1.50
		With 18-inch Radial Bowl Reflector and 6½-inch Holophane Band Refractor		
W27717	W27718	**Complete Unit**	23	**$19.60**
W27735	W27732	Unit Consists of: Porcelain Head with Reactance Socket, Canopy and Reflector Holder	15	12.35
W27143	W27143	Unit Consists of: 18-inch Radial Bowl Reflector	4	2.75
W27168	W27168	Unit Consists of: 6½-in. Holophane Band Refractor	2½	3.00
W27146	W27146	Unit Consists of: Hinged Refractor Holder	1½	1.50
		With 20-inch Flat Radial Reflector		
W27719	W27720	**Complete Unit**	20	**$14.60**
W27735	W27732	Unit Consists of: Porcelain Head with Reactance Socket, Canopy and Reflector Holder	15	12.35
W27162	W27162	Unit Consists of: 20-inch Flat Radial Reflector	5	2.25

If Streethoods for use on 25 Cycle Circuits are wanted, add to the above prices **$1.40** each and to the shipping weight 2 lbs.

Cutter Adjuster-Socket Streethood Bodies

For 250 C. P., 6.6. Ampere, 60 Cycle Series Mazda "C" Lamps

Schedule A—Standard Package Quantity 10


Cutter's Insulated Suspension Bolt No. 20893
Cutter's Interchangeable Pulley No. 20816
Cutter's Rope Clamp No. 20812
Cutter's Pole Lock No. 20868

Adjuster-Socket Streethood Bodies illustrated and listed on this page are similar to those listed on the two previous pages. The cast iron reflector holder is made longer to bring the lamp filament center of the 250 C. P. lamp in proper position with respect to the reflector and glassware.

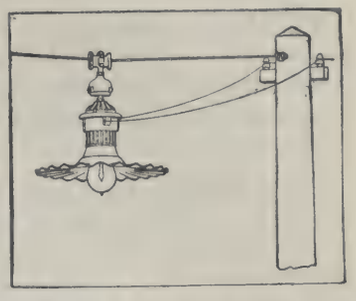
Brackets are listed separately under "Cutter Streethood Brackets;" Center-Suspension Fittings under "Parts for Center-Suspension Series Streethoods."

PRICE LIST

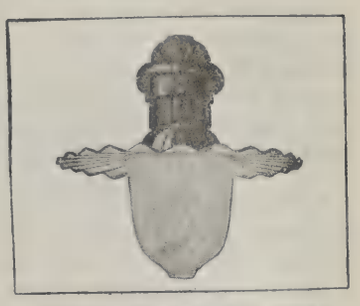
Schedule A—Standard Package Quantity 10

Prices below cover Streethood Bodies for 250 C. P., 6.6 Ampere, 60 Cycle Series Mazda "C" Lamps, but do not include lamps or wiring.

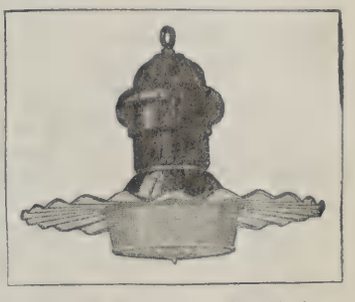
Trade No. For ¾-in. Pipe	Trade No. For 1¼-in. Pipe	Description	Ship. Wt. lbs. each	Price each
With 18-inch Radial Bowl Reflector and 8½-inch Holophane Bowl Refractor				
W27721	**W27722**	**Complete Unit**	**33**	**$24.25**
W27736	W27733	Porcelain Head with Reactance Socket, Canopy and Reflector Holder	18	14.00
	Unit			
W27143	W27143	Consists of 18-inch Radial Bowl Reflector	4	2.75
W27169	W27169	8½-inch Holophane Bowl Refractor	9½	6.00
W27145	W27145	Hinged Refractor Holder	1½	1.50
With 18-inch Radial Bowl Reflector and 8½-inch Holophane Skirted Refractor				
W27723	**W27724**	**Complete Unit**	**32**	**$24.25**
W27736	W27733	Porcelain Head with Reactance Socket, Canopy and Reflector Holder	18	14.00
	Unit			
W27143	W27143	Consists of 18-inch Radial Bowl Reflector	4	2.75
W27170	W27170	8½-in. Holophane Skirted Refractor	8½	6.00
W27145	W27145	Hinged Refractor Holder	1½	1.50
With 18-inch Radial Bowl Reflector and 8½-inch Holophane Band Refractor				
W27725	**W27726**	**Complete Unit**	**29**	**$24.25**
W27736	W27733	Porcelain Head with Reactance Socket, Canopy and Reflector Holder	18	14.00
	Unit			
W27143	W27143	Consists of 18-inch Radial Bowl Reflector	4	2.75
W27171	W27171	8½-inch Holophane Band Refractor	5½	6.00
W27145	W27145	Hinged Refractor Holder	1½	1.50
With 18-inch Radial Bowl Reflector and 8½-inch "Sol-lux" Diffuser				
W27727	**W27728**	**Complete Unit**	**28**	**$21.25**
W27736	W27733	Porcelain Head with Reactance Socket, Canopy and Reflector Holder	18	14.00
	Unit			
W27143	W27143	Consists of 18-inch Radial Bowl Reflector	4	2.75
W27172	W27172	8½-inch "Sol-lux" Diffuser	4½	3.00
W27145	W27145	Hinged Refractor Holder	1½	1.50
With 20-inch Radial Bowl Reflector with Extension for Bare Lamps				
W27729	**W27730**	**Complete Unit**	**24**	**$17.50**
W27736	W27733	Porcelain Head with Reactance Socket, Canopy and Reflector Holder	18	14.00
	Unit			
W27144	**W27144**	Consists of 20-inch Radial Bowl Reflector with Extension	**6**	**3.50**



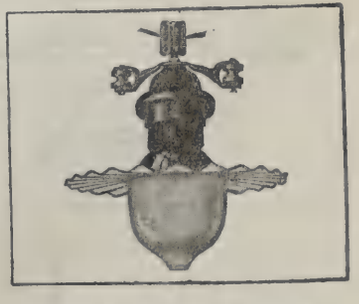
Style G 20-inch Radial Bowl Streethood Body with Extension.



18-inch Radial Bowl Streethood Body with 8½-inch "Sol-lux" Diffuser. Trade No. W27727.



Style D Streethood with 18-inch Radial Bowl Reflector and 8½-inch Holophane Band Refractor. Trade No. W27725 with No. W27161 Style D Loop.



Style FX Streethood with 18-inch Radial Bowl Reflector and 8½-inch Holophane Bowl Refractor. Trade No. W27721 with No. W27190 Fittings.

Construction of Cutter Multiple Streethoods

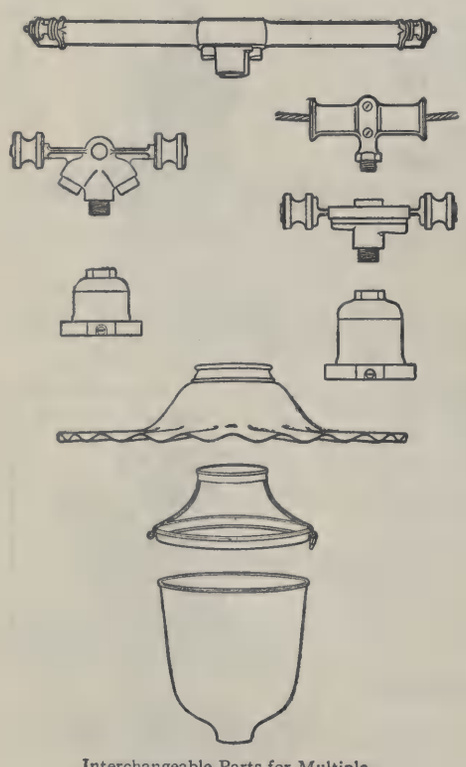
A Cutter Multiple Streethood Body consists of the Cutter "easy-to-wire" Holder-Socket with plain cap and a porcelain enameled reflector with or without diffusing glassware.

The Holder-Socket consists of a porcelain socket with cast iron cap threaded for ¾-inch pipe or for attachment to center suspension fittings and a cast iron reflector holder to fit 4-inch standard heel reflectors. The socket is provided with lamp grips to insure perfect electrical connections and prevent the lamps loosening as a result of vibration of the fixture in the wind.

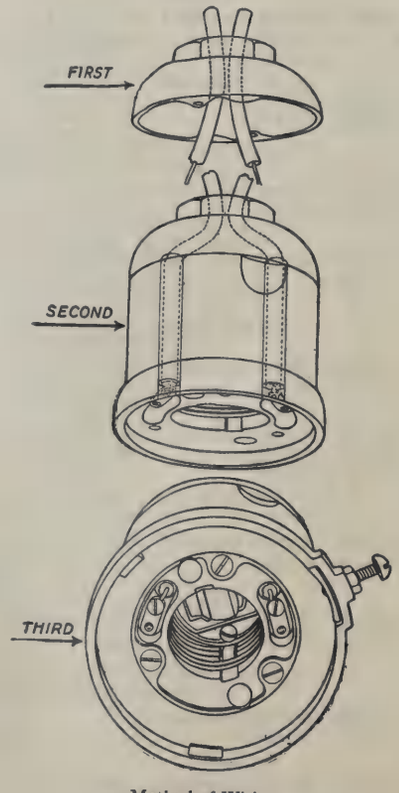
Cutter Multiple Streethood Bodies are "easy-to-wire." The wires are pulled through the cap and connected to the terminals of the socket as shown in the illustration below. The reflector is then attached rigidly by means of a single screw which grips the copper heel of the reflector and is locked in place by nuts. Only three operations are necessary to install a Cutter Multiple Streethood Body.

Reflectors are made of deep drawing steel and surfaced with three coats of highest grade porcelain enamel, reflective white underneath, green on top. The reflector is supported by a copper heel which insures maximum life because it prevents chipping of the enamel from contact with screw or clip supports. When enamel is chipped away by screws or similar supports, the metal body is exposed to the air; rust sets in and spreads rapidly over the surface of the reflector, reducing its efficiency and greatly shortening its life.

The beaded edge on Cutter Streethood Reflectors is another feature which guarantees maximum life. The edge of the steel reflector body is turned over and a smooth bead is formed. The three coats of enamel on the exterior of the reflector as well as the three coats on the interior are lapped over the beaded edge, forming a protective covering that is extremely durable.



Interchangeable Parts for Multiple Center-Suspension Streethoods.



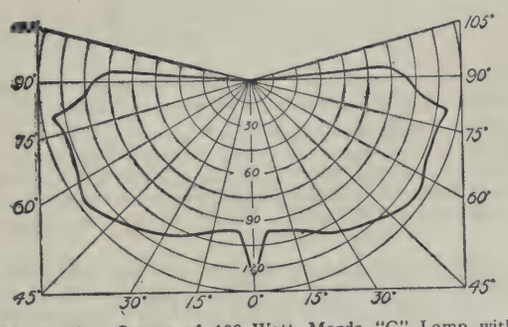
Method of Wiring Cutter Multiple Streethoods.

Efficient Illumination with Cutter Multiple Streethoods

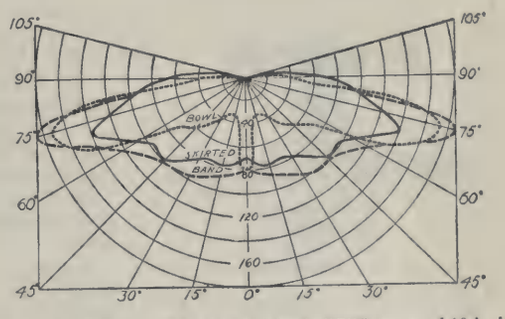
The first consideration in the selection of every street-lighting fixture is the amount of light required; that is, the size of lamp. The next consideration is the manner in which the light should be distributed. These determine one or two styles of Streethood Reflectors. The third consideration, that of the method of installation, will enable the customer to select the one best suited to his requirements. Cutter Streethood Bodies and the brackets for supporting them are listed separately. The size of lamp is given for each Streethood Body, which enables the selection of the one best suited to the lighting needs. The Streethood Body may then be offered in combination with several styles of brackets and center-suspension parts. Thus a complete fixture may be assembled to suit any condition.

To facilitate proper selection of Streethood Bodies typical distribution curves of Mazda lamps with each reflector are shown below.

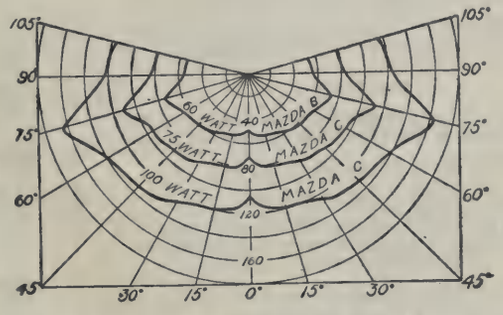
Distribution Curves



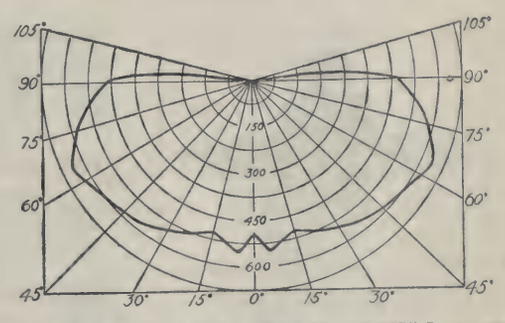
Distribution Curves of 100 Watt Mazda "C" Lamp with 18-inch Radial Bowl Reflector.



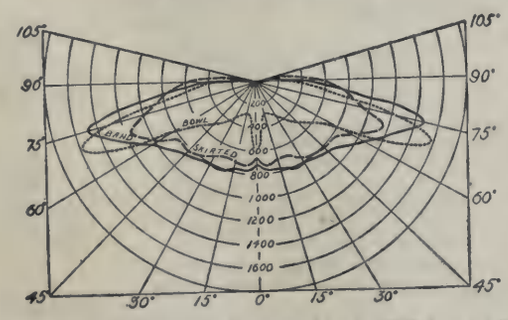
Distribution Curves of 100 Watt Mazda "C" Lamp and 18-inch Radial Bowl Reflector with 6½-inch Holophane Bowl Refractor; Band Refractor and Skirted Refractor.



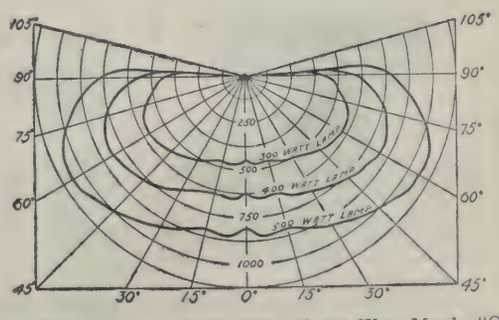
Distribution Curves of 20-inch Flat Radial Reflector with 60 Watt Mazda "B" Lamp and 75 and 100 Watt Mazda "C" Lamps.



Distribution Curves of 300 Watt Mazda "C" Lamp and 20-inch Radial Bowl Reflector with Extension.



Distribution Curves of 500 Watt Mazda "C" Lamp with 18-inch Radial Bowl Reflector and 8½-inch Bowl, Band and Skirted Refractors.

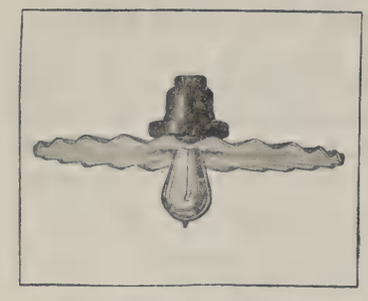


Distribution Curves of 300, 400 and 500 Watt Mazda "C" Lamps with 18-inch Radial Bowl Reflectors and "Sol-lux" Diffusers.

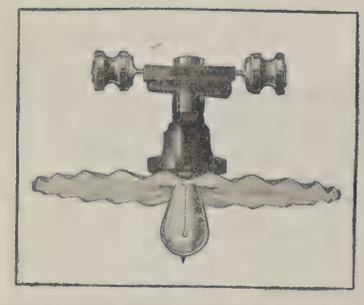
Cutter Multiple Streethood Bodies

For 40, 60, 75, 100, 150 and 200 Watt Multiple Mazda "B" and "C" Lamps

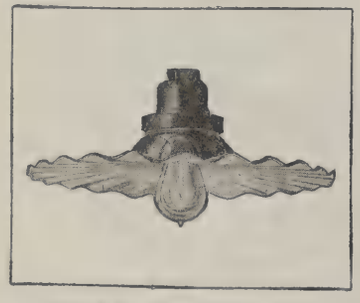
Schedule A—Standard Package Quantity 10



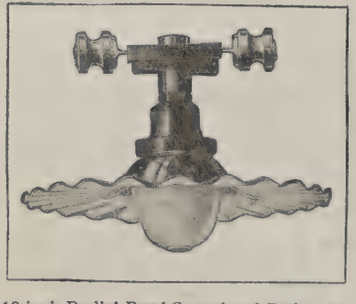
20-inch Flat Radial Streethood Body for Inside Wiring. Trade No. W27504.



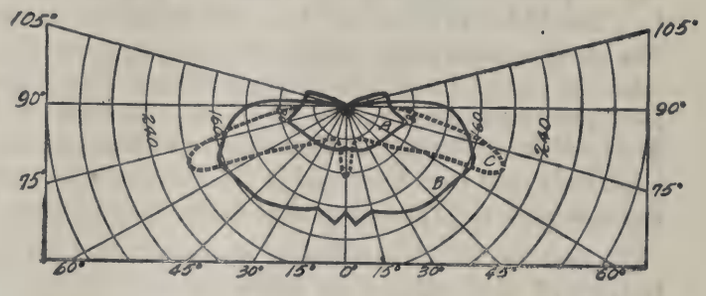
20-inch Flat Radial Streethood Body with Standard Iron Cross Arm. Trade No. W27504 with No. W27539 Cross Arm.



18-inch Radial Bowl Streethood Body for Inside Wiring. Trade No. W27500.



18-inch Radial Bowl Streethood Body with 6½-inch Holophane Bowl Refractor and Standard Iron Cross Arm. Trade No. W27500 with No. W27539 Cross Arm.



Distribution Curves of
A—20-inch Flat Radial Wave Reflector with 60 Watt Mazda "B" Lamp.
B—18-inch Radial Bowl Reflector with 200 Watt Mazda "C" Lamp.
C—18-inch Radial Bowl Reflector with 100 Watt Mazda "C" Lamp and 6½-inch Holophane Bowl Refractor.

A Cutter Multiple Streethood Body consists of the Cutter "easy-to-wire" Holder-Socket with plain cap and a porcelain enameled reflector. Caps are threaded for ¾-inch pipe.

The Holder-Socket is provided with lamp grips to prevent lamps from falling out as a result of vibration of the fixture in the wind.

Cutter Multiple Streethood Bodies are "easy-to-wire." The wires are pulled through the cap and connected to the terminals of the socket. The reflector is then attached rigidly by means of a single screw which grips the copper heel of the reflector and is locked in place by nuts. Only three operations are necessary to install a Cutter Multiple Streethood Body.

Reflectors are made of deep drawing steel and surfaced with three coats of highest grade porcelain enamel, reflective white underneath, green on top. The reflector is supported by a copper heel which protects the enamel from chipping.

PRICE LIST

Schedule A—Standard Package Quantity 10

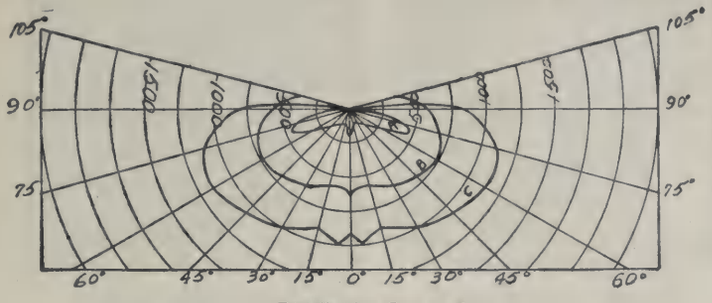
Prices below cover Streethood Bodies with Medium Screw Base Holder-Sockets for 40, 60, 75, 100, 150 and 200 Watt Multiple Mazda "B" and "C" Lamps, but do not include lamps or wiring.

Trade No.	Description	Ship. Wt. lbs. each	Price each
	With 18-inch Radial Bowl Reflector for 100, 150 and 200 Watt Multiple Mazda "C" Lamps		
W27500	**Complete Unit**	6	**$5.25**
W27536	Unit Consists of: Holder-Socket with Plain Cap for ¾-inch Pipe	2	2.50
W27143	Unit Consists of: 18-inch Radial Bowl Reflector	4	2.75
	With 18-inch Radial Bowl Reflector and 6½-inch Holophane Bowl Refractor for 100 and 150 Watt Multiple Mazda "C" Lamps		
W27501	**Complete Unit**	11	**$9.75**
W27536	Unit Consists of: Holder-Socket with Plain Cap for ¾-in. Pipe	2	2.50
W27143	Unit Consists of: 18-inch Radial Bowl Reflector	4	2.75
W27166	Unit Consists of: 6½-inch Holophane Bowl Refractor	3½	3.00
W27146	Unit Consists of: Hinged Refractor Holder	1½	1.50
	With 18-inch Radial Bowl Refractor and 6½-inch Holophane Skirted Refractor for 100 and 150 Watt Multiple Mazda "C" Lamps		
W27502	**Complete Unit**	11	**$9.75**
W27536	Unit Consists of: Holder-Socket with Plain Cap for ¾-in. Pipe	2	2.50
W27143	Unit Consists of: 18-inch Radial Bowl Reflector	4	2.75
W27167	Unit Consists of: 6½-inch Holophane Skirted Refractor	3½	3.00
W27146	Unit Consists of: Hinged Refractor Holder	1½	1.50
	With 18-inch Radial Bowl Reflector and 6½-inch Holophane Band Refractor for 100 and 150 Watt Multiple Mazda "C" Lamps		
W27503	**Complete Unit**	10	**$9.75**
W27536	Unit Consists of: Holder-Socket with Plain Cap for ¾-in. Pipe	2	2.50
W27143	Unit Consists of: 18-inch Radial Bowl Reflector	4	2.75
W27168	Unit Consists of: 6½-inch Holophane Band Refractor	2½	3.00
W27146	Unit Consists of: Hinged Refractor Holder	1½	1.50
	With 20-inch Flat Radial Reflector for 40, 60 and 75 Watt Multiple Mazda Lamps		
W27504	**Complete Unit**	7	**$4.75**
W27536	Unit Consists of: Holder-Socket with Plain Cap for ¾-inch Pipe	2	2.50
W27162	Unit Consists of: 20-inch Flat Radial Reflector	5	2.25

Cutter Multiple Streethood Bodies

For 200, 300, 400 and 500 Watt Multiple Mazda "C" Lamps

Schedule A—Standard Package Quantity 10



Distribution Curves of
A—18-inch Radial Bowl Reflector with 8½-inch Holophane Bowl Refractor and 200 Watt Multiple Mazda "C" Lamp.
B—18-inch Radial Bowl Reflector with "Sol-lux" Diffuser and 400 Watt Multiple Mazda "C" Lamp.
C—20-inch Radial Bowl Reflector with Extension and 500 Watt Multiple Mazda "C" Lamp.

A Cutter Multiple Streethood Body consists of the Cutter "easy-to-wire" Holder-Socket with plain cap and porcelain enameled reflector. Caps are threaded for ¾-inch pipe.

The Holder-Socket is provided with lamp grips to prevent lamps from falling out as a result of vibration of the fixture in the wind.

Cutter Multiple Streethood Bodies are "easy-to-wire." The wires are pulled through the cap and connected to the terminals of the socket. The reflector is then attached rigidly by means of a single screw which grips the copper heel of the reflector and is locked in place by nuts. Only three operations are necessary to install a Cutter Multiple Streethood Body.

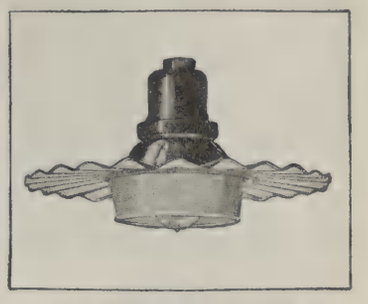
Reflectors are made of deep drawing steel and surfaced with three coats of highest grade porcelain enamel, reflective white underneath, green on top. The reflector is supported by a copper heel which protects the enamel from chipping.

PRICE LIST

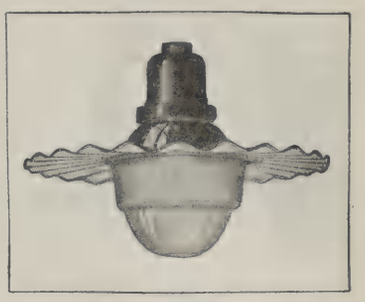
Schedule A—Standard Package Quantity 10

Prices below cover Streethood Bodies with Mogul Screw Base Holder-Sockets for 300, 400 and 500 watt Multiple Mazda "C" Lamps. When ordered for 200 watt Mazda "C" Lamps include Mogul Screw to Medium Screw Adapter No. **W27540** and add **$0.75** to the list price. Prices do not include lamps or wiring.

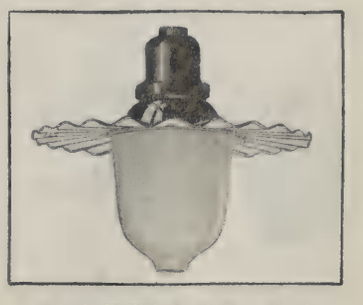
Trade No.	Description	Ship. Wt. lbs. each	Price each
	With 18-inch Radial Bowl Reflector and 8½-inch Holophane Bowl Refractor		
W27505	**Complete Unit**	19	**$13.25**
W27537	Mogul Screw Holder-Socket with Plain Cap for ¾-inch Pipe	4	3.00
W27143	Unit — 18-inch Radial Bowl Reflector	4	2.75
W27169	Consists of — 8½-inch Holophane Bowl Refractor	9½	6.00
W27145	Hinged Refractor Holder	1½	1.50
	With 18-inch Radial Bowl Reflector and 8½-inch Holophane Skirted Refractor		
W27506	**Complete Unit**	18	**$13.25**
W27537	Mogul Screw Holder-Socket with Plain Cap for ¾-inch Pipe	4	3.00
W27143	Unit — 18-inch Radial Bowl Reflector	4	2.75
W27170	Consists of — 8½-inch Holophane Skirted Refractor	8½	6.00
W27145	Hinged Refractor Holder	1½	1.50
	With 18-inch Radial Bowl Reflector and 8½-inch Holophane Band Refractor		
W27507	**Complete Unit**	15	**$13.25**
W27537	Mogul Screw Holder-Socket with Plain Cap for ¾-inch Pipe	4	3.00
W27143	Unit — 18-inch Radial Bowl Reflector	4	2.75
W27171	Consists of — 8½-inch Holophane Band Refractor	5½	6.00
W27145	Hinged Refractor Holder	1½	1.50
	With 18-inch Radial Bowl Reflector and 8½-inch "Sol-lux" Diffuser		
W27508	**Complete Unit**	14	**$10.25**
W27537	Mogul Screw Holder-Socket with Plain Cap for ¾-inch Pipe	4	3.00
W27143	Unit — 18-inch Radial Bowl Reflector	4	2.75
W27172	Consists of — 8½-inch "Sol-lux" Diffuser	4½	3.00
W27145	Hinged Refractor Holder	1½	1.50
	With 20-inch Radial Bowl Reflector with Extension for Bare Lamps		
W27509	**Complete Unit**	10	**$6.50**
W27537	Mogul Screw Holder-Socket with Plain Cap for ¾-inch Pipe	4	3.00
W27144	Unit — Consists of — 20-inch Radial Bowl Reflector with Extension	6	3.50



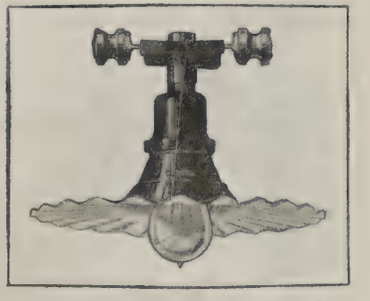
18-inch Radial Bowl Streethood Body with 8½-inch Holophane Band Refractor. Trade No. W27507



18-inch Radial Bowl Streethood Body with 8½-inch Holophane Skirted Refractor. Trade No. W27506



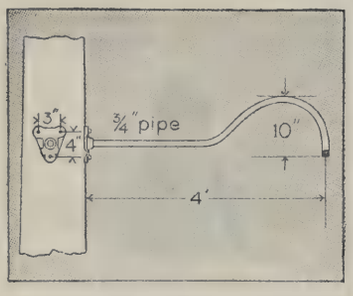
18-inch Radial Bowl Streethood Body with 8½-inch "Sol-lux" Diffuser. Trade No. W27508



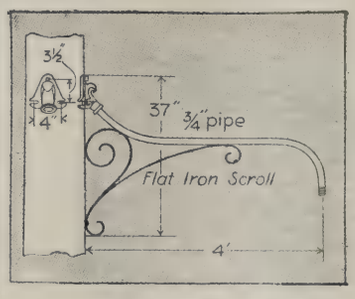
20-inch Radial Bowl Streethood Body with Extension and Standard Iron Cross Arm. Trade No. W27509

Cutter Streethood Brackets

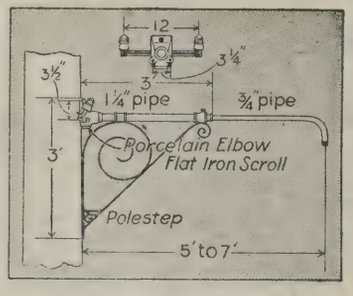
Schedule A—Standard Package Quantity 10



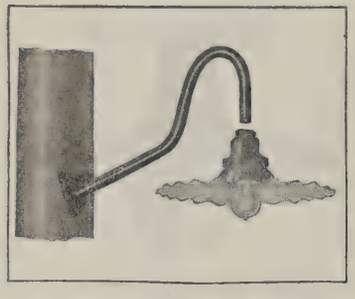
Style A Bracket
(Approximate Dimensions.)



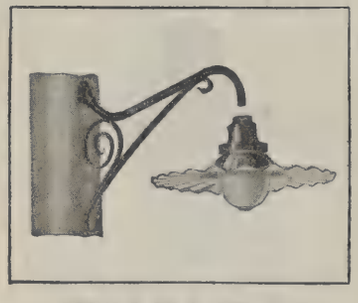
Majestic Medium Bracket
(Approximate Dimensions.)



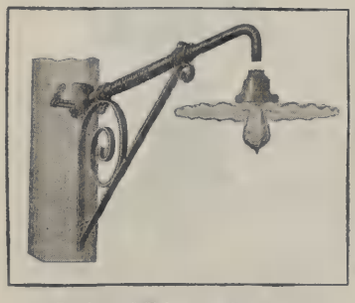
Boulevard Telescope Bracket
(Approximate Dimensions.)



Style A Bracket. Trade No. W27173



Majestic Medium Bracket.
Trade No. W27175



Boulevard Telescope Bracket.
Trade No. W27176

A Complete Cutter Bracket Type Streethood consists of one of the Brackets shown and one of the Streethood Bodies listed on the preceding pages. Brackets listed on this page are for supporting Streethood Bodies with ¾-inch canopy. Standard Iron Cross Arm (Trade No. W27539) will be furnished for spreading the wires above the Streethood Body for $1.00 list additional, when so ordered.

Style A Bracket

Consists of 4-foot gooseneck of ¾-inch pipe with heavy 3-hole grooved pole plate. Furnished with or without brace arm for guiding line wires from back of pole to Streethood Body.

Majestic Medium Bracket

A medium-weight bracket of the same style as the Majestic Bracket shown on the page opposite. Consists of ornamental grooved pole plate, 4-foot gooseneck (double bend) of ¾-inch pipe and wrought iron scroll. Shipped assembled complete as shown.

Boulevard Telescope Bracket

The ¾-inch pipe telescopes into the 1¼-inch pipe and allows for adjustments of 5 to 7 feet in reach from pole. This bracket has a heavy 3-hole cast iron pole plate with porcelain elbow for inner wiring and a cross-arm with glass insulators. The knurled set screw in the pipe joint and the pole step in the lower corner of the scroll are for the convenience of linemen when renewing lamps.

PRICE LIST

Schedule A—Standard Package Quantity 10

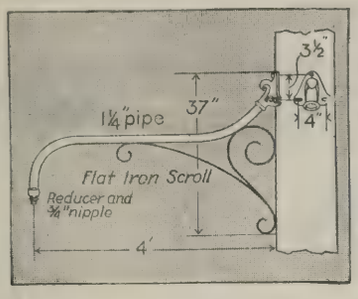
Prices below cover brackets only. Streethood Bodies to make complete Bracket Type Streethoods should be selected from the two preceding pages and ordered separately.

Trade No.	Description	Ship. Wt. lbs. each	Price each
	Style A Bracket		
W27173	**Complete Bracket**	7	**$1.75**
W27179	Bracket Consists of ¾-inch x 4-foot Gooseneck	4¾	1.35
W27180	Bracket Consists of Grooved Pole Plate	2¼	.40
	Style A Bracket with Brace Arm		
W27174	**Complete Bracket**	10	**$2.45**
W27179	Bracket Consists of ¾-inch x 4-foot Gooseneck	4¾	1.35
W27180	Bracket Consists of Grooved Pole Plate	2¼	.40
W27181	Bracket Consists of Brace Arm	3	.70
	Majestic Medium Bracket		
W27175	**Complete Bracket, Assembled**	18	**$3.25**
	Boulevard Telescope Bracket		
W27176	**Complete Bracket**	36	**$7.75**
W27147	Bracket Consists of Pole Plate with Cross Arm	9	1.75
W27148	Bracket Consists of Boulevard Bracket with Pole Step and Scroll Assembled	19	4.20
W27149	Bracket Consists of ¾-inch x 5-foot Pipe Bend	6	1.50
W27150	Bracket Consists of 2 Pony Glass Insulators		.15

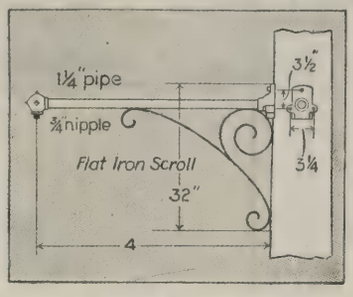
Galvanizing: When ordered in Standard Package Quantities or over, any of the brackets listed above will be furnished electro-galvanized and painted black, for 20% list additional. In less than Standard Package Quantities add 40%

Cutter Streethood Brackets

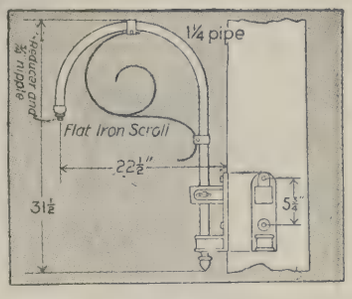
Schedule A—Standard Package Quantity 10



Majestic Senior Bracket.
(Dimensions approximate.)



Spartan Straight Arm Bracket.
(Dimensions approximate.)



Pole Crook.
(Dimensions approximate.)

A Complete Cutter Bracket Type Streethood consists of one of the brackets shown and one of the Streethood Bodies listed under "Cutter Multiple Streethood Bodies." Brackets listed on this page are furnished with ¾-inch nipple for attaching to ¾-inch Holder-Socket. Standard Iron Cross Arm (Trade No. W27539) will be furnished for spreading the wires above Streethood Body for $1.00 list additional, when so ordered.

Majestic Senior Bracket

Consists of double-bend gooseneck of 1¼-inch pipe with 3-hole grooved pole plate and wrought iron scroll assembled, 1¼ x ¾-inch reducer and ¾-inch nipple. Holds lamp 4 feet from pole.

Spartan Straight Arm Bracket

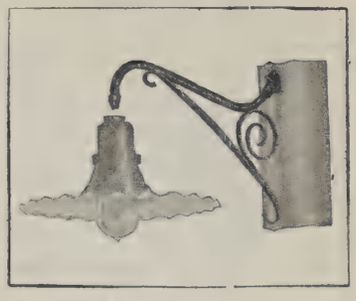
Consists of straight piece of 1¼-inch pipe with 3-hole pole plate head piece with ¾-inch nipple and wrought iron scroll assembled. Holds lamp 4 feet from pole.

Arcadian Junior Bracket

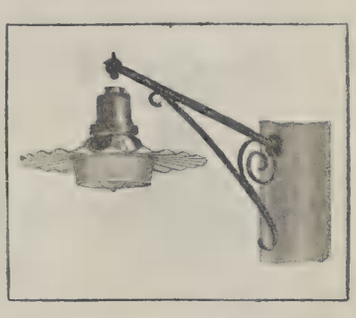
Similar to Spartan Straight Arm Bracket described above. Holds lamp 20 inches from pole. Furnished with ¾-inch nipple.

Crook Bracket

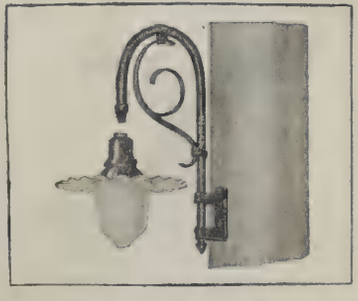
Made of 1¼-inch Pipe with wrought iron scroll assembled, 1¼ x ¾-inch reducer and ¾-inch nipple. Clamps for attaching to pole are adjustable to compensate for the rake on trolley poles.



Majestic Bracket.
Trade No. W27510



Spartan Straight Arm Bracket.
Trade No. W27511



Pole Crook.
Trade No. W27513

PRICE LIST

Schedule A—Standard Package Quantity 10

Prices below cover brackets only. Streethood Bodies to make complete Bracket Type Streethoods should be selected from "Cutter Multiple Streethood Bodies" and ordered separately.

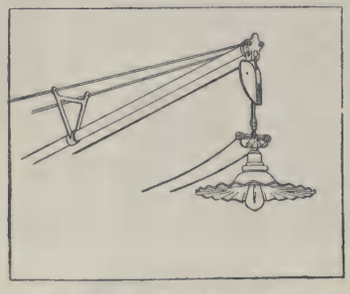
Trade No.	Description	Ship. Wt. lbs. each	Price each
	Majestic Senior Bracket		
W27510	**Complete Bracket**	26½	**$5.54**
W27177	Bracket Majestic Senior Bracket with Scroll Assembled	26	5.00
W27546	Consists of 1¼ x ¾-inch Reducer	⅜	.30
W27548	¾-inch Nipple	⅛	.15
	Spartan Straight Arm Bracket		
W27511	**Complete Bracket**	24	**$5.10**
W27152	Bracket Spartan Straight Arm Bracket Assembled	23¾	4.80
W27549	Consists of 1¼ x ¾-inch Bushing	⅛	.15
W27548	¾-inch Nipple	⅛	.15
	Arcadian Junior Bracket		
W27512	**Complete Bracket**	14	**$4.10**
W27153	Bracket Arcadian Junior Bracket Assembled	13¾	3.80
W27549	Consists of 1¼ x ¾-inch Bushing	⅛	.15
W27548	¾-inch Nipple	⅛	.15
	Pole Crook for Wooden Poles		
W27513	**Complete Bracket**	28½	**$6.45**
W27154	Crook with Scroll Assembled	20	4.50
W27546	Bracket 1¼ x ¾-inch Reducer	⅜	.30
W27548	Consists of ¾-inch Nipple	⅛	.15
W27156	Pole Plate	■	1.50
	Pole Crook for 4-inch Iron Poles		
W27514	**Complete Bracket**	36½	**$7.95**
W27155	Crook with Scroll Assembled	20	4.50
W27546	Bracket 1¼ x ¾-inch Reducer	⅜	.30
W27548	Consists of ¾-inch Nipple	⅛	.15
W27158	2 Clamps for 4-inch Pipe	8	1.50
	Pole Crook for 5-inch Iron Poles		
W27515	**Complete Bracket**	38½	**$8.15**
W27155	Crook with Scroll Assembled	20	4.50
W27546	Bracket 1¼ x ¾-inch Reducer	⅜	.30
W27548	Consists of ¾-inch Nipple	⅛	.15
W27160	2 Clamps for 5-inch Pipe	9	1.60

Galvanizing: When ordered in Standard Package Quantities or over, any of the brackets listed above will be furnished electro-galvanized and painted black, for 20% list additional. In less than Standard Package Quantities add 40%.

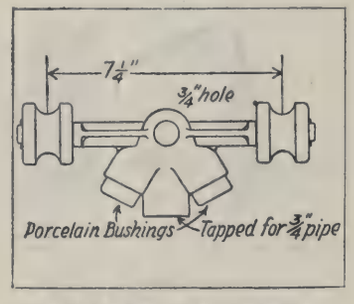
Cutter Multiple Suspension Streethoods

For 40, 60, 75, 100, 150 and 200 Watt Multiple Mazda "B" and "C" Lamps

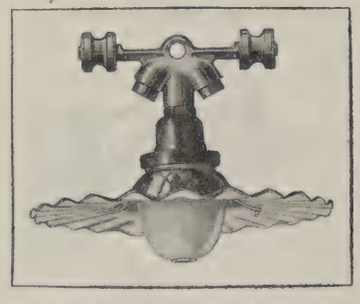
Schedule A—Standard Package Quantity 10



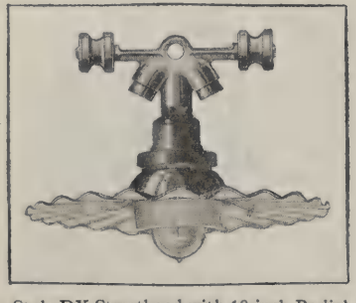
Cutter Junior Mast Arm with Style DX Streethood and 18-inch Radial Bowl Reflector.



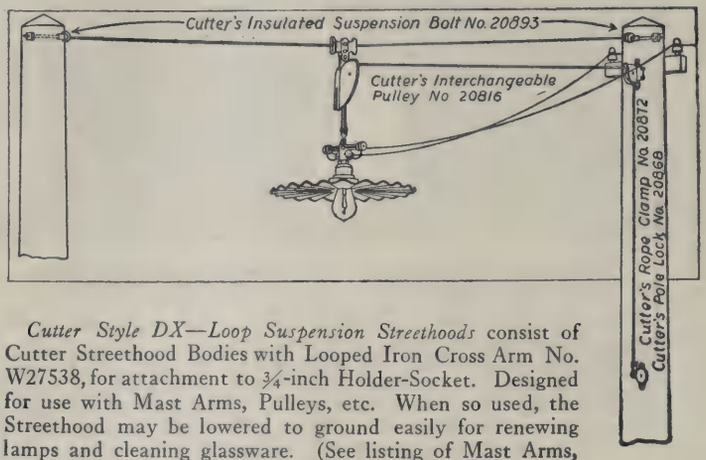
Style DX Looped Iron Cross Arm.



Style DX Streethood with 18-inch Radial Bowl Reflector and 6½-inch Holophane Bowl Refractor. Trade No. W27517



Style DX Streethood with 18-inch Radial Bowl Reflector and 6½-inch Holophane Band Refractor. Trade No. W27519


Cutter's Insulated Suspension Bolt No. 20893
Cutter's Interchangeable Pulley No 20816
Cutter's Rope Clamp No 20872
Cutter's Pole Lock No. 20868

Cutter Style DX—Loop Suspension Streethoods consist of Cutter Streethood Bodies with Looped Iron Cross Arm No. W27538, for attachment to ¾-inch Holder-Socket. Designed for use with Mast Arms, Pulleys, etc. When so used, the Streethood may be lowered to ground easily for renewing lamps and cleaning glassware. (See listing of Mast Arms, Pulleys, Insulators and Pole Line Material.)

PRICE LIST

Schedule A—Standard Package Quantity 10

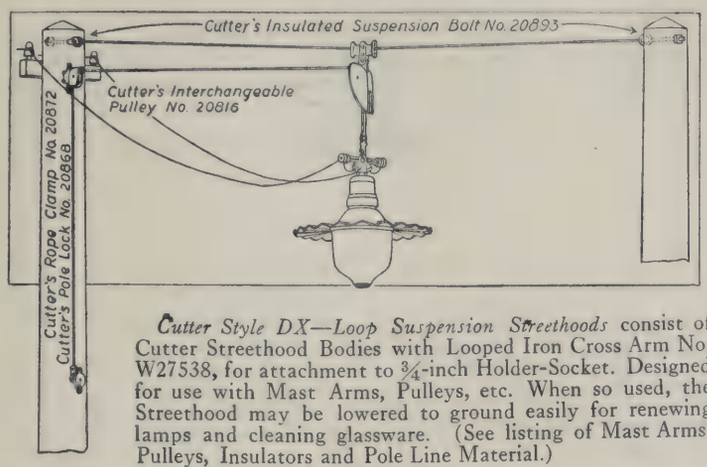
Prices below cover Streethood Bodies with Medium Screw Base Holder-Sockets for 40, 60, 75, 100, 150 and 200 Watt Multiple Mazda "B" and "C" Lamps, but do not include lamps or wiring.

Trade No.	Description	Ship. Wt. lbs. each	Price each
	With 18-inch Radial Bowl Reflector for 100, 150 and 200 Watt Multiple Mazda "C" Lamps		
W27516	**Complete Streethood**	9	**$6.75**
W27538	Streethood Consists of: Looped Iron Cross Arm	3	1.50
W27536	Streethood Consists of: Holder-Socket with Plain Cap for ¾-in. Pipe	2	2.50
W27143	Streethood Consists of: 18-inch Radial Bowl Reflector	4	2.75
	With 18-inch Radial Bowl Reflector and 6½-inch Holophane Bowl Refractor for 100 and 150 Watt Multiple Mazda "C" Lamps		
W27517	**Complete Streethood**	14	**$11.25**
W27538	Streethood Consists of: Looped Iron Cross Arm	3	1.50
W27536	Streethood Consists of: Holder-Socket with Plain Cap for ¾-in. Pipe	2	2.50
W27143	Streethood Consists of: 18-inch Radial Bowl Reflector	4	2.75
W27166	Streethood Consists of: 6½-inch Holophane Bowl Refractor	3½	3.00
W27146	Streethood Consists of: Hinged Refractor Holder	1½	1.50
	With18-inch Radial Bowl Reflector and 6½-inch Holophane Skirted Refractor for 100 and 150 Watt Multiple Mazda "C" Lamps		
W27518	**Complete Streethood**	14	**$11.25**
W27538	Streethood Consists of: Looped Iron Cross Arm	3	1.50
W27536	Streethood Consists of: Holder-Socket with Plain Cap for ¾-in. Pipe	2	2.50
W27143	Streethood Consists of: 18-inch Radial Bowl Reflector	4	2.75
W27167	Streethood Consists of: 6½-inch Holophane Skirted Refractor	3½	3.00
W27146	Streethood Consists of: Hinged Refractor Holder	1½	1.50
	With 18-inch Radial Bowl Reflector and 6½-inch Holophane Band Refractor for 100 and 150 Watt Multiple Mazda "C" Lamps		
W27519	**Complete Streethood**	13	**$11.25**
W27538	Streethood Consists of: Looped Iron Cross Arm	3	1.50
W27536	Streethood Consists of: Holder-Socket with Plain Cap for ¾-in. Pipe	2	2.50
W27143	Streethood Consists of: 18-inch Radial Bowl Reflector	4	2.75
W27168	Streethood Consists of: 6½-inch Holophane Band Refractor	2½	3.00
W27146	Streethood Consists of: Hinged Refractor Holder	1½	1.50
	With 20-inch Flat Radial Reflector for 40, 60 and 75 Watt Multiple Mazda Lamps		
W27520	**Complete Streethood**	10	**$6.25**
W27538	Streethood Consists of: Looped Iron Cross Arm	3	1.50
W27536	Streethood Consists of: Holder-Socket with Plain Cap for ¾-in. Pipe	2	2.50
W27162	Streethood Consists of: 20-inch Flat Radial Reflector	5	2.25

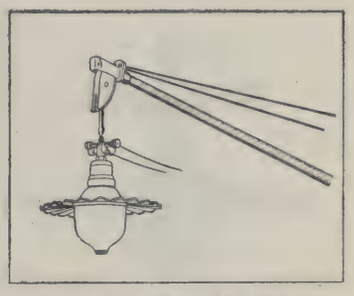
Cutter Multiple Suspension Streethoods

For 200, 300, 400 and 500 Watt Multiple Mazda "C" Lamps

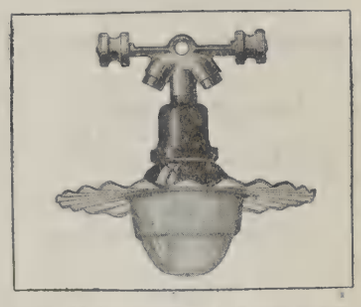
Schedule A—Standard Package Quantity 10


Cutter's Insulated Suspension Bolt No. 20893
Cutter's Interchangeable Pulley No. 20816
Cutter's Rope Clamp No. 20872
Cutter's Pole Lock No. 20868

Cutter Style DX—Loop Suspension Streethoods consist of Cutter Streethood Bodies with Looped Iron Cross Arm No. W27538, for attachment to ¾-inch Holder-Socket. Designed for use with Mast Arms, Pulleys, etc. When so used, the Streethood may be lowered to ground easily for renewing lamps and cleaning glassware. (See listing of Mast Arms, Pulleys, Insulators and Pole Line Material.)

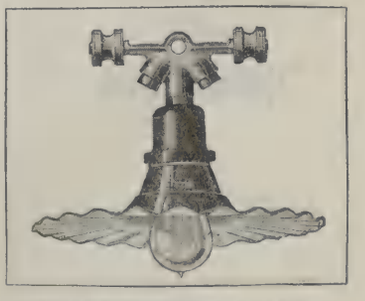


Cutter Inner-Rope Mast Arm with Style DX Streethood.



Style DX Streethood with 18-inch Radial Bowl Reflector and 8½-inch Holophane Skirted Refractor. Trade No. W27522.

Style DX Streethood with 18-inch Radial Bowl Reflector and 8½-inch "Sol-lux" Diffuser. Trade No. W27524.



Style DX Streethood with 20-inch Radial Bowl Reflector and Extension. Trade No. W27525.

PRICE LIST

Schedule A—Standard Package Quantity 10

Prices below cover Streethood Bodies with Mogul Screw Base Holder-Sockets for 300, 400 and 500 Watt Multiple Mazda "C" Lamps. When ordered for 200 Watt Mazda "C" Lamps include Mogul Screw to Medium Screw Adapter No. W**27540** and add **$0.75** to the list price.

Prices do not include lamps or wiring.

With 18-inch Radial Bowl Reflector and 8½-inch Holophane Bowl Refractor

Trade No.	Description	Ship. Wt. lbs. each	Price each
W**27521**	**Complete Streethood**	22	**$14.75**
W27538	Looped Iron Cross Arm	3	1.50
W27537	Mogul Screw Holder-Socket with Plain Cap for ¾-inch Pipe	4	3.00
W27143	18-inch Radial Bowl Reflector	4	2.75
W27169	8½-inch Holophane Bowl Refractor	9½	6.00
W27145	Hinged Refractor Holder	1½	1.50

Streethood Consists of

With 18-inch Radial Bowl Reflector and 8½-inch Holophane Skirted Refractor

Trade No.	Description	Ship. Wt. lbs. each	Price each
W**27522**	**Complete Streethood**	21	**$14.75**
W27538	Looped Iron Cross Arm	3	1.50
W27537	Mogul Screw Holder-Socket with Plain Cap for ¾-inch Pipe	4	3.00
W27143	18-inch Radial Bowl Reflector	4	2.75
W27170	8½-inch Holophane Skirted Refractor	8½	6.00
W27145	Hinged Refractor Holder	1½	1.50

Streethood Consists of

With 18-inch Radial Bowl Reflector and 8½-inch Holophane Band Refractor

Trade No.	Description	Ship. Wt. lbs. each	Price each
W**27523**	**Complete Streethood**	18	**$14.75**
W27538	Looped Iron Cross Arm	3	1.50
W27537	Mogul Screw Holder-Socket with Plain Cap for ¾-inch Pipe	4	3.00
W27143	18-inch Radial Bowl Reflector	4	2.75
W27171	8½-inch Holophane Band Refractor	5½	6.00
W27145	Hinged Refractor Holder	1½	1.50

Streethood Consists of

With 18-inch Radial Bowl Reflector and 8½-inch "Sol-lux" Diffuser

Trade No.	Description	Ship. Wt. lbs. each	Price each
W**27524**	**Complete Streethood**	17	**$11.75**
W27538	Looped Iron Cross Arm	3	1.50
W27537	Mogul Screw Holder-Socket with Plain Cap for ¾-inch Pipe	4	3.00
W27143	18-inch Radial Bowl Reflector	4	2.75
W27172	8½-inch "Sol-lux" Diffuser	4½	3.00
W27145	Hinged Refractor Holder	1½	1.50

Streethood Consists of

With 20-inch Radial Bowl Reflector with Extension for Bare Lamps

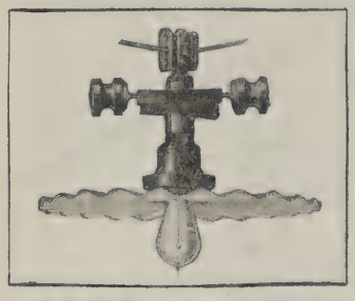
Trade No.	Description	Ship. Wt. lbs. each	Price each
W**27525**	**Complete Streethood**	13	**$8.00**
W27538	Looped Iron Cross Arm	3	1.50
W27537	Mogul Screw Holder-Socket with Plain Cap for ¾-inch Pipe	4	3.00
W27144	20-inch Radial Bowl Reflector with Extension	6	3.50

Streethood Consists of

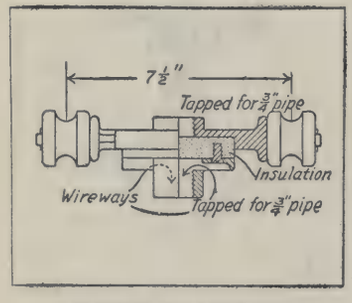
Cutter Multiple Suspension Streethoods

For 40, 60, 75, 100, 150 and 200 Watt Multiple Mazda "B" and "C" Lamps

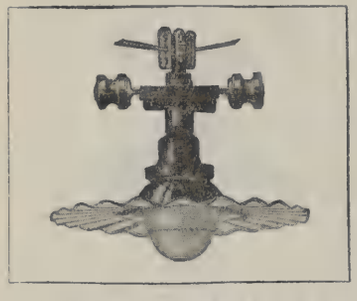
Schedule A—Standard Package Quantity 10



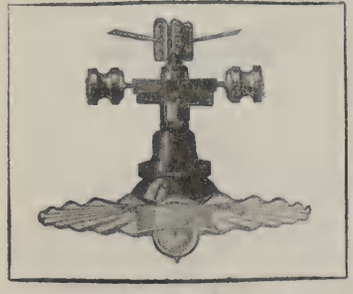
Style FX Streethood with 20-inch Flat Radial Reflector. Trade No. W27530.



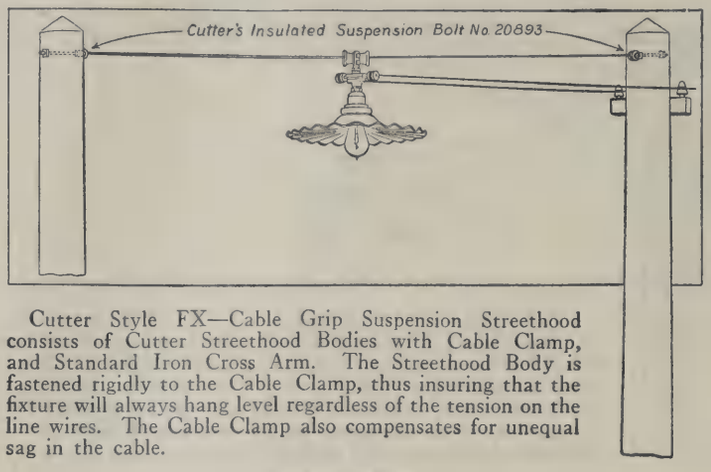
Standard Iron Cross Arm.



Style FX Streethood with 18-inch Radial Bowl Reflector and 6½-inch Holophane Skirted Refractor. Trade No. W27528.



Style FX Streethood with 18-inch Radial Bowl Reflector and 6½-inch Holophane Band Refractor. Trade No. W27529.



Cutter Style FX—Cable Grip Suspension Streethood consists of Cutter Streethood Bodies with Cable Clamp, and Standard Iron Cross Arm. The Streethood Body is fastened rigidly to the Cable Clamp, thus insuring that the fixture will always hang level regardless of the tension on the line wires. The Cable Clamp also compensates for unequal sag in the cable.

PRICE LIST

Schedule A—Standard Package Quantity 10

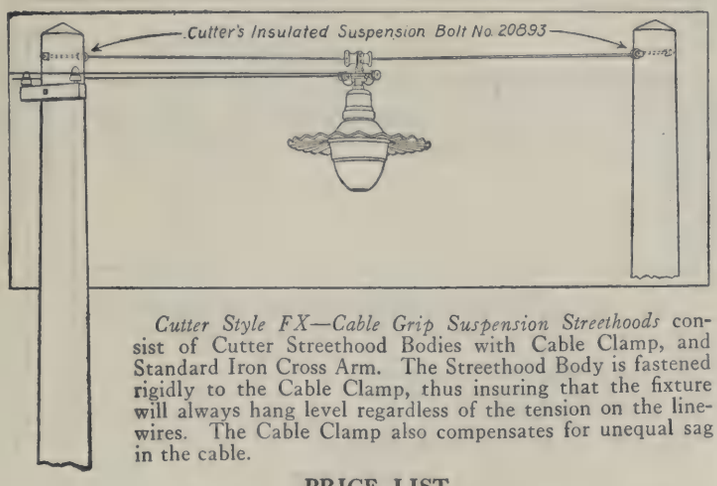
Prices below cover Streethoods with Medium Screw Base Holder-Sockets for 40, 60, 75, 100, 150 and 200 Watt Multiple Mazda "B" and "C" Lamps, but do not include lamps or wiring.

Trade No.	Description	Ship. Wt. lbs. each	Price each
	With 18-inch Radial Bowl Reflector for 100, 150 and 200 Watt Multiple Mazda "C" Lamps		
W27526	**Complete Streethood**	11½	**$6.85**
W27164	Cable Clamp	2½	.60
W27539	Standard Iron Cross Arm	3	1.00
W27536	Holder-Socket with Plain Cap for ¾-in. Pipe	2	2.50
W27143	18-inch Radial Bowl Reflector	4	2.75
	With 18-inch Radial Bowl Reflector and 6½-inch Holophane Bowl Refractor for 100 and 150 Watt Multiple Mazda "C" Lamps		
W27527	**Complete Streethood**	16½	**$11.35**
W27164	Cable Clamp	2½	.60
W27539	Standard Iron Cross Arm	3	1.00
W27536	Holder-Socket with Plain Cap for ¾-in. Pipe	2	2.50
W27143	18-inch Radial Bowl Reflector	4	2.75
W27166	6½-inch Holophane Bowl Reflector	3½	3.00
W27146	Hinged Refractor Holder	1½	1.50
	With 18-inch Radial Bowl Reflector and 6½-inch Holophane Skirted Refractor for 100 and 150 Watt Multiple Mazda "C" Lamps		
W27528	**Complete Streethood**	16½	**$11.35**
W27164	Cable Clamp	2½	.60
W27539	Standard Iron Cross Arm	3	1.00
W27536	Holder-Socket with Plain Cap for ¾-in. Pipe	2	2.50
W27143	18-inch Radial Bowl Reflector	4	2.75
W27167	6½-inch Holophane Skirted Refractor	3½	3.00
W27146	Hinged Refractor Holder	1½	1.50
	With 18-inch Radial Bowl Reflector and 6½-inch Holophane Band Refractor for 100 and 150 watt Multiple Mazda "C" Lamps.		
W27529	**Complete Streethood**	15½	**$11.35**
W27164	Cable Clamp	2½	.60
W27539	Standard Iron Cross Arm	3	1.00
W27536	Holder-Socket with Plain Cap for ¾-in. Pipe	2	2.50
W27143	18-inch Radial Bowl Reflector	4	2.75
W27168	6½-inch Holophane Band Refractor	2½	3.00
W27146	Hinged Refractor Holder	1½	1.50
	With 20-inch Flat Radial Reflector for 40, 60 and 75 Watt Multiple Mazda Lamps		
W27530	**Complete Streethood**	12½	**$6.35**
W27164	Cable Clamp	2½	.60
W27539	Standard Iron Cross Arm	3	1.00
W27536	Holder-Socket with Plain Cap for ¾-in. Pipe	2	2.50
W27162	20-inch Flat Radial Reflector	5	2.25

Cutter Multiple Suspension Streethoods

For 200, 300, 400 and 500 Watt Multiple Mazda "C" Lamps

Schedule A—Standard Package Quantity 10



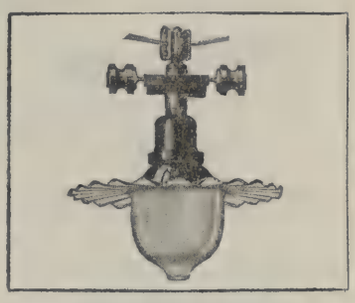
Cutter Style FX—Cable Grip Suspension Streethoods consist of Cutter Streethood Bodies with Cable Clamp, and Standard Iron Cross Arm. The Streethood Body is fastened rigidly to the Cable Clamp, thus insuring that the fixture will always hang level regardless of the tension on the line-wires. The Cable Clamp also compensates for unequal sag in the cable.

PRICE LIST

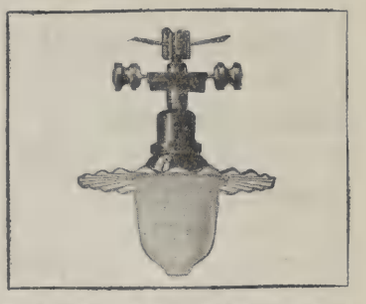
Schedule A—Standard Package Quantity 10

Prices below cover Streethoods with Mogul Screw Base Holder-Sockets for 300, 400 and 500 watt Multiple Mazda "C" Lamps. When ordered for 200 watt Mazda "C" Lamps include Mogul Screw to Medium Screw Adapter No. W**27540** and add **$0.75** to the list price. Prices do not include lamps or wiring.

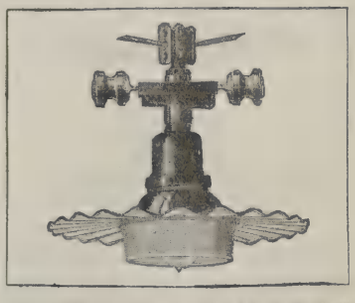
Trade No.	Description	Ship. Wt. lbs. each	Price each
	With 18-inch Radial Bowl Reflector and 8½-inch Holophane Bowl Refractor		
W27531	**Complete Streethood**	24½	**$14.85**
W27164	Streethood Consists of: Cable Clamp	2½	.60
W27539	Standard Iron Cross Arm	3	1.00
W27537	Mogul Screw Holder-Socket with Plain Cap for ¾-inch Pipe	4	3.00
W27143	18-inch Radial Bowl Reflector	4	2.75
W27169	8½-inch Holophane Bowl Refractor	9½	6.00
W27145	Hinged Refractor Holder	1½	1.50
	With 18-inch Radial Bowl Reflector and 8½-inch Holophane Skirted Refractor		
W27532	**Complete Streethood**	23½	**$14.85**
W27164	Streethood Consists of: Cable Clamp	2½	.60
W27539	Standard Iron Cross Arm	3	1.00
W27537	Mogul Screw Holder-Socket with Plain Cap for ¾-inch Pipe	4	3.00
W27143	18-inch Radial Bowl Reflector	4	2.75
W27170	8½-inch Holophane Skirted Refractor	8½	6.00
W27145	Hinged Refractor Holder	1½	1.50
	With 18-inch Radial Bowl Reflector and 8½-inch Holophane Band Refractor		
W27533	**Complete Streethood**	20½	**$14.85**
W27164	Streethood Consists of: Cable Clamp	2½	.60
W27539	Standard Iron Cross Arm	3	1.00
W27537	Mogul Screw Holder-Socket with Plain Cap for ¾-inch Pipe	4	3.00
W27143	18-inch Radial Bowl Reflector	4	2.75
W27171	8½-inch Holophane Band Refractor	5½	6.00
W27145	Hinged Refractor Holder	1½	1.50
	With 18-inch Radial Bowl Reflector and 8½-inch "Sol-lux" Diffuser		
W27534	**Complete Streethood**	19½	**$11.85**
W27164	Streethood Consists of: Cable Clamp	2½	.60
W27539	Standard Iron Cross Arm	3	1.00
W27537	Mogul Screw Holder-Socket with Plain Cap for ¾-inch Pipe	4	3.00
W27143	18-inch Radial Bowl Reflector	4	2.75
W27172	8½-inch "Sol-lux" Diffuser	4½	3.00
W27145	Hinged Refractor Holder	1½	1.50
	With 20-inch Radial Bowl Reflector with Extension for Bare Lamps		
W27535	**Complete Streethood**	15½	**$8.10**
W27164	Streethood Consists of: Cable Clamp	2½	.60
W27539	Standard Iron Cross Arm	3	1.00
W27537	Mogul Screw Holder Socket with Plain Cap for ¾-inch Pipe	4	3.00
W27144	20-inch Radial Bowl Reflector with Extension	6	3.50



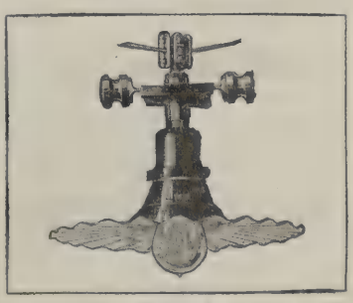
Style FX Streethood with 18-inch Radial Bowl Reflector and 8½-inch Holophane Bowl Refractor. Trade No. W27531



Style FX Streethood with 18-inch Radial Bowl Reflector and "Sol-lux" Diffuser. Trade No. W27534.



Style FX Streethood with 18-inch Radial Bowl Reflector and 8½-inch Holophane Band Refractor. Trade No. W27533

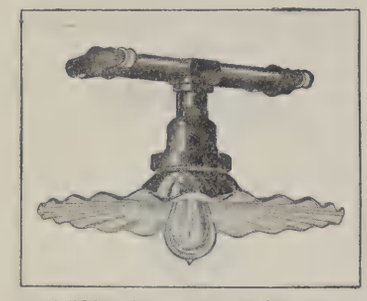


Style FX Streethood with 20-inch Radial Bowl Reflector and Extension. Trade No. W27535.

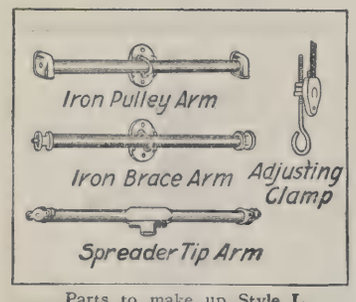
Cutter Multiple Suspension Streethoods

For 40, 60, 75, 100, 150 and 200 Watt Multiple Mazda "B" and "C" Lamps

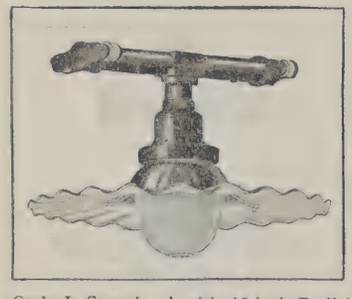
Schedule A—Standard Package Quantity 10



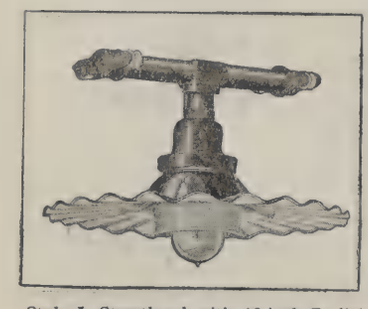
Style L Streethood with 18-inch Radial Bowl Reflector. Trade No. W27542.



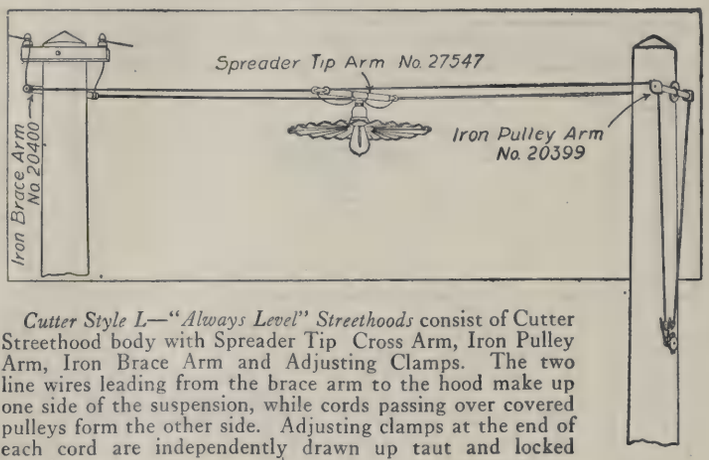
Parts to make up Style L Streethood.



Style L Streethood with 18-inch Radial Bowl Reflector and 6½-inch Holophane Bowl Refractor. Trade No. W27543.



Style L Streethood with 18-inch Radial Bowl Reflector and 6½-inch Holophane Band Refractor. Trade No. W27545.



Cutter Style L—"Always Level" Streethoods consist of Cutter Streethood body with Spreader Tip Cross Arm, Iron Pulley Arm, Iron Brace Arm and Adjusting Clamps. The two line wires leading from the brace arm to the hood make up one side of the suspension, while cords passing over covered pulleys form the other side. Adjusting clamps at the end of each cord are independently drawn up taut and locked together.

PRICE LIST

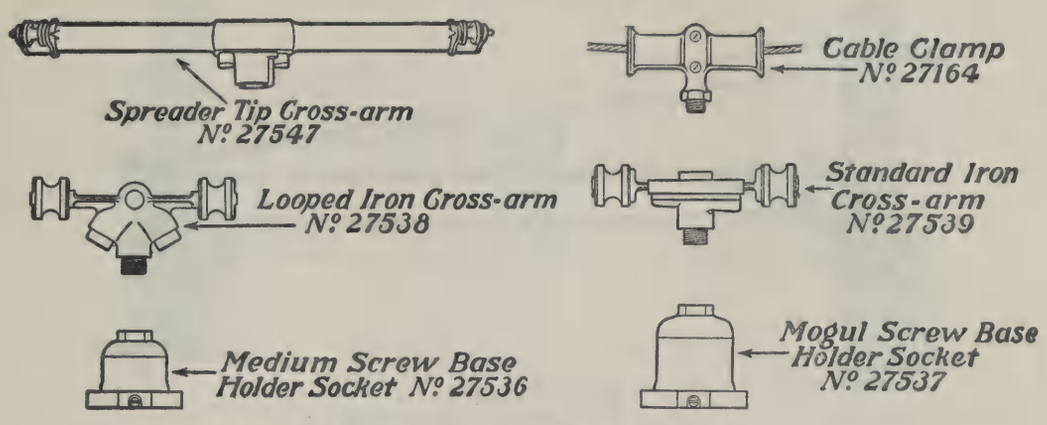
Schedule A—Standard Package Quantity 10

Prices below cover Streethood Bodies with Medium Screw Base Holder-Sockets for 40, 60, 75, 100, 150 and 200 Watt Multiple Mazda "B" and "C" Lamps, but do not include ropes, lamps or wiring.

Trade No.	Description	Ship. Wt.	Price
	With 18-inch Radial Bowl Reflector for 100, 150 and 200 Watt Multiple Mazda "C" Lamps		
W27541	**Complete Streethood**	22	**$9.45**
W27547	Spreader Tip Cross Arm	3	1.00
W27536	Holder-Socket with Plain Cap for ¾-in. Pipe	2	2.50
W27143	Streethood Consists of 18-inch Radial Bowl Reflector	4	2.75
W20399	Iron Pulley Arm	6	1.40
W20400	Iron Brace Arm	6	1.20
W20401	2 Adjusting Clamps	½	.30
	With 18-inch Radial Bowl Reflector and 6½-inch Holophane Bowl Refractor for 100 and 150 Watt Multiple Mazda "C" Lamps		
W27542	**Complete Streethood**	27	**$13.95**
W27547	Spreader Tip Cross Arm	3	1.00
W27536	Holder-Socket with Plain Cap, for ¾-in. Pipe	2	2.50
W27143	18-inch Radial Bowl Reflector	4	2.75
W27166	Streethood 6½-inch Holophane Bowl Refractor	3½	3.00
W27146	Consists of Hinged Refractor Holder	1½	1.50
W20399	Iron Pulley Arm	6	1.40
W20400	Iron Brace Arm	6	1.20
W20401	2 Adjusting Clamps	½	.30
	With 18-inch Radial Bowl Reflector and 6½-inch Holophane Skirted Refractor for 100 and 150 Watt Multiple Mazda "C" Lamps		
W27543	**Complete Streethood**	27	**$13.95**
W27547	Spreader Tip Cross Arm	3	1.00
W27536	Holder-Socket with Plain Cap for ¾-in. Pipe	2	2.50
W27143	18-inch Radial Bowl Reflector	4	2.75
W27167	Streethood 6½-inch Holophane Skirted Refractor	3½	3.00
W27146	Consists of Hinged Refractor Holder	1½	1.50
W20399	Iron Pulley Arm	6	1.40
W20400	Iron Brace Arm	6	1.20
W20401	2 Adjusting Clamps	½	.30
	With 18-inch Radial Bowl Reflector and 6½-inch Holophane Band Refractor for 100 and 150 Watt Multiple Mazda "C" Lamps		
W27544	**Complete Streethood**	26	**$13.95**
W27547	Spreader Tip Cross Arm	3	1.00
W27536	Holder-Socket with Plain Cap for ¾-in. Pipe	2	2.50
W27143	18-inch Radial Bowl Reflector	4	2.75
W27168	Streethood 6½-inch Holophane Band Refractor	2½	3.00
W27146	Consists of Hinged Refractor Holder	1½	1.50
W20399	Iron Pulley Arm	6	1.40
W20400	Iron Brace Arm	6	1.20
W20401	2 Adjusting Clamps	½	.30
	With 20-inch Flat Radial Reflector for 40, 60 and 75 Watt Multiple Mazda "B" Lamps		
W27545	**Complete Streethood**	23	**$8.95**
W27547	Spreader Tip Cross Arm	3	1.00
W27536	Holder-Socket with Plain Cap for ¾-in. Pipe	2	2.50
W27162	Streethood 20-inch Flat Radial Reflector	5	2.25
W20399	Consists of Iron Pulley Arm	6	1.40
W20400	Iron Brace Arm	6	1.20
W20401	2 Adjusting Clamps	½	.30

Parts for Multiple Streethoods

Schedule A—Standard Package Quantity 10



Interchangeable Parts for Multiple Streethood.

PRICE LIST

Schedule A—Standard Package Quantity 10

Trade No:	Description	Ship. Wt. lbs. each	Price each
W27536	Medium Screw Holder Socket with Cap for ¾-inch Pipe	2	$2.50
W27537	Mogul Screw Holder Socket with Cap for ¾-inch Pipe	4	3.00
W27540	Mogul Screw to Medium Screw Adjuster	½	.75
W27162	20-inch Flat Radial Reflector	5	2.25
W27143	18-inch Radial Bowl Reflector	4	2.75
W27144	20-inch Radial Bowl Reflector with Extension	6	3.50
W27166	6½-inch Holophane Bowl Refractor	3½	3.00
W27167	6½-inch Holophane Skirted Refractor	3½	3.00
W27168	6½-inch Holophane Band Refractor	2½	3.00
W27169	8½-inch Holophane Bowl Refractor	9½	6.00
W27170	8½-inch Holophane Skirted Refractor	8½	6.00
W27171	8½-inch Holophane Band Refractor	5½	6.00
W27172	8½-inch "Sol-lux" Diffuser	4½	3.00
W27146	6½-inch Hinged Refractor Holder	1½	1.50
W27145	8½-inch Hinged Refractor Holder	1½	1.50
W27538	Style DX Looped Iron Cross Arm	3	1.50
W27164	Cable Clamp	2½	.60
W27539	Standard Iron Cross Arm	3	1.00
W27547	Spreader Tip Cross Arm	3	1.00
W20399	Iron Pulley Arm	6	1.40
W20400	Iron Brace Arm	6	1.20
W20401	Adjusting Clamp	½	.30

Lamp Grip Multiple Sockets

For use with porcelain heads Nos. W27195 and W27196 or with other styles of Streethoods which are arranged for standard hood forks.

Cutter Lamp Grip Sockets are designed to meet the severe conditions found in outside service. The intense heat of the Type C lamps subjects the socket to greatly varying temperatures, ranging from several hundred degrees Fahr. when the lamp is burning, to below zero when the lamp is out.

These changes in temperature, taking place while the socket shells are under tension, will quickly depreciate their spring qualities and cause them to split, unless they are made sufficiently strong and some provision provided to meet these conditions.

Medium Screw Base Lamp Grip Socket.

The Cutter Lamp Grip Sockets are equipped with two vertical springs which engage the threads of the lamp collar, re-enforce the socket shells and relieve the tension. These vertical springs grip the lamp base and prevent the lamp from working loose when subjected to vibration and the contraction and expansion caused by the variations in temperature.

These springs also create an increase of positive contact between the lamp terminal and the socket.

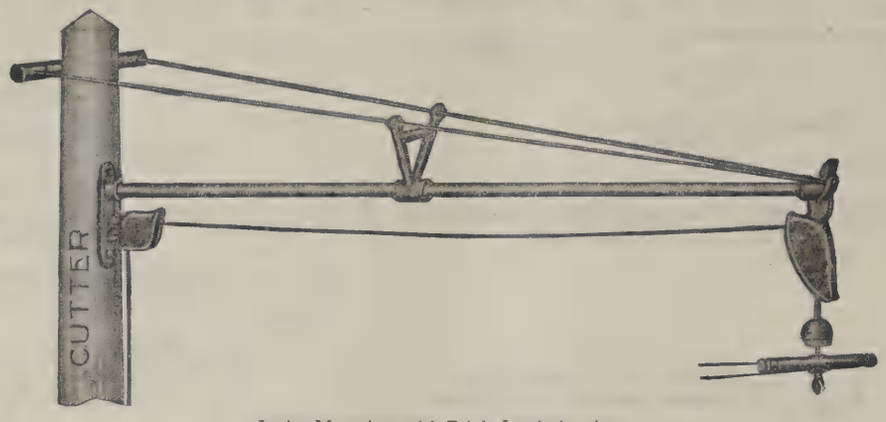
The terminals are easily accessible and very generously designed.

The use of these sockets will greatly reduce lamp breakage and outages.

Trade No.	Description	Std. Pkg.	Wt. lbs. each	Price each
W21400	Medium Screw Base	200	⅞	$0.50
W21402	Mogul Screw Base	150	1¼	.80

Cutter Mast Arms

Schedule C—Standard Package Quantity 10

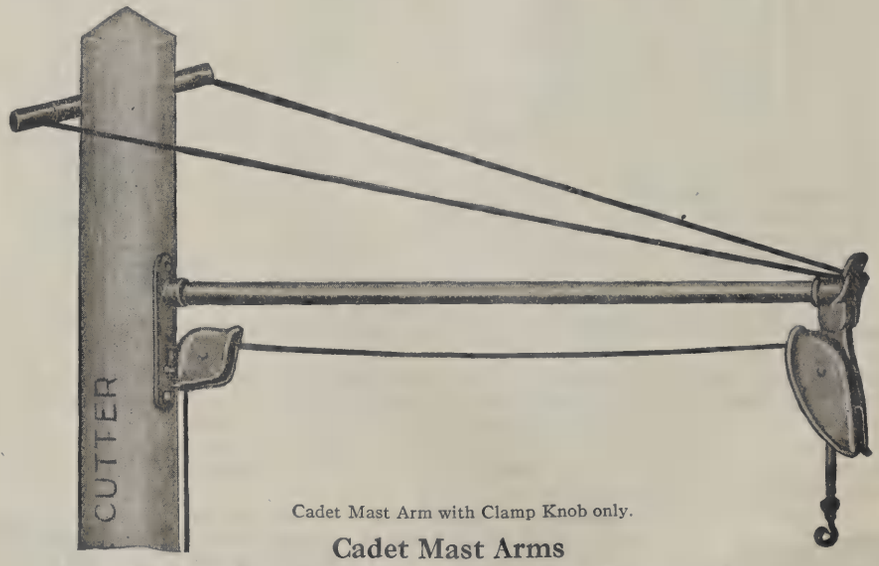


Junior Mast Arm with Triple Insulation Arm

Junior Mast Arms

Designed to meet the demand for low priced, yet complete and well braced mast arms. They have pole plates with weatherproof pulleys fitted direct to them and mast arm pulleys for lowering the lamps. Shipped complete with strain rods, strain arm, pipe and pulleys.

	With Clamp Knob Only			With Triple Insulation Arm		
Overhang feet	Trade No.	Wt. lbs. each	Price each	Trade No.	Wt. lbs. each	Price each
6	**W20618**	48	**$7.70**	**W20623**	51	**$9.05**
8	**W20619**	57	**8.50**	**W20624**	60	**9.85**
10	**W20620**	60	**9.30**	**W20625**	63	**10.65**
12	**W20621**	67	**10.10**	**W20626**	70	**11.45**
14	**W20622**	72	**10.85**	**W20627**	75	**12.20**



Cadet Mast Arm with Clamp Knob only.

Cadet Mast Arms

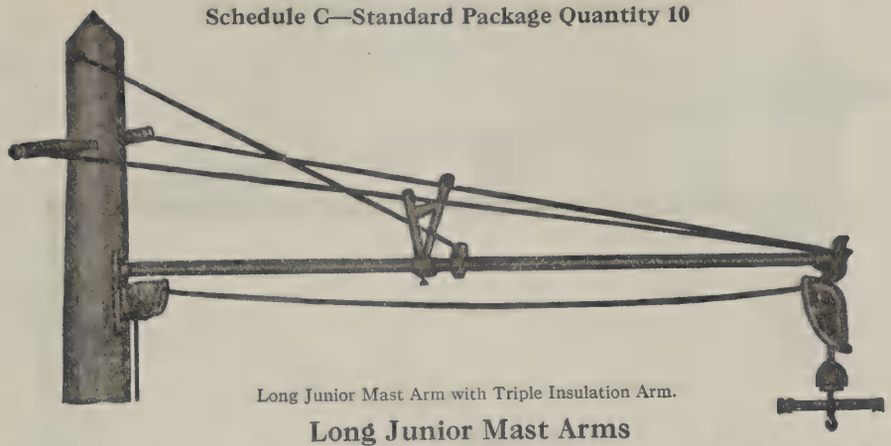
Similar to Junior Mast Arms, but without the stiffening triangle.

	With Clamp Knob Only			With Triple Insulation Arm		
Overhang feet	Trade No.	Wt. lbs. each	Price each	Trade No.	Wt. lbs. each	Price each
4	**W20698**	35	**$5.90**	**W20701**	39	**$7.25**
6	**W20699**	40	**6.70**	**W20702**	44	**8.05**
8	**W20700**	49	**7.50**	**W20703**	53	**8.85**

Galvanizing: Any of the above Mast Arms will be furnished galvanized and painted black, for 20% list additional.

Cutter Mast Arms

Schedule C—Standard Package Quantity 10

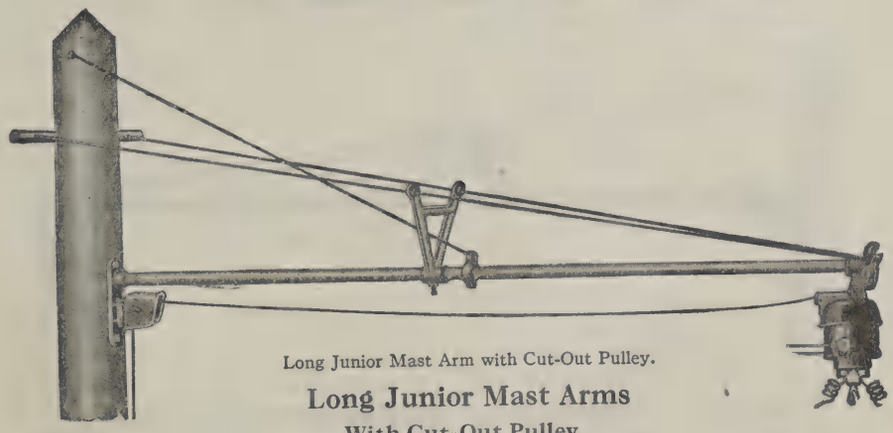


Long Junior Mast Arm with Triple Insulation Arm.

Long Junior Mast Arms

Similar to the Junior, but with double-braced strain arm. An extra support for the center of the pipe is furnished on 14-foot and longer arms.

Overhang feet	With Clamp Knob Only: Trade No.	Wt. lbs. each	Price each	With Triple Insulation Arm: Trade No.	Wt. lbs. each	Price each
6	W20628	52	$8.50	W20637	55	$9.85
8	W20629	61	9.30	W20638	64	10.65
10	W20630	64	10.05	W20639	67	11.40
12	W20631	70	10.85	W20640	73	12.20
14	W20632	79	12.05	W20641	83	13.40
15	W20633	85	12.45	W20642	89	13.80
16	W20634	90	12.85	W20643	93	14.20
18	W20635	94	13.80	W20644	98	15.15
20	W20636	100	14.80	W20645	104	16.15



Long Junior Mast Arm with Cut-Out Pulley.

Long Junior Mast Arms

With Cut-Out Pulley

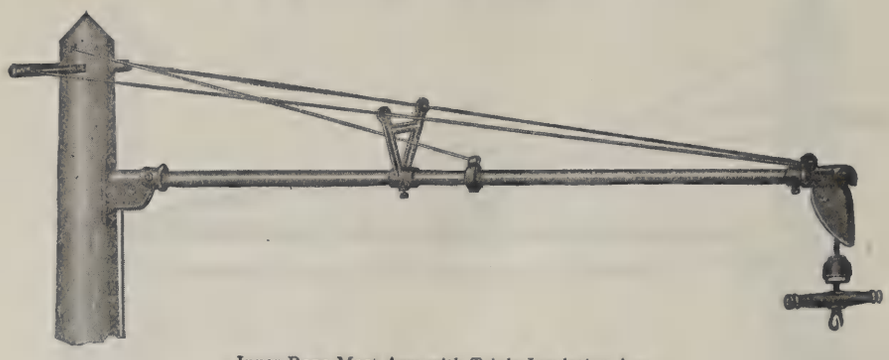
Long Junior Mast Arms as listed above with Standard Cut-Out Pulley in place of lamp-supporting pulley with clamp knob.

Overhang feet	With Series Cut-Out Pulley: Trade No.	Wt. lbs. each	Price each	With Multiple Cut-Out Pulley: Trade No.	Wt. lbs. each	Price each
6	W27200	68	$16.85	W27210	68	$16.85
8	W27201	77	17.65	W27211	77	17.65
10	W27202	80	18.40	W27212	80	18.40
12	W27203	86	19.20	W27213	86	19.20
14	W27204	95	20.40	W27214	95	20.40
15	W27205	101	20.80	W27215	101	20.80
16	W27206	106	21.20	W27216	106	21.20
18	W27207	110	22.15	W27217	110	22.15
20	W27208	116	23.15	W27218	116	23.15

Galvanizing: Any of the above Mast Arms will be furnished galvanized and painted black, for 20% list additional.

Cutter Mast Arms

Schedule C—Standard Package Quantity 10

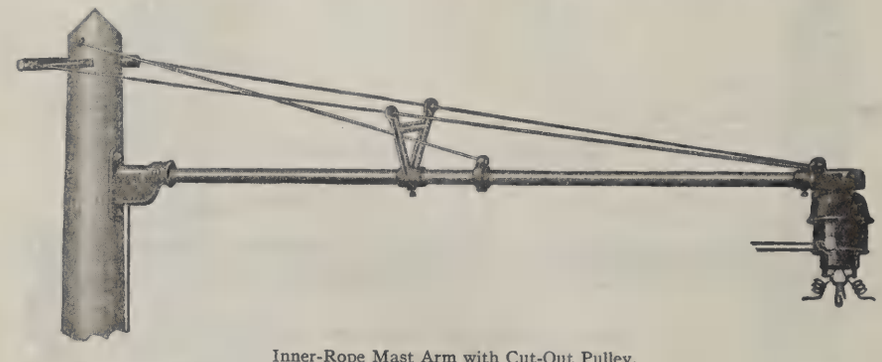


Inner-Rope Mast Arm with Triple Insulation Arm.

Inner-Rope Mast Arms

The pole pulley is built inside the pole plate and the outer supporting pulley fits in a clamp that allows the rope to pass through the pipe. Extra center rod and double braced strain arm furnished with 14-foot and longer arms.

Overhang feet	With Clamp Knob only			With Triple Insulation Arm		
	Trade No.	Wt. lbs. each	Price each	Trade No.	Wt. lbs. each	Price each
6	**W20680**	50	**$7.70**	**W20689**	53	**$9.05**
8	**W20681**	56	**8.50**	**W20690**	59	**9.85**
10	**W20682**	66	**9.30**	**W20691**	69	**10.65**
12	**W20683**	76	**10.05**	**W20692**	79	**11.40**
14	**W20684**	91	**12.45**	**W20693**	89	**13.80**
15	**W20685**	95	**12.85**	**W20694**	99	**14.20**
16	**W20686**	101	**13.25**	**W20695**	109	**14.60**
18	**W20687**	111	**14.25**	**W20696**	119	**15.60**
20	**W20688**	121	**15.25**	**W20697**	129	**16.60**



Inner-Rope Mast Arm with Cut-Out Pulley.

Inner-Rope Mast Arms

With Cut-Out Pulley

Inner-Rope Mast Arms as listed above with Standard Cut-Out Pulley in place of lamp-supporting pulley.

Overhang feet	With Series Cut-Out Pulley			With Multiple Cut-Out Pulley		
	Trade No.	Wt. lbs. each	Price each	Trade No.	Wt. lbs. each	Price each
6	**W27220**	66	**$16.05**	**W27230**	66	**$16.05**
8	**W27221**	72	**16.85**	**W27231**	72	**16.85**
10	**W27222**	82	**17.65**	**W27232**	82	**17.65**
12	**W27223**	92	**18.40**	**W27233**	92	**18.40**
14	**W27224**	107	**20.80**	**W27234**	107	**20.80**
15	**W27225**	111	**21.20**	**W27235**	111	**21.20**
16	**W27226**	117	**21.60**	**W27236**	117	**21.60**
18	**W27227**	127	**22.60**	**W27237**	127	**22.60**
20	**W27228**	137	**23.60**	**W27238**	137	**23.60**

Galvanizing: Any of the above Mast Arms will be furnished galvanized and painted black, for 20% list additional.

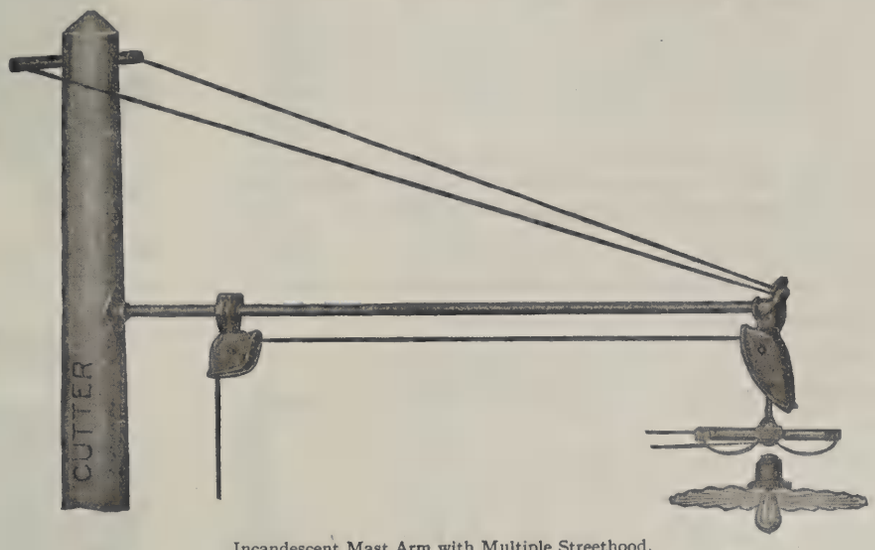
Cutter Mast Arms

Schedule C—Standard Package Quantity 10

Corporal Mast Arms

Similar to Inner-Rope Mast Arm, listed on proceeding page but without stiffening triangle.

Overhang feet	With Clamp Knob only: Trade No.	Wt. lbs. each	Price each	With Triple Insulation Arm: Trade No.	Wt. lbs. each	Price each
4	**W20704**	39	**$5.90**	**W20707**	43	**$7.25**
6	**W20705**	44	**6.70**	**W20708**	48	**8.05**
8	**W20706**	49	**7.50**	**W20709**	53	**8.85**

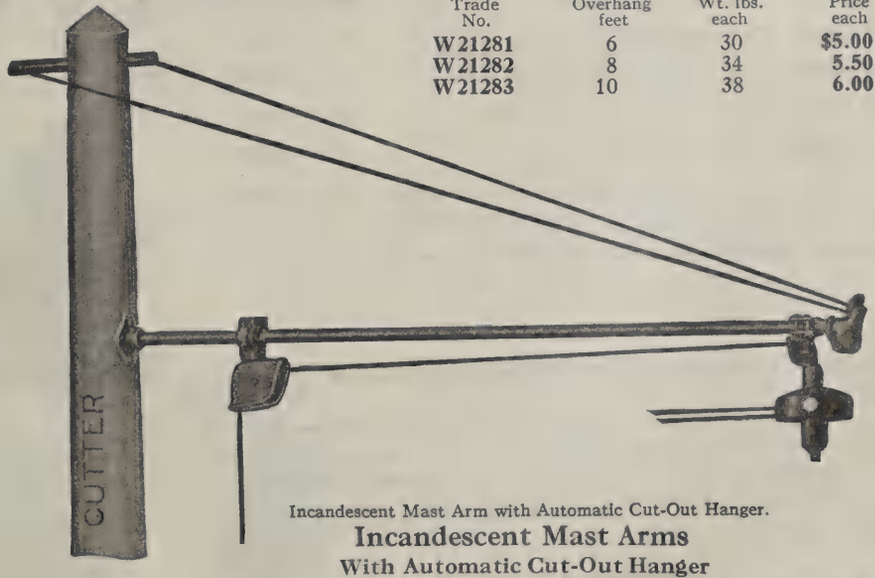


Incandescent Mast Arm with Multiple Streethood.

Incandescent Mast Arms

Designed especially for Cutter Multiple Streethood Bodies. Shipped complete, as shown, with ¾-inch pipe arm, curved pole plate, inner weatherproof pulley, outer Petite Pulley with cross arm, strain arm and rods, but without Streethood Body or Rope.

Trade No.	Overhang feet	Wt. lbs. each	Price each
W21281	6	30	**$5.00**
W21282	8	34	**5.50**
W21283	10	38	**6.00**



Incandescent Mast Arm with Automatic Cut-Out Hanger.

Incandescent Mast Arms

With Automatic Cut-Out Hanger

Incandescent Mast Arms as described above, with Automatic Cut-Out Hanger in place of Petite Pulley.

Trade No.	Overhang feet	Wt. lbs. each	Price each
W27240	6	45	**$9.35**
W27241	8	49	**9.85**
W27242	10	53	**10.35**

Galvanizing: Any of the above Mast Arms will be furnished galvanized and painted black, for 20% list additional.

Cutter Cut-Out Pulleys

Schedule D—Standard Package Quantity 10

Standard Cut-Out Pulleys For Series or Multiple Circuits

An ingenious, simple and positive device which sustains the lamp and holds it in contact independent of the hoisting rope.

When the lamp is lowered, the series circuit is closed, the multiple circuit is opened. The circuit wires are run taut to the pulley and are never lowered The lamp can be lowered straight down without interfering with trolley wires or other obstacles.

Lamps can be cleaned, trimmed, adjusted or replaced on live circuits with perfect safety. The pulley acts as a positive insurance against accidents and protects expensive lamps from damage under adverse conditions.

No ladders or poles to climb.

It is designed particularly for use on high voltage circuits either D. C. or A. C.

The contacts are self-cleaning.

There is nothing about the pulley to wear or get out of order.

The switching and supporting features are entirely automatic and certain in operation.

You pull the rope—the pulley does the rest.

Made for rope or chain, as ordered.

Recommended for use with Long Junior and Inner-Rope Mast Arms in place of outer mast arm pulleys.

Trade No. For Series Circuits	Trade No. For Multiple Circuits	Description	Wt. lbs.	Price each
W20763	**W20773**	With cable clamp	25	**$10.00**
W20768	**W20778**	With 1¼-inch mast arm clamp	25	**10.00**
W20769	**W20779**	With 1½-inch mast arm clamp	25	**10.00**
W20770	**W20780**	With ceiling plate	25	**10.00**
W27209	**W27219**	With 1¼-inch inner-rope mast arm clamp	25	**10.00**

Use Cutter ⅜-inch Hoisting Rope or ¼-inch Ebony Wire Rope with these pulleys. Made for use with galvanized chain when so ordered.

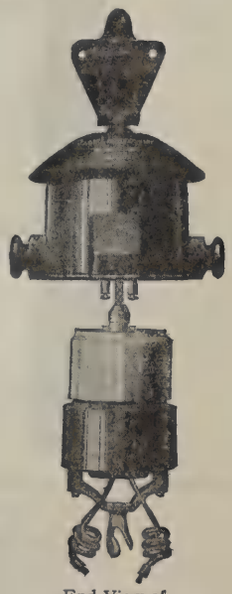
Standard Cut-Out Pulley with Cable Clamp.

Standard Cut-Out Pulley with Mast Arm Clamp.

Jupiter Cut-Out Pulleys for Series Circuits

Built along the same general lines as Cutter Standard Cut-Out Pulleys, but designed for extra heavy duty service. Recommended for D. C. and A. C. Series Circuits of 2300 volts or higher and for localities where atmospheric conditions demand extra high insulation and heavy current carrying parts. Made for rope or chain as ordered.

Trade No.	Description	Wt. lbs.	Price each
W21470	With cable clamp	65	**$14.00**
W21471	With 1¼-inch mast arm clamp	65	**14.00**
W21472	With 1½-inch mast arm clamp	65	**14.00**
W27229	With 1¼-inch inner-rope mast arm clamp	65	**14.00**



End View of Jupiter Cut-Out Pulley with Mast Arm Clamp.

Cutter Pulleys

Schedule D

Lamp-Supporting Pulley with Clamp Knob.

Clamp Knob.

Lamp-Supporting Pulleys

Holds the lamp when raised and releases it when about to be lowered. Has a long swivel clamp to fit any size suspension wire or cable and a malleable iron clamp knob to hold the lamp. On raising the lamp, this knob is engaged by the pulley and takes all the strain off the rope. Another pull at the rope guides the knob out so that the lamp can be readily lowered. The action is entirely automatic. You pull the rope till it reaches a dead stop, and the pulley does the rest. There are no extra catches or fingers to bend out of shape or bind on the casing or to get clogged with sleet. It is the only weatherproof safety pulley that works every time. The clamp knob clamps any size rope up to ½-inch.

PRICE LIST

Trade No.	Description	Std. Pkg.	Wt. lbs.	Price each
W20782	With clamp knob only.....	50	9	$1.45
W20784	With triple insulation arm .	50	13	2.80
W27243	With Goliath cross arm.....	50	20	3.70

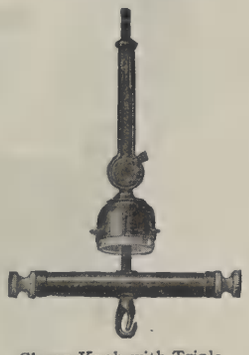
Mast Arm Pulleys

A modification of the lamp-supporting pulley, having an extra strong single piece clamp, which fits the iron pipe of a mast arm and which also forms the headpiece so that the strain rods can be run direct to it.

For 1¼-inch (Bore) Pipe

Trade No.	Description	Std. Pkg.	Wt. lbs.	Price each
W20786	With clamp knob only	50	10	$1.65
W20788	With triple insulation arm . .	50	14	3.00
W27244	With Goliath cross arm.....	50	21	3.90

Mast Arm Pulley.



Clamp Knob with Triple Insulation Arm.

Inner-Rope Pulleys

A lamp-supporting pulley with a hooded end clamp for use with mast arms in which the rope runs through the pipe.

For 1¼-inch (Bore) Pipe

Trade No.	Description	Std. Pkg.	Wt. lbs.	Price each
W20794	With clamp knob only....	50	14	$1.80
W20796	With triple insulation arm..	50	18	3.15
W27245	With Goliath cross arm....	50	25	4.05

Clamp Knobs

Trade No.	Description	Std. Pkg.	Wt. lbs.	Price each
W20802	With hook only.....	100	1½	$0.30
W20804	With triple insulation arm.	100	6	1.65
W27246	With Goliath cross arm....	100	13	2.55

Inner-Rope Pulley.

Ceiling Pulleys

A form of the lamp-supporting pulley, with a plate for use on bridges or under beams in shops or yards.

Trade No.	Description	Std. Pkg.	Wt. lbs.	Price each
W20810	With clamp knob only....	50	9	$1.65
W20811	With triple insulation arm	50	13	3.00
W27247	With Goliath cross arm....	50	20	3.90

Swivel Pole Pulley.

Ceiling Pulley.

Swivel Pole Pulleys

A weatherproof pole pulley, swiveled so that it can swing sideways and keep in line with the hoisting rope. Has a strong malleable iron pole plate.

Trade No.	Description	Std. Pkg.	Wt. lbs.	Price each
W20813	.....	100	4¼	$0.75

Jumbo Pole Pulleys

Similar to the above, but larger, to take ¾-inch rope.

Trade No.	Description	Std. Pkg	Wt. lbs.	Price each
W20814	.....	75	5½	$1.10

For galvanizing any of the above, add 50 per cent to list price, which includes final coat of black enamel.

Cutter Pulleys

Schedule D

Interchangeable Pulleys

A weatherproof pulley with a universal clamp made of malleable iron, which will grip any standard size of suspension wire or cable. By taking out the two bolts the clamp can be opened out so as to form a wall plate, which fits the curved surface of a pole and which is easily fastened in place by lag screws. When so used it makes a swiveled pole pulley similar in action to the Cutter Swivel Pole Pulley.

Trade No.	Description	Std. Pkg.	Wt. lbs. each	Price each
W20816	.....	100	4¼	$0.75

Interchangeable Pulley.

Sleeve Pulley.

Jumbo Changeable Pulleys

Similar to the interchangeable pulley, but larger, to take ¾-inch rope.

W20817	.....	75	5½	$1.10

Sleeve Pulleys

A weatherproof pulley with a sleeve clamp to grip iron pipe.

W20818	For ¾-inch (Bore) pipe...	100	5¼	$0.80

Midget Changeable Pulley.

Petite Pulley with Cross Arm.

Midget Changeable Pulley

Similar to the interchangeable pulley, but smaller, to support Cutter Multiple Streethoods.

W20415	.....	100	2½	$0.70

Petite Pulley with Cross Arm

Consists of a Petite Lamp-Supporting Pulley for cable suspension, with a movable cross arm. Designed for use with Cutter Multiple Streethoods.

W20413	.....	50	6½	$1.50

Pole Housing.

Pole Housing

The pole plate and pulley casing are made in one piece, with the sheaves placed so the rope can run through the pipe, as with the Cutter Inner-Rope and Corporal Mast Arms.

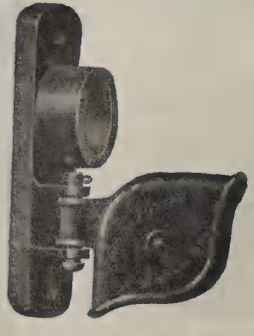
W20826	For 1¼-inch (Bore) pipe.	75	6½	$1.20
W20827	For 1½-inch (Bore) pipe.	75	6¾	1.20

Tail Pulley.

Tail Pulleys

A companion to the pole housing for use with Cutter Inner-Rope and Corporal Mast Arms.

W20828	For 1¼-inch (Bore) pipe.	75	6¾	$0.90
W20829	For 1½-inch (Bore) pipe.	75	7	.90



Junior Pole Plate with Pulley.

Junior Pole Plate with Pulley

As furnished with the Junior, Long Junior and Cadet Mast Arms. Socket for 1¼-inch pipe is cast on the pole plate. Pulley is similar to the Swivel Pole Pulley.

W27248	.....	75	8	$1.20

For galvanizing any of the above, add 50 per cent to list price, which includes final coat of black enamel.

Cutter Insulators and Cross Arms

Schedule E

No. W20836

No. W20839

No. W20844

No. W27256

Triple Insulation Arm.

Goliath Cross Arm.

High Voltage Insulators

High voltage insulators have a double petticoat porcelain bell, which forms a good watershed and gives high insulation even in wet weather. The rivets which fasten the metal cap to the porcelain pass under the elongated head of the bolt which supports the hook. The cap is sealed with insulating material and the extra petticoat gives a large surface insulation, making the device well suited for use on arc circuits exposed to weather, smoke or fumes.

While designed especially for use on arc circuits of high voltage, the extra protection and the elimination of leaks afforded by this insulator make it a desirable one, even for circuits of comparatively low voltage.

Trade No.	Description	Std. Pkg.	Wt. lbs. each	Price each
W20836	With ring above and sister hook below	100	4	**$0.90**
W20839	With clamp for wire rope above and ring below	100	4	**1.00**
W20841	With clamp for chain above and ring below	100	4	**1.00**
W27249	With clamp for ⅜-inch rope above and ring below	100	4	**1.00**

For galvanizing all iron parts, add 20 cents each to list price, which includes final coat of black enamel.

Jupiter Insulators

Built on the same lines generally as high voltage insulators, but with a greatly enlarged series of petticoats to give higher surface insulation. Therefore it has the same high breakdown insulation (ample for 12000-volt circuits) and an extra large surface to reduce the leakage in wet weather.

Trade No.	Description	Std. Pkg.	Wt. lbs. each	Price each
W20844	With ring above and sister hook below	75	6	**$1.35**
W27250	With clamp for wire rope above and ring below	75	6	**1.45**
W27256	With clamp for chain above and ring below	75	6	**1.45**
W27257	With clamp for ⅜-inch rope above and ring below	75	6	**1.45**

For galvanizing all iron parts, add 20 cents each to list price, which includes final coat of black enamel.

Triple Insulation Arms

Triple insulation arms have a high voltage insulator above an enameled wood arm, thus giving a triple insulation between the line wire and the supporting ring.

The arm is coated with a baked enamel, which outwears paint in the weather, and has its ends bound by strong metal ferrules to prevent their splitting. Every part of the whole device is built for fine wear and high insulation, making it a fine insulating arm for all high voltage lamps, and the only low priced one adapted for use with alternating series lamps. It is second only to the Goliath Cross-Arm.

Trade No.	Finish	Std. Pkg.	Wt. lbs. each	Price each
W20852	Enameled	75	5	**$1.35**
W20853	*Galvanized	75	5	**1.60**

Goliath Cross Arms

An insulating cross arm having both the wire supports and the lamp hook insulated from the support by a Jupiter Insulator. The cross arm is of iron, fitted with porcelain knobs for supporting the line wires and a sister hook for the lamp.

Trade No.	Finish	Std. Pkg.	Wt. lbs. each	Price each
W27165	Enameled	50	10½	**$2.25**
W27258	*Galvanized	50	10½	**2.75**

*Includes final coat of black enamel

Cutter Insulators and Cross Arms

Schedule E

Grip Arms

Consists of the plain arm with a "U" bolt for clamping same to 1¼-inch (bore) iron piping as used on mast arms, outriggers and brackets.

Trade No.	Finish	Std. Pkg.	Wt. lbs. each	Price each
W20863	Enameled	200	1¾	$0.75
W20864	*"U" Bolt, galvanized	200	1¾	.85

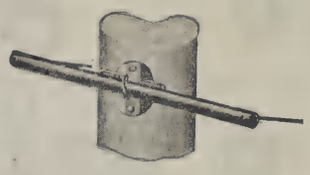
Grip Arm.

Strain Arms

As Furnished on Junior and Cadet Mast Arms

Strain arms are made of wrought iron with a cast iron pole plate.

Trade No.	Std. Pkg.	Wt. lbs. each	Price each
W20746	100	8½	$1.20



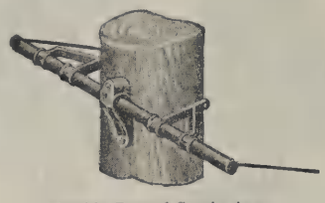
Strain Arm.

Double-Braced Strain Arms

As Furnished on Long Junior Mast Arms

Double-braced strain arms are longer than the regular strain arms and have side braces to prevent rocking in high winds.

Trade No.	Std. Pkg.	Wt. lbs. each	Price each
W20747	50	10	$2.00



Double Braced Strain Arm.

Cutter Pole Line Material

Schedule F

Pole Locks

Has the keyhole at the bottom and not at the top (where the rain and sleet would drive into it). The double catch makes it non-pickable, the back fits either a wall or a pole, and the casting makes it weatherproof. Just the thing to prevent tampering with hoisting ropes. One key free with every ten locks.

Trade No.	Finish	Std. Pkg.	Wt. lbs. each	Price each
W20868	Painted	100	1½	$0.75
W20869	*Galvanized	100	1½	.85
W20870	Extra key	25	1 oz.	.20

Pole Lock.

Rope Cleats

Strong and neat (though no cleat with its coil of rope makes as neat a job as the rope clamp and pole lock). Has the edges rounded so as not to cut the rope.

Trade No.	Finish	Std. Pkg.	Wt. lbs. each	Price each
W20871	Galvanized	200	1	$0.30

Rope Cleat.

Rope Clamps

Made of malleable iron, will readily clamp any size rope up to ⅜-inch, enabling the end of the hoisting rope to be locked at the pole. Can be used over and over again when the rope wears out.

Trade No.	Finish	Std. Pkg.	Wt. lbs. each	Price each
W20872	Painted	400	¼	$0.18
W20873	*Galvanized	400	¼	.22

½-inch Rope Clamps

Same as above, for ½-inch ropes.

Trade No.	Finish	Std. Pkg.	Wt. lbs. each	Price each
W20874	Painted	400	¾	$0.20
W20875	*Galvanized	400	¾	.25

Chain Clamps

A neat, secure fastening, enabling the end of the hoisting chain to be locked to the pole. Made for No. 1 or No. 3 Oneida Chain.

Trade No.	Finish	Std. Pkg.	Wt. lbs. each	Price each
W20876	Painted	400	½	$0.18
W20877	*Galvanized	400	½	.22

*Includes final coat of black enamel.

Rope Clamp.

Chain Clamp.

Cutter Pole Line Material

Schedule F

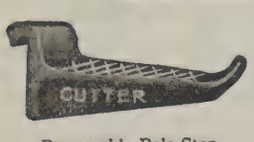
Weatherproof Lamp Rope.

Ebony Wire Rope.

Trimmer's Rope.

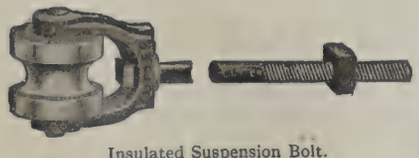
Showing Pole Steps in Use.

Pole Step Socket.

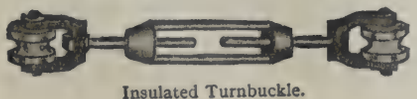


Removable Pole Step.

Insulated Fork.



Insulated Suspension Bolt.



Insulated Turnbuckle.

Weatherproof Lamp Rope

A fine braided cotton rope with a weatherproof finish, which keeps out the rain and makes it extra durable. We recommend the 3/8 and 1/2-inch sizes for hoisting arc lamps, the 1/4 and 5/16-inch for use with the swinging hoods and the 3/16-inch for the Always Level Streethood.

Trade No.	Size inches	Wt. lbs. Std. Pkg.	Approx. Wt. lbs. per 100 ft.	Price per lb.
W22340	3/16	100	2	**$1.40**
W22341	1/4	100	2 1/2	**1.40**
W22342	5/16	100	3 1/8	**1.40**
W22343	3/8	100	5	**1.40**
W22344	1/2	100	8	**1.75**

Ebony Wire Rope

A 1/4-inch wire rope made of six flexible strands (each with soft center) around a flexible (black) center. The only wire rope really pliable enough to work freely with standard types of pulleys.

Trade No.	No. of Feet in Std. Pkg.	Approx. Wt. lbs. per 100 ft.	Price per ft.
W20883	1000	5	**$0.10**

Trimmer's Rope

Trimmer's rope is a 30-foot hoisting rope, with a snap hook at one end and six rings near the other end. The rings can be readily clamped at any desired intervals, so as to accommodate lamps hung at varying heights above the street. Just the thing for use with hoisting ropes, ending in a Cutter Rope Clamp and locked with a Cutter Pole Lock.

Trade No.	Std. Pkg.	Wt. lbs.	Price each
W20884	25	4	**$3.75**

Removable Pole Steps

Removable pole steps are much more easily carried than a ladder. A pair of them weighs less than 14 ounces, and can be slipped into the pocket. The sockets for them are hooded over so as to be sleet-proof.

Trade No.	Description	Std. Pkg.	Wt. lbs.	Price each
W20887	*Pole Step, galvanized . . .	250	7/16	**$0.30**
W20888	*Socket, galvanized	250	7/16	**.20**

Insulated Forks

A wrought iron fork holds a heavy porcelain spool with 11/16-inch groove, which insulates the suspension wire or cable from the pole. Made for 1/2-inch lag screw. Prices do not include the lag screws.

Trade No.	Description	Std. Pkg.	Wt. lbs.	Price each
W20892	*Galvanized	250	1	**$0.30**

Insulated Suspension Bolts

Consists of insulated fork with 12-inch bolt, 1/2-inch in diameter and having 6 inches of thread.

Shipped complete with nut and washer.

Trade No.	Description	Std. Pkg.	Wt. lbs.	Price each
W20894	*Galvanized	200	2	**$0.60**

Insulated Turnbuckles

An insulated fork on each end; maximum spread, 24 inches; adjustment, 9 inches.

Trade No.	Description	Std. Pkg.	Wt. lbs.	Price each
W20896	*Galvanized	50	6	**$1.60**

*Includes final coat of black enamel.

CUTTER INDUSTRIAL LIGHTING REFLECTORS

ILLUMINATION DATA

Two Examples of Efficient Industrial Lighting Systems

INDUSTRIAL LIGHTING

Statistics show that if the average expense of five workmen and their supervision equals $5,000 annually, the cost of illumination is paid for if it saves only three minutes daily of each man's time—or one-half of one per cent of the cost of wages and supervision. Yet good illumination, on an average, saves 30 minutes daily per man. Not only does good lighting pay for itself by saving the time of workmen, but it brings other returns. These include increased production for the same labor costs and overhead, reduction of spoilage and seconds, decrease in the number of accidents, less eye-strain, and more cheerful and sanitary conditions for employees.

Present day conditions are forcing all industrial plants to realize the necessity for good lighting. The scarcity of labor and the demands for better working conditions, the great losses of high-priced material spoiled, and the urgency of filling orders on schedule time make it necessary for every industrial plant to have improved lighting equipment.

DESIGN OF INDUSTRIAL LIGHTING SYSTEMS

Obviously, the ideal lighting system for any factory is the one which enables the workmen to perform their duties with the greatest accuracy and speed and with the least eye strain. To be practicable the system should be flexible in operation and moderate in first cost as well as maintenance.

Refer to "Cutter Handy Wiring Tables and Illumination Data," which gives information concerning requirements for and types of good factory lighting, methods of making illumination calculations and rules for designing systems. Our Engineering Service Department will assist in making plans and estimates. Complete designs will be submitted when drawings and sketches are submitted with the following information: (1) class of work to be performed in each building or department; (2) dimensions of rooms, height of ceilings, location of windows, girders, shafting, etc.; (3) location of machinery, work benches, etc.; (4) color of walls, and (5) whether conduit or open wiring is to be installed.

ELIMINATION OF GLARE

Glare is one of the most harmful conditions to be encountered in artificial lighting. Men who are permitted to work in glaring light are subject to premature fatigue. Glare causes eye-strain, accidents, spoilage of materials, and decreases production.

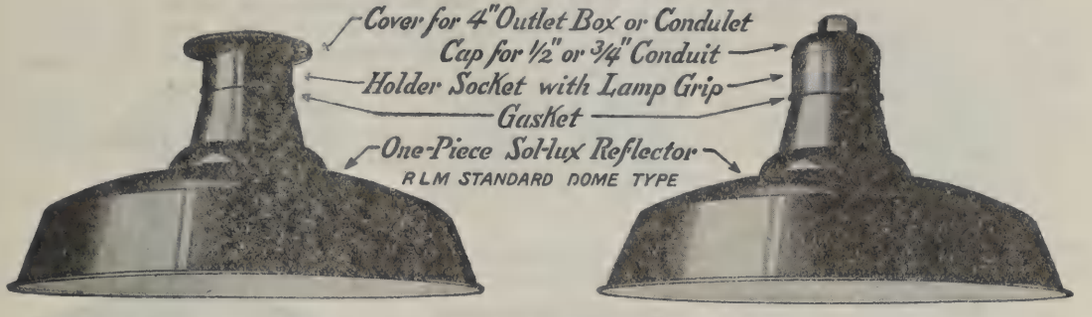
Direct glare results from mounting a brilliant light source, such as a bare or improperly shaded lamp, in the direct line of vision. This condition may be corrected by shielding the lamp filament or mounting the lighting unit high above the working plane. Reflected glare is the result of bright rays reflected from polished metal, oily surfaces, etc. It may be reduced by diffusing the light so that the intensity directly beneath the lighting unit is not sufficient to cause a correspondingly high intensity reflected from objects on the working plane.

The practical solution of the problem of eliminating glare is to use reflectors which shield the lamp filament from the direct line of vision. In buildings where high mounting heights are possible bowl type reflectors should be used. In buildings where the ceilings are low, units for general illumination should be installed as close as possible to the ceiling. Cutter Holder-Sockets possess a particular advantage for the latter purpose because they allow lamps and reflectors to be installed directly to the conduit. For localized lighting, bowl type reflectors are the most satisfactory.

Cutter SOL-LUX Industrial Lighting Fixtures

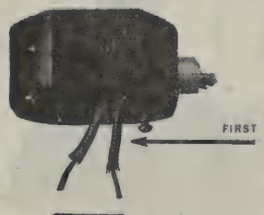
Holder-Socket-Reflectors

"Easy to Wire"—Guaranteed Weather-Proof


Cover for 4" Outlet Box or Condulet
Cap for ½" or ¾" Conduit
Holder Socket with Lamp Grip
Gasket
One-Piece Sol-lux Reflector
R L M STANDARD DOME TYPE

Cutter Holder Socket Reflectors consist of one-piece porcelain enameled steel reflectors fastened securely to the porcelain body of the Holder Socket. Gaskets between the porcelain sockets and reflectors make the fixtures weather proof.

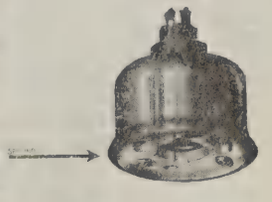
This adaptation of the Cutter "Easy-to-wire" Holder Socket to standard types of one piece reflectors, meets the requirements for heavy duty service fixtures which may be installed and wired with the minimum expenditure of time.

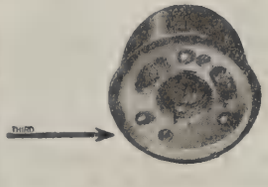


One-Piece Angle Reflector.

Cutter Holder Socket Reflectors are easy to wire. One complete fixture can be installed by one man in two minutes. Only a few operations are necessary. With the Holder Socket Reflector for attachment to Outlet-Box, the wires are pulled through the vertical openings in the porcelain socket and connected to the terminals. The reflector is then fastened to the socket by means of three screws which engage in bayonet slots in the top of the reflector. The Holder Socket Reflector is attached to conduit in a similar manner. In either case, there are no loose wires to stuff back or washers and lock nuts to adjust. Cutter Holder Socket Reflectors are water tight and have cast iron covers, heavily galvanized and painted. They will not corrode. The Reflectors are insulated from the conduit and the terminals are protected from accidental short circuit.

Holder Socket Reflectors are held rigidly in place and in a level position. The reflectors are in correct position with respect to the lamp filment, thereby securing the distribution of light for which they are designed.





One-Piece Bowl Reflector.

Holder Socket Reflectors insure permanent high efficiency. They are well protected from dust accumulation and the reflectors are easily cleaned.

Holder Socket Reflectors are interchangeable. Reflectors of different types may be substituted at any time and reflectors for medium base and mogul base lamps may be interchanged respectively with medium screw and mogul screw sockets.

Methods of attachments:—Holder Socket Reflectors may be used on any type of installation and for either interior or exterior lighting purposes. They may be suspended:

1. On ½-inch or ¾-inch Conduit.
2. Directly from the Outlet-Box or Condulet
3. On chain or cord by using Suspension Eyes.
4. On Reinforced drop cord by using porcelain bushings.

Approved Construction-Cutter Holder Sockets are approved by the National Board of Fire Underwriters.

Cutter SOL-LUX Industrial Lighting Reflectors

Holder-Socket-Reflectors

"Easy to Wire"—Guaranteed Weather-Proof

Cutter Holder Socket Reflectors listed below are combinations of Sol-lux One-Piece Reflectors and Cutter Holder Sockets. Prices cover fixtures complete less the lamps. The Reflectors and Sockets are listed separately to permit of other combinations than those listed.

The following Holder Sockets are used with Sol-lux one-piece Reflectors—Medium Base Sockets are interchangeable with all reflectors for 200-watt or smaller lamps, and Mogul Base Sockets with all reflectors for 300-watt or larger lamps.

HOLDER SOCKETS FOR ONE-PIECE REFLECTORS

TRADE NUMBERS					
For ½-inch* Conduit	For ¾-inch Conduit	With 4-inch Outlet Box Cover	With Cover for Condulet†		Price Each
W30693	W30694	W30684	W30685	Medium Screw Base	$1.00
W30772	W30773	W30980	W30981	Mogul Screw Base	1.50

Holder-Socket-Reflector R.L.M. Standard Dome Type.

Complete Holder Socket Reflectors

With Cap for ½-Inch or ¾-Inch Conduit

R L M STANDARD DOME TYPE

TRADE NUMBERS		Consisting of:							
Complete Unit		Holder-Sockets							
For ½" Conduit	For ¾" Conduit	For ½" Conduit	For ¾" Conduit	One-piece Reflector	For Mazda Lamp Size	Diam. of Refr. Inches	Std. Pkg.	Std. Pkg. Wt.	Price Each Complete Unit
W30668	W30747	W30693	W30694	W306075	75	12⅛	10	50	$2.70
W30669	W30748	W30693	W30694	W306150	100–150	14⅛	10	60	2.90
W30670	W30749	W30693	W30694	W306200	200	16⅜	5	40	3.60
W30671	W30750	W30772	W30773	W306500	300–500	18⅛	5	50	4.40
W30672	W30751	W30772	W30773	W306000	750–1000	20¾	3	45	5.90
				STANDARD BOWL TYPE					
W30673	W30752	W30693	W30694	W307060	25–40–60	7½	20	40	2.20
W30674	W30753	W30693	W30694	W307075	75	8½	10	35	2.35
W30675	W30754	W30693	W30694	W307150	100–150	8½	10	40	2.40
W30676	W30755	W30693	W30694	W307200	200	10½	10	45	2.90
W30677	W30756	W30772	W30773	W307500	300–500	12¾	5	40	3.60
W30678	W30757	W30772	W30773	W307000	750–1000	15½	3	40	5.00
				STANDARD ANGLE TYPE					
W30679	W30758	W30693	W30694	W304040	25–40	6⅝	20	40	2.00
W30680	W30759	W30693	W30694	W304060	60	8	10	35	2.45
W30681	W30760	W30693	W30694	W304200	75–150–200	10½	10	45	3.25
W30682	W30761	W30772	W30773	W304500	300–500	12½	5	40	4.75
W30683	W30762	W30772	W30773	W304000	750–1000	15½	3	40	6.40

Holder-Socket-Reflector Standard Bowl Type.

Holder-Socket-Reflector Standard Angle Type.

Complete Holder Socket Reflectors

With Cover for Outlet Box or Condulet †

R L M STANDARD DOME TYPE

Consisting of:									
Complete		Holder Socket for Outlet Box	Holder Socket for Condulet†	One-Piece Reflector					
For 4" Outlet Box	For Condulet								
W30948	W30964	W30684	W30685	W306075	75	12⅛	10	50	2.70
W30949	W30965	W30684	W30685	W306150	100–150	14⅛	10	60	2.90
W30950	W30966	W30684	W30685	W306200	200	16⅜	5	40	3.60
W30951	W30967	W30980	W30981	W306500	300–500	18⅛	5	50	4.40
W30952	W30968	W30980	W30981	W306000	750–1000	20¾	3	45	5.90
				STANDARD BOWL TYPE					
W30953	W30969	W30684	W30685	W307060	25–40–60	7½	20	40	2.20
W30954	W30970	W30684	W30685	W307075	75	8½	10	35	2.35
W30955	W30971	W30684	W30685	W307150	100–150	8½	10	40	2.40
W30956	W30972	W30684	W30685	W307200	200	10½	10	45	2.90
W30957	W30973	W30980	W30981	W307500	300–500	12¾	5	40	3.60
W30958	W30974	W30980	W30981	W307000	750–1000	15½	3	40	5.00
				STANDARD ANGLE TYPE					
W30959	W30975	W30684	W30685	W304040	25–40	6⅝	20	40	2.00
W30960	W30976	W30684	W30685	W304060	60	8	10	35	2.45
W30961	W30977	W30684	W30685	W304200	75–150–200	10½	10	45	3.25
W30962	W30978	W30980	W30981	W304500	300–500	12½	5	40	4.75
W30963	W30979	W30980	W30981	W304000	750–1000	15½	3	40	6.40

Holder-Socket-Reflector Standard Angle Type.

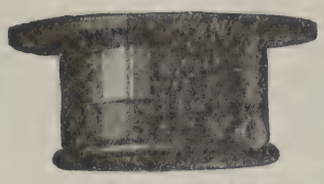
* Furnished with porcelain bushing for reinforced drop cord suspension when so ordered without additional charge.
† Furnished with cover for Crouse-Hinds Condulets, Series LO, CL, BO, BLM, DSO and DSP. Specify type of Condulet when ordering

SCHEDULE "H" DISCOUNTS

CUTTER SOL-LUX INDUSTRIAL LIGHTING REFLECTORS AND HOLDERS

SCHEDULE H

Holder-Socket with Cap for Attachment to ½-inch Conduit



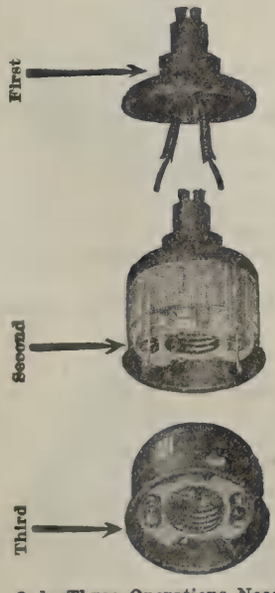
Holder-Socket with 4-inch Outlet-Box Cover

Holder-Socket with Porcelain Bushing for Reinforced Drop-Cord Suspension

2¼-inch Single Screw Spring Holder for Porcelain Sockets Showing Reflector

2¼-inch Single Screw Spring Holder for Brass Shell Sockets

Only Two Operations Necessary for Installing Holder-Sockets Direct to Outlet Box



Only Three Operations Necessary for Wiring Holder-Sockets for Attachment to Conduit

HOLDER-SOCKETS

The use of Cutter Holder-Sockets, which are combination holders for standard-heel reflectors and sockets for Mazda lamps, is an important factor in obtaining efficient illumination. The functions of Holder-Sockets, their simple construction and easy to wire features recommend them for installations where utility and efficiency are the determining factors .

Holder-Sockets are made with Cap for attachment to ½-inch and ¾-inch conduit stems, with cover for attachment directly to outlet boxes and condulets, and with porcelain bushing for reinforced drop cord suspension. Holders are made for both 2¼-inch and 3¼-inch standard-heel reflectors.

Lamp Grips—Holder-Sockets are provided with lamp grips to insure perfect electrical connections and prevent the lamps loosening as a result of vibration. This feature is particularly important where the lamps are subjected to wind pressure; also in places where there is excessive vibration.

2¼-INCH HOLDER-SOCKETS

With Keyless Porcelain Medium Screw Sockets

Trade No.		Std. Pkg.	Wt., Lbs. Std. Pkg.	Price Each
W30650	For ½-inch conduit attachment....	20	30	$1.25
W30984	For ¾-inch conduit.....	20	30	1.25
W30651	With 4-inch outlet box cover.....	20	25	1.25
W30982	With cover for Crouse-Hinds Condulet †.....	20	25	1.25
W30652	For drop-cord attachment.....	20	30	1.25

3¼-INCH HOLDER-SOCKETS

With Keyless Porcelain Mogul Screw Sockets

W30654	For ½-inch conduit attachment....	10	35	$1.75
W30985	For ¾-inch Conduit.....	10	35	1.75
W30655	With 4-inch outlet box cover.....	10	30	1.75
W30983	With cover for Crouse-Hinds Condulet†	10	30	1.75
W30656	For drop cord suspension.....	10	35	1.75

2¼-INCH SPRING WIRE HOLDERS

Single screw spring wire holders are made for use with porcelain and brass shell sockets and for 2¼-inch standard-heel reflectors only.

W30986	For brass shell sockets.....	100	7	.18
W30987	For porcelain sockets.....	100	7	.18

†Furnished with cover for Crouse-Hinds Condulets, series LO, CL, BO, BLM, DSO and DSP. Specify type of Condulet when ordering.

CUTTER SOL-LUX INDUSTRIAL LIGHTING REFLECTORS

With 2¼-inch and 3¼-inch Standard Heels

One of the principal advantages of standard-heel reflectors is that different types of reflectors with the same size of heel may be used with the same holder, which permits changes in light distribution without disturbing the wiring. Another advantage is that reflectors may be removed easily for cleaning. The 2¼-inch heel is supplied on reflectors for 200-watt lamps and smaller, and the 3¼-inch heel on reflectors for 300-watt lamps and larger. Standard-heel reflectors used with Cutter Holder-Sockets are recommended for conduit outlet box and reinforced drop-cord installations. Single screw spring wire holders may be used for attaching 2¼-inch standard-heel reflectors to brass-shell or porcelain sockets.

Standard 2¼-inch Heel
Showing Methods of Suspension

R L M STANDARD DOME TYPE

Porcelain Enamel, White Interior, Green Exterior

Trade No.	For Mazda Lamp Size	Diam. Inches	Depth. Inches	Std. Pkg.	Wt., Lbs. Std. Pkg.	Price Each
W326075	75	12⅛	5½	15	40	$1.55
W326150	100–150	14⅛	6½	15	50	1.85
W326200	200	16⅜	7¾	10	45	2.15
W336500	300–400–500	18⅛	7¾	5	25	3.00
W336000	750–1000	20¾	10¼	3	25	4.40

R L M Standard Dome Type

STANDARD BOWL TYPE

Porcelain Enamel, White Interior, Green Exterior

W327060	25–40–60	7½	5	50	50	.95
W327075	75	8½	6⅛	20	35	1.10
W327150	100–150	8½	7¼	20	35	1.15
W327200	200	10½	8⅜	20	35	1.70
W337500	300–400–500	12½	8⅜	10	30	2.35
W337000	750–1000	15¾	11⅞	5	35	3.35

Enam-aluminum Interior, Green Baked Paint Exterior

W227060	25–40–60	7½	5	50	50	.70
W227075	75	8½	6⅛	40	50	.85
W227150	100–150	8½	7	30	50	.87
W227200	200	10½	8⅜	15	30	1.30

Standard Bowl Type

STANDARD ANGLE TYPE

Porcelain Enamel, White Interior, Green Exterior

W324040	25–40	6¾	5½	50	40	1.15
W324060	60	8¼	6¾	30	40	1.30
W324200	75–100–150–200	10½	9	20	40	1.95
W334500	300–400–500	12½	11½	5	20	3.55
W334000	750–1000	15¼	15½	3	30	5.25

Enam-aluminum Interior, Green Baked Paint Exterior

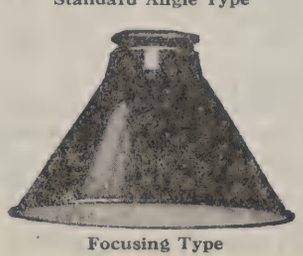
W224040	25–40–50	6¾	5½	50	40	.47
W224060	60	8¼	6¾	40	40	.70
W224150	75–100–150–200	10½	9	20	35	1.20

Standard Angle Type

FOCUSING TYPE

Enam-aluminum Interior, Green Baked Paint Exterior

W225040	25–40	6¾	4⅜	50	40	.47
W225060	60	8¼	5	50	40	.70
W225150	75–100–150	10	7¼	20	35	1.10



Focusing Type

CUTTER SOL-LUX INDUSTRIAL LIGHTING REFLECTORS

With Snap-Ring Holders for Brass-Shell Sockets

SCHEDULE "H"

And with Single-Screw Spring Wire Holders for Porcelain Sockets

The snap-ring holder forms an easy and dependable method of attaching reflectors to brass-shell sockets. When attaching the snap-ring holder to the socket, the socket shell is placed over the reflector at an angle. The snap-ring is expanded to let the bead of the socket shell slip into the groove in the snap-ring, and the tension holds the reflector firmly in place. The snap-ring holder is substantial in construction and positive in operation. Reflectors are furnished with the clamp strap shown in the accompanying illustration.

Reflectors for porcelain sockets consist of reflectors with standard 2¼-inch heels as listed on the preceding page, with single screw spring wire holder which may be quickly attached to the socket and the reflector when it is being installed.

R L M Standard Dome Type

Snap Ring Holder with Clamp Strap for Brass Shell Socket

2¼-inch Standard Heel with Spring Wire Holder for Porcelain Socket

Standard Bowl Type

Standard Angle Type

Focusing Type

R L M STANDARD DOME TYPE

Porcelain Enamel, White Interior, Green Exterior

Trade Numbers For Brass Shell Socket	For Porcelain Socket	For Mazda Lamp Size	Diam. In.	Dpth. In.	Std. Pkg.	Wt., Lbs. Std. Pkg.	Price, Each For Brass Shell Socket	Price, Each For Porcelain Socket
W 316075	W 366075	75	12⅛	5⅞	15	40	$1.65	$1.73
W 316150	W 366150	100-150	14⅛	6⅞	15	40	1.95	2.03
W 316200	W 366200	200	16⅜	8⅛	10	45	2.25	2.33

STANDARD BOWL TYPE

Porcelain Enamel, White Interior, Green Exterior

W 317060	W 367060	25-40-60	7½	5⅜	50	50	1.05	1.13
W 317075	W 367075	75	8½	6½	20	35	1.20	1.28
W 317150	W 367150	100-150	8½	7⅜	20	35	1.25	1.33
W 317200	W 367200	200	10½	8¼	20	35	1.80	1.88

Enam-aluminum Interior, Green Baked Paint Exterior

W 211060	W 267060	25-40-60	7¼	5⅜	50	40	.80	.88
W 211075	W 267075	75	8¼	6⅜	20	35	.95	.93
W 211150	W 267150	100-150	8¼	7⅜	20	35	.97	1.05
W 211200	W 267200	200	10½	8¼	20	35	1.40	1.48

STANDARD ANGLE TYPE

Porcelain Enamel, White Interior, Green Exterior

W 314040	W 364040	25-40	6⅜	5⅞	50	40	1.25	1.33
W 314060	W 364060	40-60	8¼	7⅛	30	40	1.40	1.48
W 314200	W 364200	75-100-150-200	10½	9¾	20	40	2.12	2.20

Enam-aluminum Interior, Green Baked Paint Exterior

W 214040	W 264040	25-40	6⅝	5⅞	50	40	.57	.65
W 214060	W 264060	40-60	8	6⅛	40	40	.80	.88
W 214200	W 264200	75-100-150-200	10	9⅛	20	35	1.37	1.45

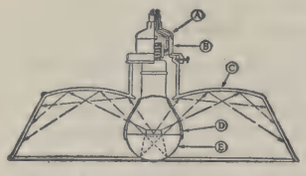
FOCUSING TYPE

Enam-aluminum Interior, Green Baked Paint Exterior

W 215040	W 265040	25-40	6⅝	4½	50	35	.57	.65
W 215060	W 265060	60	8	5⅛	40	40	.80	.88
W 215150	W 265150	75-100-150	10	7⅜	20	35	1.20	1.28

REFLECTO-CAP-DIFFUSERS

SCHEDULE H



Cross-Section of Reflecto-Cap-Diffuser
A, ½-inch Cap; B, Holder-Socket; C, Porcelain Enameled Reflector; D, Wire Spring Holder for Cap; E, Cap Silver-Plated on Inside.

Parts of Reflecto-Cap-Diffuser, Showing Reflector, Holder-Socket and Silver-Plated Cap

Reflecto-Cap-Diffuser Assembled

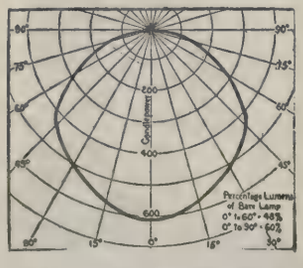


Diagram Showing Distribution of Light from the Reflecto-Cap-Diffuser

The Reflecto-Cap-Diffuser consists of a steel reflector (finished with green porcelain-enamel on the outside, and white porcelain-enamel on the inside), and a silver-plated cap, highly polished on the inside, and provided with a wire holder for attaching it to the bulb of ■ Mazda "C" Lamp.

Direct glare is eliminated by the Reflecto-Cap-Diffuser by means of the silver-plated cap which covers the lower part of the bulb of the lamp. This cap conceals the filament and directs the rays of light to the large reflector above. The light is distributed evenly over the entire surface of the reflector, so that it is possible to view the unit from any direction without discomfort to the eyes. The size and shape of the reflector has been scientifically determined to give a thorough diffusion of light, and thus eliminate reflected glare from shiny objects in the working plane. The net result of illumination with this system is that the eyes can perform their tasks at all times without any discomfort, because all objects are evenly and softly illuminated.

Cutter "Sol-lux" bowl and dome types of reflectors are suitable for widespread use in mills and factories, and the Reflecto-Cap-Diffuser is not intended to supplant them for general factory lighting. But where illumination of high intensity is required for detailed and accurate workmanship, or where materials with polished or oily surfaces offer special danger from reflected glare, the Reflecto-Cap-Diffuser should be installed. The units should be spaced not to exceed one and two-thirds times their height from the working plane.

REFLECTO-CAP-DIFFUSERS

	No.	Description	Dimen., In. Diam.	Dimen., In. Depth	Packing No. in St.Pk.	Packing Apx. Lbs. Shp.Wt.	List Price Each
		Complete Unit: Reflector, Holder-Socket, Metal Cap with Spring Wire	17	8¾	10	50	$5.10
For 75-watt Mazda C Lamps	W 30647	Enameled Steel Reflector	17	5¾	10	30	2.90
	W 30650	Holder-Socket	2¼ Fitter	3⅝	20	20	1.25
	W 30648	Lamp Cap with Spring Wire Holder	2¾	1 5/16	80	....	.95
		Complete Unit: Reflector, Holder-Socket, Metal Cap with Spring Wire	17	9¼	10	55	5.60
For 100-watt Mazda C Lamps	W 30647	Enameled Steel Reflector	17	5¾	10	30	2.90
	W 30657	Holder-Socket	2¼ Fitter	4⅛	20	30	1.70
	W 30661	Lamp Cap with Spring Wire Holder	3⅛	1½	80	....	1.00
		Complete Unit: Reflector, Holder-Socket, Metal Cap with Spring Wire	21	9¼	4	45	7.10
For 150-watt Mazda C Lamps	W 30660	Enameled Steel Reflector	21	6⅜	4	35	4.50
	W 30659	Holder-Socket	3¼ Fitter	3½	20	30	1.60
	W 30661	Lamp Cap with Spring Wire Holder	3⅛	1½	80	....	1.00
		Complete Unit: Reflector, Holder-Socket, Metal Cap with Spring Wire	21	10	4	45	7.20
For 200-watt Mazda C Lamps	W 30660	Enameled Steel Reflector	21	6⅜	4	35	4.50
	W 30663	Holder-Socket	3¼ Fitter	4¼	20	30	1.60
	W 30664	Lamp Cap with Spring Wire Holder	3¾	1¾	80	....	1.10
		Complete Unit: Reflector, Holder-Socket, Metal Cap with Spring Wire	21	11⅞	4	50	7.90
For 300-watt Mazda C Lamps	W30660	Enameled Steel Reflector	21	6⅜	4	35	4.50
	W 30666	Holder-Socket	3¼ Fitter	6⅛	20	45	2.00
	W 30667	Lamp Cap with Spring Wire Holder	4⅜	2 1/16	80	....	1.40

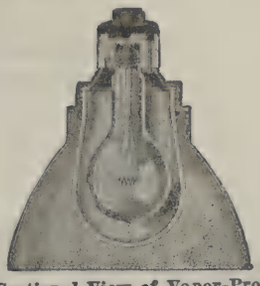
CUTTER SOL-LUX VAPOR PROOF FIXTURES

SCHEDULE "H"

With Easy-to-Wire Holder Sockets Approved Constructions

Vapor-Proof Fixture with Ball Globe

Vapor-Proof Fixture with Pear Shape Globe and Guard



Sectional View of Vapor-Proof Fixture with Bowl Type Reflector and Pear Shape Globe

Vapor-Proof Fixture with Concentric Type Reflector and Pear Shape Globe

Vapor-Proof Fixture with Deep Dome Type Reflector and Ball Globe

Sol-lux Vapor proof fixtures are safety first units of the highest class. They are designed for use in plants where explosive gases and dust accumulating in the standard types of industrial lighting fixtures would cause explosions and fires and where moisture and smoke fumes would hasten corrosion of exposed metal parts.

Each fixture uses the well-known Cutter Holder Socket, approved by the National Board of Underwriters. This socket is easy to wire and is provided with lamp grips to insure perfect electrical connections and prevent the lamps from loosening when the fixture is subjected to vibration. The cap and globe holder are made of cast iron, heavily galvanized and painted. They will not corrode under the most severe service conditions. Special gaskets are used in all joints to make the fixtures tight. Fixtures may be used with or without lamp guards. Prices below include clear glass globe but not lamp or wiring.

With Globe Only

Trade Numbers: For ½" Pipe	Trade Numbers: For ¾" Pipe	Trade Numbers: With 4" Out. Box Cover†	Size of Reflec.	For Lamp Sizes	Diameter of Globe*	Std. Pkg.	Ship. Wt. Lbs., Each	Price Each
W 30774	W 30788	W 30910	.....	25–40–60	5" Ball, Clear	10	15	$2.50
W 30775	W 30789	W 30911	.....	75–100–150	5" Ball, Clear	10	20	3.00
W 30776	W 30790	W 30912	.....	200	5x6" Pear, Clear	5	25	3.50
W 30777	W 30791	W 30913	.....	300–400–500	8" Ball, Clear	3	30	4.85
				With Deep Dome Reflector				
W 30778	W 30792	W 30914	12	75	5" Ball, Clear	10	25	4.90
W 30779	W 30793	W 30915	14	100–150	5" Ball, Clear	10	30	5.25
W 30780	W 30794	W 30916	16	200	5x6" Pear, Clear	5	35	6.00
W 30781	W 30795	W 30917	18	300–500	8" Ball, Clear	3	40	8.00
				With Bowl Reflector				
W 30782	W 30796	W 30918	10½	75–100	5" Ball, Clear	10	25	4.75
W 30783	W 30797	W 30919	10½	200	5x6" Pear, Clear	5	30	5.10
W 30784	W 30798	W 30920	15	300–500	8" Ball, Clear	3	35	7.10
				With Concentric Reflector				
W 30785	W 30799	W 30921	14"	75	5" Ball, Clear	10	30	4.25
W 30786	W 30800	W 30922	16"	100–150	5" Ball, Clear	10	35	5.35
W 30787	W 30909	W 30923	18"	200	5x6" Pear, Clear	5	40	6.50

LAMP GUARDS—HEAVILY TINNED

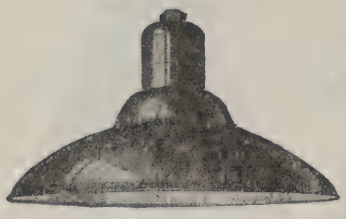
Trade No.	Diam.	Depth	For Fixture Nos.	Price Each
W 30924	5½	5	30774, 5, 8, 9, 82, 5, 6, 8, 9, 92, 3, 6, 99, 800, 910, 1, 4, 5, 8, 21, 22	$1.00
W 30925	6½	7	30776, 80, 3, 7, 90, 4, 7, 909, 12, 6, 9, 23	1.25
W 30926	8½	8	30777, 81, 4, 91, 5, 8, 30913, 7, 20	1.75

*Extra globes will be furnished at the following list prices: No. 30764, 5-inch Ball, Clear, $1.00; No. 30763, 5-inch Ball, Ruby, $2.00; No. 30765, 5-inch x 6-inch Pear, Clear, $2.00; No. 30766, 8-inch Ball, Clear, $3.00.

†These fixtures will be furnished when so specified (without additional charge) for Crouse-Hinds Condulets, Series LO, CL, BO, BLM, DSO, and DESP. Specify type of Condulet when ordering.

CUTTER SOL-LUX INDUSTRIAL LIGHTING EQUIPMENT—SCHEDULE "H"

Reflectors—Sol-lux Fixtures—Lamp Accessories—Suspensions



Holder-Socket-Reflectors—Shallow

Holder-Socket-Reflector—Concentric Type

Sol-lux Fixtures

Sol-lux Glass Lamp Cap

Pole Plate

Corner Plate

½-inch x 4 foot Gooseneck with Grooved Pole Plates

½-inch x 4-foot Gooseneck with Wall Flange

HOLDER-SOCKET-REFLECTORS—ONE-PIECE

Shallow Dome Type, Porcelain Enamel

Trade Numbers For ½-in. Cond.	For ¾-in. Cond.	For Mazda Lamp Size	Diam. Inches	Depth Inches	Std. Pkg.	Wt., Lb. St.Pk.	Price Each
W 30691	W 30770	25–60	12¼	3¾	20	60	$2.60
W 30692	W 30771	75–150	15¼	5½	15	70	2.90

Concentric Type—Porcelain Enamel

W 30688	W 30767	25–75	14	2⅜	20	65	2.70
W 30689	W 30768	100–150	16	3⅜	15	75	3.05
W 30690	W 30769	200	18	3⅜	10	70	3.50

SHALLOW DOME REFLECTORS

Trade No.	For Mazda Lamp Size	Diam. Inches	Depth Inches	Std. Pkg.	Wt., Lbs. Std.Pkg.	Price Each
W 323040	25–40–50	10¼	3⅞	30	55	$0.95
W 323060	40–60	12¼	4¼	20	45	1.05
W 323075	75	12¼	5	20	45	1.35
W 323150	100–150–200	15¼	6½	5	60	2.00

Baked Paint Enamel, with Snap-Ring Holder for Brass-Shell Sockets

With Single Screw Spring Wire Holder for Porcelain Sockets

For Brass Shell Socket	For Porcelain Socket	For Mazda Lamp Size	Diam. In.	Depth In.	St. Pk.	Lbs. St. Pk.	For Brass Shell Skt.	For Porcelain Skt.
W 113020	W 163020	20	8	3⅛	40	50	$0.65	$0.73
W 113040	W 163040	25–40–50	10¼	3⅞	20	40	.70	.78
W 113060	W 163060	40–60	12¼	4¼	20	35	.85	.93
W 113075	W 163075	75	12¼	5	15	35	.90	.98
W 113150	W 163150	100–150–200	15¼	6⅛	10	35	1.20	1.28

SOL-LUX GLASS LAMP CAPS WITH SPRINGS

For Brass Shell Socket	For Mazda Lamp Size	Std. Pkg.	For Porcelain Socket
W 30695	75	48	$0.65
W 30696	100–150	48	.70
W 30697	200	48	.75
W 30698	300	36	.90
W 30699	400–500	36	1.00

SOL-LUX FIXTURES WITH GLASSWARE

Porcelain Enameled-Steel—For ½-Inch Conduit

Trade No.		St.Pk.	Weight Lb.,Ea.	Price Each
W 30452	6" Holder. 10" Acorn Globe Medium Sc. Socket	12	13	$5.45
W 30453	6" Holder, 10" Stalactite Med. Sc. Socket	12	12	4.70
W 30456	8" Holder, 12" Acorn Globe, Mogul Sc. Socket	12	17	7.15
W 30518	6"x15" Reflec., Porc. En. extra		7	1.25
W 30519	8"x18" Reflec., Porc. En. extra		8	2.00

GOOSENECKS AND FITTINGS

Trade No.		St.Pk.	Weight Lb.,Ea.	Price Each
W 21365	3-ft. Gooseneck of ½-in. pipe, paint enameled	200	2⅞	$0.50
W 21366	4-ft. Gooseneck of ½-in. pipe, paint enameled	150	3⅛	.65
W 21443	4-ft. Gooseneck of ¾-in. pipe, paint enameled	150	4¾	.90
W 21487	Grooved Poleplates for ½-inch pipe, paint enameled	125	1¼	.30
W 21438	Grooved Poleplate for ¾-inch pipe, paint enameled	400	2¼	.40
W 21488	Wall Flange, threaded for ½" pipe, paint enameled	400	1	.20
W 21489	Same, to slip over ½-inch pipe, paint enameled	500	1	.30
W 21490	Wall Flange threaded for ¾" pipe, paint enameled	500	2	.30
W 21491	Same, to slip over ¾-inch pipe, paint enameled	400	2	.40
W 21492	Corner Plate for ½-inch pipe, paint enameled	400	2½	.70
W 21493	Same, for ¾-inch pipe, paint enameled	300	2½	.80

CUTTER "SOL-LUX" BRACKET FIXTURES

Standard Bracket With "Sol-Lux" Holder and Diffusing Ball Globe

Spartan Junior Bracket With "Sol-Lux" Holder Reflector and Stalactite

Wall Bracket With "Sol-Lux" Holder and Diffusing Ball Globe

Entrance Bracket With "Sol-Lux" Holder, Reflector and Acorn Diffusing Globe

FOR MAZDA "C" LAMPS

SCHEDULE H

For 200-watt or smaller Mazda "C" lamps 6x10-inch diffusing ball or acorn globes or 6x8-inch diffusing stalactites are recommended; for 300-watt and larger lamps 8x12-inch diffusing ball or acorn globes are recommended. Fixtures listed below are furnished with "Sol-lux" porcelain-enameled-steel holders with lamp-grip sockets but are not wired.

For 6x15-inch porcelain-enameled-steel reflector, No. 30518, add $1.25 list; for 8x18-inch porcelain-enameled-steel reflector, No. 30518, add $2.00 list.

For sign on globe, add $1.50 list for less than 20 letters; add $3.00 list for 20 to 40 letters.

STANDARD BRACKETS WITH "SOL-LUX" HOLDERS

A simple form of bracket suspension, consisting of a 3-foot gooseneck of ½-inch pipe, with grooved wall-plate for inner wiring.

	Ship. Wt., Lbs. Ea.	Med. Sc. Skt. Trade No.	Med. Sc. Skt. Price Each	Mogul Sc. Skt. Trade No.	Mogul Sc. Skt. Price Each
With 6-in. holder only.....	10	*W*31001	$3.40	*W*31002	$3.60
With 8-in. holder only.....	11	*W*31003	3.60	*W*31004	3.80
With 6x10-in. ball globe..	17	*W*31005	5.40	*W*31006	5.60
With 6x10-in. acorn globe	17	*W*31007	6.15	*W*31008	6.35
With 6x8-in. stalactite.....	16	*W*31009	5.40	*W*31010	5.60
With 8x12-in. ball globe..	19	*W*31011	6.85	*W*31012	7.05
With 8x12-in. acorn globe	19	*W*31013	7.85	*W*31014	8.05

For galvanized bracket, add 30 cents list.

SPARTAN JUNIOR BRACKETS WITH "SOL-LUX" HOLDERS

An artistic and substantial bracket made of ½-inch pipe, with wrought iron scroll and grooved wall-plate for inner wiring; holds the lamp 3 feet from wall.

With 6-in. holder only.....	18	*W*31015	5.00	*W*31016	5.20
With 8-in. holder only.....	19	*W*31017	5.20	*W*31018	5.40
With 6x10-in. ball globe..	25	*W*31019	7.00	*W*31020	7.20
With 6x10-in. acorn globe	25	*W*31021	7.75	*W*31022	7.95
With 6x8-in. stalactite.....	24	*W*31023	7.00	*W*41024	7.20
With 8x12-in. ball globe....	27	*W*31025	8.45	*W*31026	8.65
With 8x12-in. acorn globe	27	*W*31027	7.45	*W*31028	9.65

For galvanized bracket, add 70 cents list.

WALL BRACKETS WITH "SOL-LUX" HOLDERS

Consists of a 4-foot gooseneck of ½-inch pipe with wall-flange; holds the lamp 3 feet from wall, leaving 1 foot of pipe to extend through the wall for interior wiring.

With 6-in. holder only.....	11	*W*31029	3.80	*W*31030	4.00
With 8-in. holder only.....	12	*W*31031	4.00	*W*31032	4.20
With 6x10-in. ball globe..	18	*W*31033	5.80	*W*31034	6.00
With 6x10-in. acorn globe	18	*W*31035	6.55	*W*31036	6.75
With 6x8-in. stalactite.....	17	*W*31037	5.80	*W*31038	6.00
With 8x12-in. ball globe..	20	*W*31039	7.25	*W*31040	7.45
With 8x12-in. acorn globe	20	*W*31041	8.25	*W*31042	8.45

For galvanized bracket, add 40 cents list.

ENTRANCE BRACKETS WITH "SOL-LUX" HOLDERS

Consists of a 4-foot gooseneck of ¾-inch pipe, elbow and piece of ½-inch pipe at outer end; cast-iron scroll and wall-plate; holds the lamp 3 feet from wall.

With 6-in. holder only.....	28	*W*31043	6.25	*W*31044	6.45
With 8-in. holder only.....	29	*W*31045	6.45	*W*31046	6.65
With 6x10-in. ball globe..	35	*W*31047	8.25	*W*31048	8.45
With 6x10-in. acorn globe	35	*W*31049	9.00	*W*31050	9.20
With 6x8-in. stalactite.....	34	*W*31051	8.25	*W*31052	8.45
With 8x12-in. ball globe..	37	*W*31053	9.70	*W*31054	9.90
With 8x12-in. acorn globe	37	*W*31055	10.70	*W*31056	10.90

For galvanized bracket, add $1.00 list.

Cutter SOL-LUX Sign Lights

"Sol-lux" Sign Lights consist of "Sol-lux" Holders with painted diffusing ball globes. Prices include porcelain-enameled-steel holder. Add the price of the sign light selected to the price of the bracket selected to obtain the list price of the complete fixture.

Signs or emblems are painted on one side only; for painting on two sides, add $1.50 list; for prices for special lettering and for illustrations of brackets, refer to the previous page. Shipping weight of sign light, 19 pounds; standard package quantity, 12 sign lights.

Lunch-Room Sign Lights

Trade No.	Description	Price each
W31057	6-in. holder, 6x10-in. globe, med. sc. skt.	$6.20
W31058	6-in. holder, 6x10-in. globe, mog. sc. skt.	6.40
W31059	8-in. holder, 8x12-in. globe, med. sc. skt.	7.65
W31060	8-in. holder, 8x12-in. globe, mog. sc. skt.	7.85

Theatre Sign Lights

W31061	6-in. holder, 6x10-in. globe, med. sc. skt.	6.20
W31062	6-in. holder, 6x10-in. globe, mog. sc. skt.	6.40
W31063	8-in. holder, 8x12-in. globe, med. sc. skt.	7.65
W31064	8-in. holder, 8x12-in. globe, mog. sc. skt.	7.85

Shine-Parlor Sign Lights

W31065	6-in. holder, 6x12-in. globe, med. sc. skt.	6.20
W31066	6-in. holder, 6x10-in. globe, mog. sc. skt.	6.40
W31067	8-in. holder, 8x12-in. globe, med. sc. skt.	7.65
W31068	8-in. holder, 8x12-in. globe, mog. sc. skt.	7.85

Billiard Sign Lights

W31069	8-in. holder, 8x12-in. globe, med. sc. skt.	7.65
W31070	8-in. holder, 8x12-in. globe, mog. sc. skt.	7.85

Barber-Shop Sign Lights

W31071	8-in. holder, 8x12-in. globe, med. sc. skt.	9.15
W31072	8-in. holder, 8x12-in. globe, mog. sc. skt.	9.35

Masonic Sign Lights

W31073	8-in. holder, 8x12-in. globe, med. sc. skt.	9.15
W31074	8-in. holder, 8x12-in. globe, mog. sc. skt.	9.35

B. P. O. E. Sign Lights

W31075	8-in. holder, 8x12-in. globe, med. sc. skt.	9.15
W31076	8-in. holder, 8x12-in. globe, mog. sc. skt.	9.35

Knights of Columbus Sign Lights

W31077	8-in. holder, 8x12-in. globe, med. sc. skt.	9.15
W31078	8-in. holder, 8x12-in. globe, mog. sc. skt.	9.35

Standard Brackets

Consist of a 3-foot gooseneck of ½-inch pipe, with grooved wall-plate for inner wiring.

Trade No.	Description	Ship. Wt., lbs. each	Price each
W30627	Bracket only, painted	4	$0.70
W30628	Bracket only, electro-galvanized and painted	4	1.00

Wall Brackets

Consist of a 4-foot gooseneck of ½-inch pipe and wall plate: holds lamp three feet from wall, leaving one foot of pipe to extend through wall for interior wiring.

W30638	Bracket only, painted	5	1.10
W30639	Bracket only, electro-galvanized and painted	5	1.50

Spartan Junior Brackets

Made of ½-inch pipe, with wrought-iron scroll and grooved wall-plate; holds the lamp three feet from wall.

W30631	Bracket only, painted	12	2.30
W30632	Bracket only, electro-galvanized and painted	12	3.00

Entrance Brackets

Consist of a 4-foot gooseneck of ¾-inch pipe, elbow and piece of ½-inch pipe, with cast-iron scroll and wall-plate; holds the lamp three feet from wall.

W30642	Bracket only, painted	22	3.55
W30643	Bracket only, electro-galvanized and painted	22	4.55

SCHEDULE "H" DISCOUNTS

CUTTER AUTOMATIC CUT-OUT HANGERS AND REFLECTORS

Cutter Automatic Cut-Out Hanger with ½-inch Male Thread Fitting (Showing Pipe Suspension)

Showing Cable Suspension

Showing Ceiling Suspension

Midget Changeable Pulley

Cutter Automatic Cut-Out Hanger with Holder-Socket-Reflector (R L M Standard Dome Type)

Cutter Automatic Cut-Out Hanger with Holder-Socket-Reflector (Standard Angle Type)

SCHEDULE "H"
CUTTER AUTOMATIC CUT-OUT HANGER FOR MULTIPLE CIRCUITS, WITH UNIVERSAL SUSPENSION CLAMP

The efficiency of reflectors is greatly reduced if they are not kept clean. Reliable tests show that on the average, the loss of light amounts to nearly 50 per cent of that which is available when the reflectors are kept clean. Cutter Automatic Cut-Out Hangers facilitate cleaning reflectors without the use of ladders, thus saving much time and expense with absolute protection against accidental short circuits or contact with live wires. A pull on the rope disconnects the fixture from the circuit. It is then lowered to the floor for renewing lamps and cleaning. A pull on the rope raises the fixture to burning position where it is automatically locked in place and supported independently of the hoisting rope.

This hanger may be used with Angle type reflectors and other fixtures requiring a fixed location. The position of the lower switch is always the same with respect to the upper part of the pulley.

The Universal Suspension Clamp furnished with this device, may be used for fastening the hanger to ceiling or on cable, or on a pipe bracket of ¾-inch to 1¼-inch bore. With this hanger use Cutter Midget Changeable Pulley and $\frac{3}{16}$-inch or ¼-inch Weatherproof Cord, or ¼-inch galvanized Ebony wire rope. See schedule "F" list and discounts.

PRICE LIST—AUTOMATIC CUT-OUT HANGERS
Prices Do Not Include Wiring

Trade No.		Std. Pkg.	Ship. Wt., Ea.	Price Each
W30941	With ½" Male Thread Fitting	10	20	$5.25
W30942	With ¾" Male Thread Fitting	10	20	5.35
W30943	With Sister Hook below.....	10	20	5.55
W30944	With Med. Screw Holder Skt. for 2¼" Std. Heel Reflectors....	10	22	6.50
W30945	With Mogul Screw Holder Skt. for 3¼" Std. Heel Reflectors....	10	22	7.00

CUTTER AUTOMATIC CUT-OUT REFLECTORS

Fixtures listed below are combinations of Cutter Holder-Socket-Reflectors and Cut-Out Hanger No. 30941. These fixtures are complete ready to be installed and wired. Prices do not include lamps or wiring. Other combinations will be furnished when so ordered.

Trade No. Comp.	Consisting of Hanger No.	Reflec. No.	Size Lamp	Std. Pkg.	Ship. Wt. Std. Pkg.	Price Each
With R. L. M. Standard Dome Type Reflectors						
W30927	30941	30668	75	20	400	$7.95
W30928	30941	30669	100–150	10	200	8.15
W30929	30941	30670	200	10	200	8.85
W30930	30941	30671	300–500	5	125	9.65
W30931	30941	30672	750–1000	3	75	11.15
With Standard Bowl Type Reflectors						
W30932	30941	30674	75	20	400	7.60
W30933	30941	30675	100–150	10	200	7.65
W30934	30941	30676	200	10	200	8.15
W30935	30941	30677	300–500	5	125	8.85
W30936	30941	30678	750–1000	3	75	10.25
With Standard Angle Type Reflectors						
W30937	30941	30681	75–100–150–200	10	200	8.50
W30938	30941	30682	300–400–500	5	125	10.00
W30939	30941	30683	750–1000	3	75	11.65
With Concentric Type Reflectors						
W30940	30941	30688	25–75	20	400	8.00
With Shallow Dome Type Reflectors						
W30946	30941	30692	75–150	10	200	8.15

MIDGET CHANGEABLE PULLEY

A weatherproof pulley with a universal clamp which will grip any standard size of suspension wire or cable. By taking out the two bolts, the clamp can be opened out so as to form a plate, which fits the wall, ceiling, girder, or the curved surface of a pole. May be used with ¼-inch or smaller rope.

Trade No.	Description	Std. Pkg.	Wt., Lbs., Each	Price, Each
W20415	Midget Changeable Pulley	100	2½	$0.70

When ordered with standard packages of Hangers and Cut-Out Reflectors the same discounts will apply.

CUTTER FLOOD-LIGHTING PROJECTORS

ENGINEERING DATA

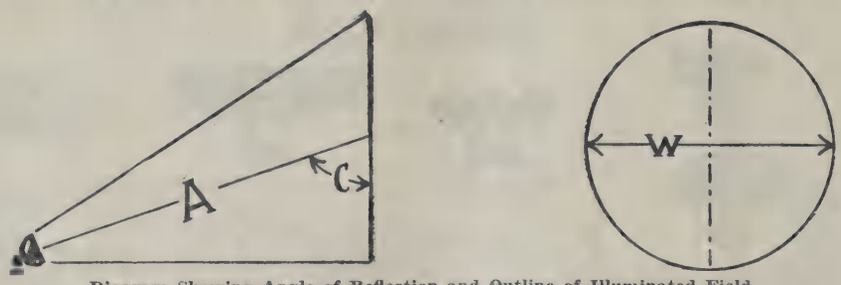


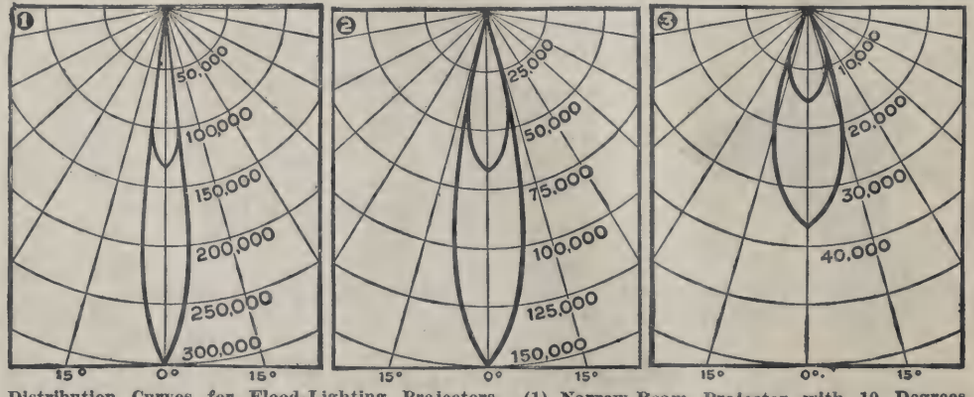
Diagram Showing Angle of Reflection and Outline of Illuminated Field

The data given below is approximate for all installations where the angle C of projection lies between 45 and 90 degrees. Although the illuminated field is elliptical in shape when the beam is directed upon it at an angle, the actual variation from a circle is comparatively small between these angles. As the majority of installations will approach such conditions, data covering smaller angles of projection has been omitted. Complicated layouts should be referred to our engineering department for recommendations.

For protective lighting, the area surrounding the buildings should be lighted to an intensity of one foot-candle or more. Wide-angle-beam projectors will generally fill the requirements better than narrow-beam.

In the tables below the values of A are assumed distances from the projecter to the illuminated field. In column W the diameter of the lighted area is given, and in the column headed "foot-candles" the intensities obtained at the assumed distances from both 400 and 1000-watt lamps are given.

10° SPREAD Narrow-Beam Projector					20° SPREAD Wide-Angle-Beam Projector				30° SPREAD Wide-Angle-Beam Projector				
			Foot-Candles				Foot-Candles				Foot-Candles		
A	W	Area	400 Watt Lamp	1000 Watt Lamp	W	Area	400 Watt Lamp	1000 Watt Lamp	W	Area	400 Watt Lamp	1000 Watt Lamp	A
25	4	13	160	400	9	64	50	200	13	132	19.2	64.1	25
50	9	64	40	100	18	254	20	50	27	572	4.8	16.0	50
75	13	132	18	45	26	530	9	22	40	1,256	2.1	7.2	75
100	18	254	10	25	35	860	5	12.5	54	2,290	1.2	4.0	100
125	23	415	6.4	16	44	1,520	3.2	8	67	3,500	.77	2.6	125
150	26	530	4.5	11	53	2,200	2.2	5.6	80	5,020	.53	1.8	150
175	31	755	3.3	8	62	3,020	1.6	4.1	94	6,940	.4	1.3	175
200	35	960	2.5	6.3	71	3,960	1.2	3.1	107	8.990	.3	1.0	200
225	39	1,193	2.0	5	79	4,900	1	2.5	121	11,480	.....	.8	225
250	44	1,520	1.6	4	88	6,080	.8	2.0	134	14,090	.....	.65	250
275	48	1,810	1.3	3.3	97	7,400	.67	1.7	147	16,960	.....	.53	275
300	52	2,200	1.1	2.8	106	8,820	.56	1.4	161	20,320	.....	.45	300
325	57	2,550	.95	2.4	115	10,370	.48	1.2	174	23,750	.....	.38	325
350	61	3,020	.82	2.1	123	11,870	.41	1.0	188	27,720	.....	.33	350
375	66	3,420	.71	1.8	132	13,680	.36	.9	202	31,700	.....	.3	375
400	70	3,960	.63	1.6	141	15,600	.31	.78	215	36,300	.....	.25	400
425	75	4,410	.55	1.4	150	17,650	.28	.70	228	40,800	.....	.....	425
450	79	4,900	.50	1.3	157	19,820	.25	.62	241	45,600	.....	.....	450
475	83	5,410	.45	1.1	167	21,880	.22	.55	255	51,000	.....	.....	475
500	88	6,080	.4	1.0	176	24,300	.2	.50	268	56,400	.....	.....	500



Distribution Curves for Flood-Lighting Projectors. (1) Narrow-Beam Projector with 10 Degrees Spread, the Smaller Curves for 400-watt and the Larger Curves for 1000-watt Lamps. (2) Wide-Angle-Beam Projector with 20-Degree Spread. (3) Wide-Angle-Beam Projector with 30-Degree Spread.

CUTTER FLOOD-LIGHTING PROJECTORS

"Universal" Projector with Steel Bow and Table Mounting, for 250 and 500-Watt Flood-lighting Lamps.

"Universal" with Steel Bow and Pipe Stand

"Standard" Projector with Steel Bow and Table Mounting, for 500 to 1000-Watt Standard Mazda "C" Lamps.

"Universal" and "Standard" Flood-Lighting Projectors may be adjusted for any mounting requirement. Narrow and wide-angle-beam reflectors may be used interchangeably in the same body. The reflectors are made of copper, heavily silver plated and finished with a coat of water and fume-proof lacquer. The narrow-beam reflector has a divergence of 10 degrees and the wide-angle-beam reflector a divergence of 30 degrees.

The mogul-base multiple socket in the "Universal" Projector is adjustable for focusing the lamp. In the "Standard" Projector, the mogul-base socket is adjustable vertically and horizontally to permit the use of 300, 400, 500, 750 and 1000-watt standard Mazda "C" lamps.

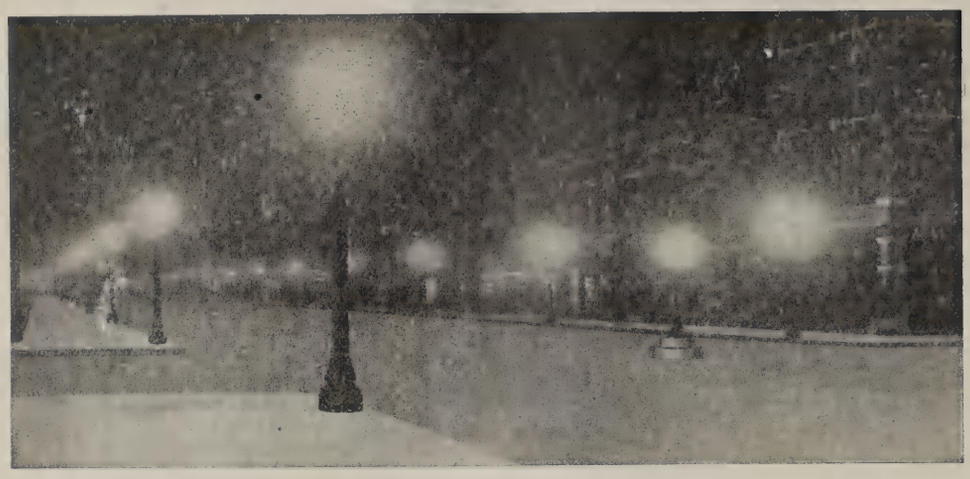
PRICE LIST AND SPECIFICATIONS

Key to Style Numbers—A, cast aluminum body for "Universal;" C, cast iron body for "Universal;" M, cast aluminum body for "Standard;" R, cast iron body for "Standard;" N, narrow-beam reflector; W, wide-angle reflector; S, pipe standard; B, steel bow and table.

Example—Style ANB is "Standard" Projector with aluminum body, narrow-beam reflector and steel bow with table.

"Universal" For 250 and 500 Watt Flood Light Lamps Trade No.	Style	"Standard" For 300-1000 Watt Mazda "C" Lamps Trade No.	Style	Description	Weight, Lbs. Net	Ship.	Price Each
W30700	ANB	W30731	MNB	Narrow-beam projector	46	81	$42.00
W30702	ANS	W30732	MNS	Narrow-beam projector	52	87	44.00
W30703	AWB	W30733	MWB	Wide-angle-beam projector	46	81	42.00
W30705	AWS	W30734	MWS	Wide-angle-beam projector	52	87	44.00
W30706	CNB	W30735	RNB	Narrow-beam projector	70	105	32.00
W30708	CNS	W30736	RNS	Narrow-beam projector	76	111	34.00
W30709	CWB	W30737	RWB	Wide-angle-beam projector	70	105	32.00
W30711	CWS	W30738	RWS	Wide-angle-beam projector	76	111	34.00
W30714	AN	W30741	MN	Body only, with narrow-beam reflector	26	50	38.00
W30715	AW	W30742	MW	Body only, with wide-angle-beam reflector	25	50	38.00
W30716	CN	W30743	RN	Body only, with narrow-beam reflector	60	74	28.00
W30717	CW	W30744	RW	Body only, with wide-angle-beam reflector	49	74	28.00
W30712	.....	W30739	.....	Narrow-beam reflector only	3	5	7.50
W30713	.....	W30740	.....	Wide-angle-beam reflector only	2	5	7.50
W30718	Steel bow for any style body				6	8	1.00
W30719	Table with bolts and nuts for any style body				11	15	5.00
W30721	Three-foot by 1¼-inch pipe stand with table and flange for connecting to bow				17	20	5.00
W30722	Floor stand only, for 1¼-inch pipe				11	15	3.75
W30723	Bow flange only, for 1¼-inch pipe				2	4	.50
W30724	Brass padlock with two keys				1	1	1.00
W30746	Cap with bow No. 30718 for mounting any style body on Cutter ornamental posts (with shank at top 3½ inches in diameter and 5 inches high) or on standard 3-inch pipe				9	11	2.00

ORNAMENTAL STREET-LIGHTING SYSTEMS WITH CUTTER POSTS AND BRACKETS



Ornamental street lighting is the paramount attainment in city beautification. It expresses art and economy, progress and morality, safety and comfort as the prime issues of a city or town government. An installation of ornamental standards accomplishes an aesthetic purpose as well as a practical one. It encourages civic betterment and stimulates business activity. Streets are kept cleaner and building fronts are made more attractive because of their pleasing appearance by day. By night, adequate illumination is afforded by clusters of soft lights or single units of high candle power lamps enclosed in globes of diffusing glass.

The selection of artistic standards is the most important consideration in the plan of an ornamental lighting system. The posts should harmonize with their surroundings, should be sturdy in construction and easy to install. Cutter Posts are made by pioneers in the field of outdoor electric lighting. Over a quarter of a century has been devoted to the design and manufacture of electrical lighting fixtures. Cutter Posts are artistic and original in design. They are made of best quality grey iron, the recognized standard material for ornamental posts. They are made from metal patterns, thus insuring clean castings with ornaments true to design. There are many designs to select from, so that one can be found exactly suited to any individual requirement.

Until recently, the single-light standard has been used almost exclusively in the residential portions of cities, for park and boulevard lighting and for entrances to private grounds and public buildings. The development of the high efficiency incandescent units of high candle power has made it possible to install single-light posts in business districts, so spaced that the illumination is adequate for all purposes, and the cost of installation and maintenance reduced to a minimum.

These new lamps are more efficient in the 15 or 20-ampere class. As it is not practical usually to supply power to the lamps at these values, compensators are mounted in the tops of the posts to take power from a 6.6 or 7.5-ampere line and deliver it to the lamps at 15 or 20 amperes.

Operating these lamps on a series circuit of high potential necessitates the use of a pot-head in the base of the post. This is described on a following page. This device also makes clusters of series lamps economical and safe, whereas in the past, multiple lamps have been used generally for cluster lighting.

The popular designs of Cutter Posts are listed on the following pages. Post parts are listed separately to facilitate selecting special combinations other than those listed complete. Special designs and drawings, showing many pleasing combinations will be submitted upon request. Our Engineering Service Department plans complete systems and furnishes expert advice when request is made.

Unless otherwise ordered, all Cutter Posts, Newels and Brackets will be furnished in black finish.

CUTTER ORNAMENTAL POSTS

SCHEDULE I—STANDARD PACKAGE QUANTITY, 20 OF ONE STYLE

Arcadian, with Sol-lux Senior Top

Arcadian, with Extension Capitol and Octagonal Senior Top

Arcadian, with Octagonal Senior Top

The Arcadian post has a 20-inch octagonal base. The height from ground to bottom of globe without extension capitol is 12 feet. The extension capitol adds 6 inches to the height. The height from ground to center of light source is 12 ft. 8 in. without extension capitol and 13 ft. 2 in. with extension capitol.

Prices cover posts with Sol-lux Senior and Octagonal Senior tops. Prices do not include lamps, wiring or foundation bolts. Use four ¾-inch foundation bolts, or ⅝-inch expansion bolts.

Description	With Sol-lux Top — Trade No.	Ship. Wt., Lbs.	Price Each	With Octagonal Top — Trade No.	Ship Wt., Lbs.	Price Each
With regent film socket for straight series lamp..	W 24196	425	$69.00	W 24212	430	$70.00
Same, with extension capitol	W 24197	440	74.00	W 24213	445	75.00
With mogul screw multiple socket for 300 to 1000-watt lamps	W 24198	425	68.00	W 24214	430	69.00
Same, with extension capitol	W 24199	440	73.00	W 24215	445	74.00
With extension capitol, mogul socket and compensator* for 400 C. P. 15-amp. lamps	W 24200	447	83.00	W 24216	452	84.00
Same, for 600 C. P., 20-amp. lamps	W 24201	449	84.00	W 24217	454	85.00
Same, for 1000 C. P., 20-amp. lamps	W 24202	454	86.00	W 24218	459	87.00

Egyptian Senior globes, metal frames and ventilators will be substituted for Octagonal Senior globes, metal trimmings and ventilators when so ordered, without additional charge. See another page for prices of post tops and parts to make other combinations.

*Compensator coils and reactance coils are designed for use on 60-cycle circuits only. Price of posts with coils for operation on 25-cycle circuits will be furnished on application. Compensator coils have taps for either 6.6 or 7.5-ampere primary circuit.

CUTTER ORNAMENTAL POSTS

SCHEDULE I—STANDARD PACKAGE QUANTITY, 20 OF ONE STYLE

Suburban, with Sol-lux Junior Top

Suburban, with Extension Capitol and Sol-lux Junior Top

Suburban, with Octagonal Junior Top

The Suburban post has a 16-inch octagonal base. The height from ground to bottom of globe without extension capitol is 10 feet. The extension capitol adds 6 inches to the height. The height from ground to center of light source is 10 ft. 6 inches without extension capitol and 11 ft. with extension capitol.

Prices cover posts with Sol-lux Junior and Octagonal Junior tops. Prices do not include lamps, wiring or foundation bolts. Use four ¾-inch foundation bolts or ⅝-inch expansion bolts.

Description	With Sol-lux Top — Trade No.	Ship. Wt., Lbs.	Price Each	With Octagonal Top — Trade No.	Ship Wt., Lbs.	Price Each
With Regent film socksts for straight series lamps	W 24203	270	$52.00	W 24219	273	$53.00
Same, with extension capitol	W 24204	285	57.00	W 24220	278	58.00
With medium screw multiple socket for 200-watt or smaller lamps	W 24205	270	50.70	W 24221	273	51.70
Same, with extension capitol	W 24206	285	55.70	W 24222	278	56.70
With mogul screw multiple socket for 300 to 500-watt lamps	W 24207	270	51.00	W 24223	273	52.00
Same, with extension capitol	W 24208	285	56.00	W 24224	278	57.00
With extension capitol, mogul screw socket and reactance coil* for 100 c. p. 6.6-amp. lamps	W 24209	273	64.10	W 24225	278	65.10
Same, with reactance coil for 250 c.p. 6.6-amp. lps	W 24210	275	65.50	W 24226	280	66.50
Same, with compensator for 400 c.p. 15-amp. lamps	W 24211	277	66.00	W 24227	282	67.00

Egyptian Junior globes, metal frames and ventilators will be substituted for Octagonal Junior globes, metal trimmings and ventilators when so ordered without additional charge.

*Compensator coils and reactance coils are designed for use on 60-cycle circuits only. Price for posts with coils for operation on 25-cycle circuits will be furnished on application.

CUTTER ORNAMENTAL POSTS

SCHEDULE I—STANDARD PACKAGE QUANTITY, 20 OF ONE STYLE

SINGLE-LIGHT POSTS FOR MAZDA C HIGH EFFICIENCY LAMPS

Continental, with Sol-lux Senior Top

Colony, with Egyptian Junior Top

Colony, with Sol-lux Junior Top

Dimensions

	Continental	Continental Medium	Colony
Base, diameter	20 inches	18 inches	16 inches
Base, height	31 inches	28 inches	21 inches
Column, diameter above base	7½ inches	7 inches	5¾ inches
Column, diameter near top	5¾ inches	5 inches	3¾ inches
Height to top of column	11 ft., 4 in.	10 ft., 4 in.	8 ft., 10 in.
Height to light center	13 ft., 3 in.	12 ft., 3 in.	10 ft., 6 in.
Number and size of foundation bolts	Four ⅞ or 1"	Four ¾"	Three ¾"

Prices below do not include lamps, compensators, wiring or foundation bolts.

Description	With Sol-lux Top: Trade No.	Wt., Lbs. Each	Price Each	With Egyptian Top: Trade No.	Wt., Lbs. Each	Price Each
Continental, Senior top, mogul multiple socket	W22262	575	$75.80	W22269	565	$77.30
Same, with Regent film series socket	W22263	576	76.80	W22270	566	78.30
Cont. Med., Sr. top, mogul mult. socket	W22264	495	74.00	W22271	485	75.50
Same, with Regent film series socket	W22265	496	75.00	W22272	486	76.50
Colony, Jr. top, med. screw mult. socket	W22266	309	47.70	W22273	294	49.90
Same, with mogul multiple socket	W22267	309	48.00	W22274	294	50.20
Same, with Regent film series socket	W22268	310	49.00	W22275	295	51.20

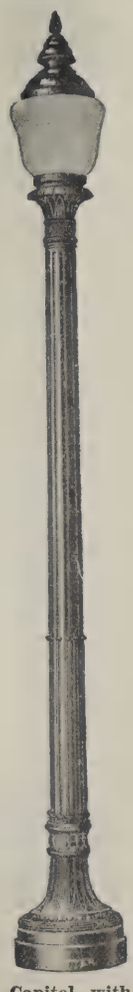
*Includes casing No. 22171; if reactance coils or compensators are used order Egyptian Junior casing No. 22118. Add $1.20 list and price of coil selected.

CUTTER ORNAMENTAL POSTS

SCHEDULE I—STANDARD PACKAGE QUANTITY, 20 OF ONE STYLE

SINGLE-LIGHT POSTS FOR MAZDA C HIGH EFFICIENCY LAMPS

Capitol, with Egyptian Senior Top



Capitol, with Sol-lux Senior Top

Capitol, with Octagonal Senior Top

The Capitol post is a standard of highly artistic design and is made in two heights. One has a base 20 inches in diameter, 2 feet 5 inches high. The height to top of columns is 12 ft. 4 in.; height to light center, 14 ft. 1 in. The shorter post has a base 18 inches in diameter, 2 ft. 5 in. high. The height to top of column is 9 ft. 10 in.; to light center, 11 ft. 7 in. In both posts the diameter of the column is 7½ inches above the base, tapering to 6 in. diameter near the top. Use four ⅞-inch or 1-inch foundation bolts or ⅝-inch expansion bolts.

Prices below cover posts complete with Cutter Ornamental Tops, Egyptian casing and sockets but not the lamps, compensators, wiring or foundation bolts. See another page for prices of parts to make other combinations.

Description	12-ft. 4-in. Capitol Trade No.	Wt.,Lbs. Each	Price Each	9-ft. 10-in. Capitol Trade No.	Wt.,Lbs. Each	Price Each
With Egypt. Sr. top, mogul screw multiple socket	W22276	550	$76.00	W22282	495	$73.00
Same with Regent film series socket	W22277	551	77.00	W22283	496	74.00
With Sol-lux Sr. top, mogul screw mult. socket	W22278	550	75.00	W22284	495	72.00
Same, with Regent film series socket	W22279	551	76.00	W22285	496	73.00
With octagonal Sr. top, mogul screw mult. socket	W22280	555	76.00	W22286	500	73.00
Same, with Regent film series socket	W22281	556	77.00	W22287	501	74.00

CUTTER ORNAMENTAL POSTS

SCHEDULE I—STANDARD PACKAGE QUANTITY, 20 OF ONE STYLE

SINGLE-LIGHT POSTS FOR MAZDA C HIGH EFFICIENCY LAMPS

Broadway, with Egyptian Senior Top

Broadway, with Sol-lux Senior Top

Broadway, with Octagonal Senior Top

The Broadway post is a massive standard of plain but artistic design. It is especially adapted to white way lighting in large cities. Base, 20 inches in diameter, 2 ft., 8 in. high. Column, 7½ in. diameter above the base, tapering to 6⅛ in. diameter near the top. Height to top of column, 12 ft. 3 in.; to light center, 14 ft.

The Plaza post is of the same design and dimensions as the Broadway, except as to height. It is designed for white way lighting in the average city or town. Height to top of column, 10 ft. 4 in.; to light center, 12 ft. 1 in.

Prices below cover posts complete with ornamental tops and sockets but not the lamps, compensators, wiring or foundation bolts. See another page for prices of parts to make other combinations. With either post, use four 1-inch foundation bolts or ⅝-inch expansion bolts.

Description	Broadway Trade No.	Broadway Wt., Lbs. Each	Broadway Price Each	Plaza Trade No.	Plaza Wt., Lbs. Each	Plaza Price Each
With Egyptian Sr. top, mogul multiple socket	W 22288	575	$76.80	W 22294	505	$71.80
Same, with Regent film series socket	W 22289	575	77.80	W 22295	506	72.80
With Sol-lux Sr. top, mogul multiple socket	W 22290	585	75.30	W 22296	515	70.30
Same, with Regent film series socket	W 22291	586	76.30	W 22297	516	71.30
With Octagonal Sr. top, mogul multiple socket	W 22292	590	76.30	W 22298	520	70.30
Same, with Regent film series socket	W 22293	591	76.30	W 22299	521	71.30

CUTTER ORNAMENTAL POSTS

SCHEDULE I—STANDARD PACKAGE QUANTITY, 20 OF ONE STYLE

SINGLE-LIGHT STANDARD FOR MAZDA C HIGH EFFICIENCY LAMPS

Park View, with Sol-lux Junior Top

Park View, with Egyptian Junior Top

Villa, with 16-inch Ball Globe

The Park View post is designed especially for lighting parks, boulevards and entrances to public buildings. Base, 16 in. in diameter, 17 in. high. Column, 5½ in. in diameter above the base, tapering to 3½ inches near the top. Height to top of column, 9 ft. 5 in.; to light center, 10 ft. 9 in. Use three ¾-inch foundation bolts or ⅝-inch expansion bolts.

The Villa post has a base 17 in. in diameter, 18 in. high. Column, 5 in. in diameter above the base, tapering to 2⅞ in. near the top. Height to top of column, 9 ft. 4 in.; to light center, 10 ft. 8 in. Use three ¾-inch foundation bolts or ⅝-inch expansion bolts.

Prices below cover posts with sockets and with or without glassware, as listed. Prices do not include lamps, compensators, wiring or foundation bolts. See another page for prices of parts to make other combinations.

Description	Park View Trade No.	Park View Wt.,Lbs. Each	Park View Price Each	Villa Trade No.	Villa Wt.,Lbs. Each	Villa Price Each
With 8-in. globe holder, med. screw mult. socket	W 22125	284	$36.70	W 22133	234	$31.20
Same, with mogul screw multiple socket	W 22126	284	37.00	W 22134	234	31.50
Same, with Regent film series socket	W 22127	285	38.00	W 22135	235	32.50
With Sol-lux Jr. top medium screw mult. socket	W 22128	319	50.70	W 22136	252	43.20
Same, with mogul screw multiple socket	W 22129	319	51.00	W 22137	252	43.50
Same, with Regent film series socket	W 22130	320	52.00	W 22138	253	44.50

*For reactance coils and compensators order Egyptian Junior casing No. 22118 instead of the Park View globe holder No. 22171. Add $1.20 [illegible] price of coil selected.

CUTTER ORNAMENTAL STREET LIGHTING FIXTURES

A complete ornamental street-lighting unit consists of a base and a column, preferably cast in one piece, surmounted by the lighting fixture or post top. Auxiliary equipment for the lamps and wiring are necessary detail parts to make the unit complete.

Ornamental Post

The post should have a base large enough to give stability without occupying excess space on the sidewalk. The column should have gracefully tapering lines so that when cast integral with the base it forms a standard with correct proportions throughout.

Post Top

Cutter Sol-lux Fixtures are designed for use particularly with Cutter Ornamental Posts, but they may be adapted for use with other designs. Each fixture consists of:

(1) Casing, which fits the top of the column, forming both the capitol and the globe holder. This supports the socket for the lamp, compensator coil and porcelain disc insulator, and globe with or without trimmings, and ventilator.

(2) High efficiency globe, which diffuses the light and eliminates glare.

(3) Ventilator, which allows circulation of air for Mazda C lamps. It is made of porcelain enameled steel, white inside and black outside. The Sol-lux Senior and Junior ventilators are equipped with porcelain enameled reflectors which direct the upward rays of light into useful planes.

How to Select Complete Street-Lighting Units

The size and general appearance of a city and the width of the street to be lighted, the average height of abutting buildings, etc., should be considered in the selection of modern street-lighting units. Although the Arcadian and Suburban standards are suitable and recommended for nearly all installations, other designs afford selections to suit particular conditions regarding height, size of bases and columns, design, etc.

The following list gives the different styles of Cutter standards with principal dimensions, weight and price of standard (base and column). The use of the tops recommended for each standard insures harmonious combinations and simplifies the selection of the complete unit. The price of a complete unit is the price of the standard added to the price of the top which can be secured from the lists on the following pages. Prices of the most popular combinations of complete standards will be found on preceding pages.

Trade No.	Name of Standard	Height of Base and Column	Base Dimen. In.	Ht. of Base In.	Shp. Wt. Lbs.	Style of Top Recommended	Price of Standard
W21368	*Arcadian	11 ft. 10 in.	20 oct.	....	410	Sol-lux Sr., Oct. Sr., Egyp. Sr.	$49.00
W21369	*Suburban	9 ft. 11 in.	16 oct.	....	240	Sol-lux Jr., Oct. Jr., Egyp. Jr.	36.00
W21290	†Continental	11 ft. 4 in.	20 dia.	31	510	Sol-lux Sr., Egyptian Sr.	51.80
W22193	†Continental Med.	10 ft. 4 in.	18 dia.	28	430	Sol-lux Sr., Egyptian Sr.	50.00
W21291	†Colony	8 ft. 10 in.	16 dia.	21	250	Sol-lux Jr., Egyptian Jr.	31.20
W21292	†Capitol	12 ft. 4 in.	20 dia.	31	495	Sol-lux Sr., Egyptian Sr.	50.50
W21293	†Capitol	9 ft. 10 in.	18 dia.	31	440	Sol-lux Sr., Egyptian Sr.	47.50
W21294	†Broadway	12 ft. 3 in.	20 dia.	33	520	Sol-lux Sr., Egyptian Sr.	51.30
W21295	†Plaza	10 ft. 4 in.	20 dia.	33	450	Sol-lux Sr., Egyptian Sr.	46.30
W21297	Park View	9 ft. 5 in.	16 dia.	17	260	Sol-lux Jr., Egyptian Jr.	32.20
W21298	Boulevard	10 ft. 9 in.	14 dia.	34	240	Sol-lux Jr.	29.20
W21300	Riverside	11 ft. 1 in.	18 dia.	47	380	Sol-lux Sr., Sol-lux Jr., Egyptian Sr., Sol-lux Jr., with casings 22171, 22176 or 22118	

The following posts are listed complete with their respective holders (for globes having 8-inch fitters. The prices of the porcelain disc insulator, socket, glassware and ventilator should be added to the following prices to obtain the price of the complete unit.

W21398	Commonwealth	11 ft. 5 in.	18 sq.	24	410	Sol-lux Sr., Octagonal Sr.	$45.00
W21399	Villa	9 ft. 4 in.	17 dia.	18	230	Sol-lux Jr., Egyp. Jr.	30.00
W21408	Bridge newel or traffic post	5 ft 2 in.	14 dia.	24	180	Sol-lux Jr., Oct. Jr., Egyp. Jr.	31.70
W21430	Metropolitan newel	6 ft. 4 in.	14 sq.	24	190	Sol-lux Jr., Oct. Jr., Egyp. Jr.	34.20
W21409	Gate-post newel	2 ft. 11 in.	14 dia.	24	110	Sol-lux Jr., Oct. Jr., Egyp. Jr.	24.20

*Arcadian and Suburban posts may be used with or without casing No. 22372. When used without casing (the compensator coil being omitted) add $1.50 list for 8-inch globe holder No. 22173. Porcelain disc insulator No. 22166 may then be added with the kind of socket desired. Any Senior style of globe and ventilator may be used with the Arcadian post and any Junior style of globe and ventilator may be used to make the Suburban design a complete unit.

†Continental, Colony, Capitol, Broadway and Plaza posts will be drilled and threaded to receive G. E. Novalux Fixtures when so ordered, for $1.50 list additional. In ordering, state type and Trade No. ..... of fixture to be used.

CUTTER SOL-LUX FIXTURES

PARTS FOR SOL-LUX AND OCTAGONAL POST TOPS

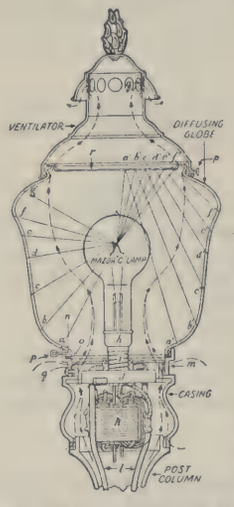


Fig. 1—Sectional View of Sol-lux Senior Top

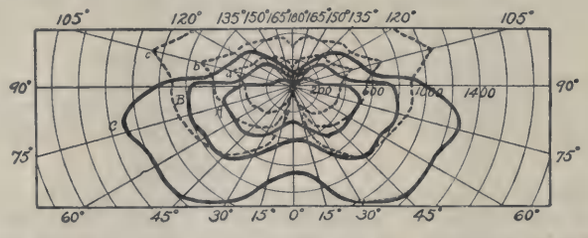


Fig. 2—Curves a, b and c Show Light Distribution of 40, 600 and 1000 C. P. Mazda C Lamps. Curves A, B and C Show Light Distribution of Same Lamps in Sol-lux Senior Globes.

Arcadian Casing

The fixture shown in Fig. 1 is the top part of the Arcadian post illustrated on a preceding page. The casing (or extension capital) fits directly on the column and receives a compensator suspended beneath the porcelain disc illustrated in Fig. 7 on the following page. Two tapered holes in the disc allow the cable to pass through and be hermetically sealed when connected to the socket terminal. This relieves the socket of the strain due to the weight of the cable and forms a pothead type of connection in the top of the post.

Fig. 3—Sol-lux Senior Top

Spring Globe Holder

The globe ring (m) is a separate piece. It fits either the casing or the column, so that if the compensator should be omitted the casing likewise may be omitted. The globe ring is provided with an insect screen and with a globe seat made of felt. It has a spring globe holder which reduces the cost of upkeep by protecting expensive globes from breakage. This is often a considerable item in localities where severe weather conditions cause an uneven expansion and contraction of metal against glass. Frequently globes are broken by careless tightening of set screws. The spring globe holder eliminates this danger. The globes are more easily and quickly fastened in the holder than when three or more screws are used. When assembled, they are protected from breakage as a result of vibration.

Fig. 4—Octagonal Senior Top

Sol-lux and Octagonal Globes

The globe shown in Fig. 6 transmits the greater part of the useful light to the sidewalks and streets, but there is sufficient illumination to show the outlines of building fronts. These results will be apparent by reference to the polar diagrams shown in Fig. 2. Globes with metal trimmings are desirable because of the lantern effects produced. The metal is narrow and the illumination, therefore, is not changed appreciably by the loss of the light which is intercepted by the metal trimmings. The globes are made of high efficiency glass, especially adapted for use with Mazda C lamps.

Porcelain Enameled Ventilators

The ventilator for the top of the globe is made of steel and is regularly finished in black porcelain enamel outside and white inside. Other colors, such as green outside to match posts with verde green finish, or white outside and inside to match the globe, will be furnished when ordered in quantities.

Porcelain enamel is a vitreous covering. It protects the steel from rust and makes the ventilator easy to clean.

CUTTER SOL-LUX FIXTURES

PARTS FOR SOL-LUX AND OCTAGONAL POST TOPS

Diagrams of Connections for Auto-transformers

Fig. 5—Ventilator with Reflector

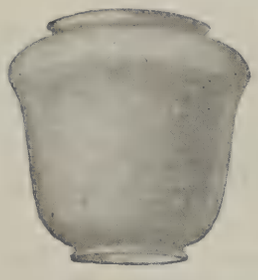


Fig. 6—Sol-lux Senior Globe

Fig. 7—Porcelain Disc Insulator with Compensator, Mogul Socket and Lamp

Fig. 8—Arcadian Extension Capitol

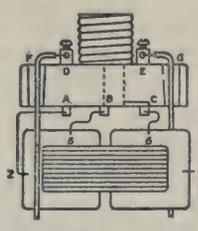


Fig. 9

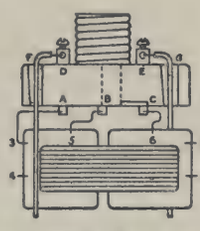


Fig. 10

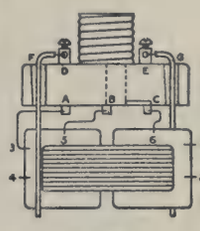


Fig. 11

Capacity of Coil	Candlepower of Lamp	Line Current	Lamp Current	Connections A	B	C	Fig. No.
102-200 watt	400	6.6	15	1	5	6	9
102-200 watt	400	7.5	15	2	5	6	9
200-300 watt	600	6.6	20	1	5	6	10
200-300 watt	600	7.5	20	2	5	6	10
200-300 watt	400	6.6	15	3	5	6	10
200-300 watt	400	7.5	15	4	5	6	10
300-500 watt	1000	6.6	20	1	5	6	11
300-500 watt	1000	7.5	20	2	5	6	11
300-500 watt	600	6.6	20	3	5	6	11
300-500 watt	600	7.5	20	4	5	6	11

Auto Transformers (or Compensator Coils)

The demand for increased efficiencies in lighting systems led the lamp manufacturers to produce series Mazda lamps, which operate at 15 and 20 amperes. In order that these lamps might be operated on standardized series circuits of 6.6 or 7.5 amperes auto-transformers were designed for use with each lamp. The current is taken from the line at either 6.6 or 7.5 amperes and delivered to the lamp at 15 amperes for 400 candle power lamps and 20 amperes for 600 and 1000 candle power lamps.

Regent Film Sockets

With auto-transformers for 15 or 20-ampere lamps, mogul base multiple sockets are used. Since the 400 and 600 candle power lamps are available for connection directly in series on 6.6 or 7.5 ampere circuits, the initial cost of the system may be reduced by omitting the auto-transformers. In that case, Regent film sockets are used. This socket is the series line safety valve. It uses a perfectly calibrated film protecting the lamp from damaging line surges and reducing lamp renewal expense to a minimum.

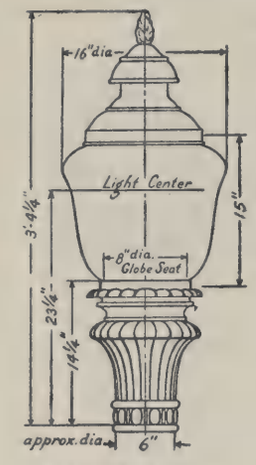
It should be noted, however, that a considerable increase in efficiency is obtained by the use of 15 and 20-ampere lamps as compared to 6.6 or 7.5-ampere lamps. Whether this saving warrants the additional expense of installing auto-transformers depends on local conditions for each particular installation. Our Engineering Service Department will solve such problems as these without expense to those interested.

Reactance Coils

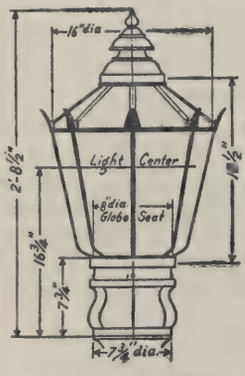
For installations of series lamps not larger than 250 candle power a reactance coil may be substituted for the auto-transformer. A mogul base multiple socket is used and no regulating equipment is required.

CUTTER SENIOR ORNAMENTAL TOPS

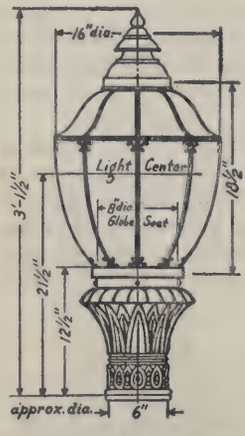
Designed for Use with 300 to 1000-watt Multiple Lamps and 400, 600 and 1000 C. P. Series Mazda C Lamps



Sol-lux Senior Top



Octagonal Senior Top



Egyptian Senior Top

SOL-LUX SENIOR TOPS

Trade No.	Description	Ship. Wt., Lbs.	Price Each
W22926	Sol-lux Senior top, including casing, porcelain disc insulator, globe, ventilator and reflector and mogul screw multiple socket	65	$24.00
W22928	Same, but with Regent film series socket	66	25.00
W22928	Same, but with mogul socket and compensator* for 15-amp. 400 C. P. lamps	72	34.00
W22929	Same, but with mogul socket and compensator* for 20-amp. 600 C. P. lamps	74	35.00
W22930	Same, but with mogul socket and compensator* for 20 amp. 1000 C. P. lamps	77	37.00
	Parts for Sol-lux Senior Tops		
W22175	Casing, with 8-inch globe holder	40	6.50
W22166	‡Porcelain disc insulator, without socket	3	.70
W22167	Sol-lux Senior globe	13	8.50
W22168	Sol-lux Senior ventilator with reflector	9	7.50

OCTAGONAL SENIOR TOPS

W22931	Octagonal Senior top, including casing (extension capital), porcelain disc insulator, globe, trimmings, ventilator and mogul screw multiple socket	47	25.00
W22932	Same, but with Regent film series socket	48	26.00
W22933	Same, but with mogul socket and compensator* for 15-amp. 400 C. P. lamps	54	35.00
W22934	Same, but with mogul socket and compensator* for 20-amp. 600 C. P. lamps	56	36.00
W22935	Same, but with mogul socket and compensator* for 20-amp. 1000 C. P. lamps	59	38.00
	Parts for Octagonal Senior Tops		
W22372	†Casing (extension capital), with 8-inch globe holder	17	6.50
W22173	Globe holder ring, with 8-inch fitter	3	1.50
W22166	‡Porcelain disc insulator, without socket	3	.70
W22950	Octagonal Senior globe (one piece)	16	11.00
W22556	Trimmings for globe (galvanized steel, enameled black)	6	2.00
W22557	Ventilator	5	4.00

EGYPTIAN SENIOR TOPS

W22936	Egyptian Senior top, including casing, porcelain disc insulator, globe, trimmings, ventilator and mogul screw multiple socket	55	25.50
W22937	Same, but with Regent film series socket	56	26.50
W22938	Same, but with mogul socket and compensator* for 15-amp. 400 C. P. lamps	62	35.50
W22939	Same, but with mogul socket and compensator* for 20-amp. 600 C. P. lamps	64	36.50
W22940	Same, but with mogul socket and compensator* for 20-amp. 1000 C. P. lamps	67	38.50
	Parts for Egyptian Senior Tops		
W22113	Casing, with 8-inch globe holder	30	7.00
W22166	‡Porcelain disc insulator, without socket	3	.70
W22114	Egyptian Senior globe (one piece)	15	8.50
W22115	Trimmings for globe (cast iron, enameled black)	5	4.50
W22557	Ventilator	5	4.00

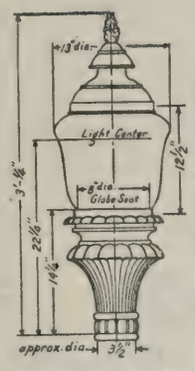
*Compensators are designed for use on 60-cycle circuits; prices for 25-cycle compensators upon application. Compensators for 600 C. P. lamps have extra taps for 400 C. P. lamps, and compensators for 1000 C. P. lamps have extra taps for 600 C. P. lamps. All compensators have taps for either 6.6 or 7.5-ampere line. Prices for special compensators will be quoted upon application.

‡A porcelain disc insulator should be used with each casing or globe holder listed. When ordering parts to make combinations other than those listed specify the kind of socket and coil (if any). Add to the price of the disc insulator 50 cents for a medium screw multiple socket, 80 cents for a mogul screw multiple socket and $1.80 for a Regent film series socket. When coils are used, add to the price of the disc insulator, 80 cents for mogul screw socket with the following: $9.50 for 250 C. P. reactance coil, $10.00 for 400 C. P. compensator, $11.00 for 600 C. P. compensator and $13.00 for 1000 C. P. compensator.

†Casing No. 22372 may be omitted when compensator or reactance coil is not used; in such cases, globe holder ring No. 22173 is used.

CUTTER JUNIOR ORNAMENTAL TOPS

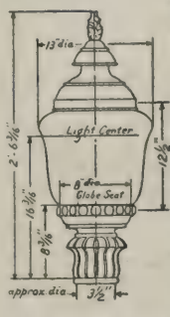
Designed for Use with 500-watt or Smaller Multiple Lamps and 400 C. P. or Smaller Series Mazda C. Lamps



Sol-lux Junior Top

SOL-LUX JUNIOR TOPS

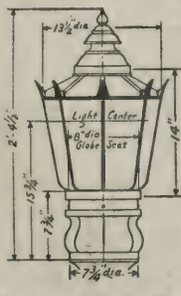
Trade No.	Description	Ship. Wt., Lbs.	Price Each
W22941	Sol-lux Junior top, including casing No. 22171, porcelain disc insulator, globe, ventilator and reflector, and medium screw multiple socket	59	$16.50
W22942	Same, but with mogul screw multiple socket	59	16.80
W22943	Same, but with Regent film series socket	60	17.80
W22944	Same, but with casing No. 22176, mogul socket and reactance coil* for 6.6-amp. 100 C. P. lamps	62	27.00
W22945	Same, but with casing No. 22176, mogul socket and reactance coil* for 6.6-amp. 250 C. P. lamps	64	28.30
W22946	Same, but with casing No. 22176, mogul socket and compensator* for 15-amp. 400 C. P. lamps	66	28.80
	Parts for Sol-lux Junior Tops		
W22176	Casing, with 8-inch globe holder	38	5.30
W22171	§Park View 8-inch globe holder for Nos. 22941, 22942 and 22943	20	3.30
W22166	‡Porcelain disc insulator, without socket	3	.70
W22169	Sol-lux Junior globe	11	5.50
W22170	Sol-lux Junior ventilator and reflector	7	6.50



Sol-lux Globe and Ventilator with Park View Globe Holder

OCTAGONAL JUNIOR TOPS

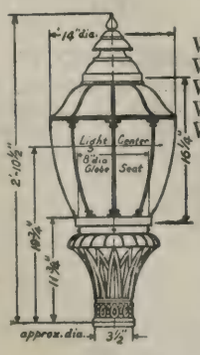
W22869	Octagonal Junior top, including casing (extension capital), porcelain disc insulator, globe, trimmings, ventilators and medium screw multiple socket	44	20.70
W22870	Same, but with mogul screw multiple socket	44	21.00
W22871	Same, but with Regent film series socket	45	22.00
W22872	Same, but with mogul socket and reactance coil* for 6.6-amp. 100 C. P. lamps	49	29.20
W22873	Same, but with mogul socket and reactance coil* for 6.6-amp. 250 C. P. lamps	49	30.50
W22949	Same, but with mogul socket and compensator* for 15-amp. 400 C. P. lamps	51	31.00
	Parts for Octagonal Junior Tops		
W22372	†Casing (extension capital), with 8-inch globe holder	17	6.50
W22173	Globe holder ring with 8-inch fitter	3	1.50
W22166	‡Porcelain disc insulator, without socket	3	.70
W22558	Octagonal Junior globe (one piece)	11	7.50
W22559	Trimmings for globe (galvanized steel, enameled black)	3	1.50
W22557	Ventilator	8	4.00



Octagonal Junior Top

EGYPTIAN JUNIOR TOPS

W22874	Egyptian Junior top, including casing, porcelain disc insulator, globe, trimmings, ventilator, and medium screw multiple socket	44	18.70
W22875	Same, but with mogul screw multiple socket	44	19.00
W22876	Same, but with Regent film series socket	45	20.00
W22877	Same, but with mogul socket and reactance coil* for 6.6-amp. 100 C. P. lamps	47	27.00
W22878	Same, but with mogul socket and reactance coil* for 6.6-amp. 250 C. P. lamps	49	28.50
W22879	Same, but with mogul socket and compensator* for 15-amp. 400 C. P. lamps	51	29.00
	Parts for Egyptian Junior Tops		
W22118	Casing with 8-inch globe holder	20	4.50
W22166	‡Porcelain disc insulator, without socket	3	.70
W22116	Egyptian Junior globe (one piece)	11	6.00
W22117	Metal frame for globe (cast iron, enameled black)	5	3.00
W22557	Ventilator	8	4.00



Egyptian Junior Top

*Reactance coils and compensators are designed for 60-cycle circuits; prices for 25-cycle compensators on application. Compensators for 400 C. P. lamps have taps for both 12 and 15-amp. lamps and 6.6 and 7.5-amp. line.

§Park View globe holders will not accommodate compensator or reactance coils.

‡A porcelain disc insulator should be used with each casing or globe holder listed. When ordering parts to make combinations other than those listed specify the kind of socket and coil (if any). Add to the price of the disc insulator 50 cents for a medium screw multiple socket, 80 cents for a mogul screw multiple socket, and $1.80 for a Regent film series socket. When coils are used, add to the price of the disc insulator 80 cents for mogul screw socket with the following: $8.10 for 100 C. P. reactance coil, $9.50 for 250 C. P. reactance coil, and $10.00 for 400 C. P. compensator.

†Casing No. 22372 may be omitted when compensator or reactance coil is not used; in such cases, globe holder ring No. 22173 is used.

PARTS FOR CUTTER ORNAMENTAL POSTS

Schedule I—Standard Package Quantity, 20 of One Style or Trade Number

DIFFUSING BALL GLOBES

Park View Globe Holder with 8x16x6-inch Ball Globe and Ventilator

Trade No.	Diam. In.	Size of Fitter, In. Lower	Size of Fitter, In. Top	Wt., Lbs. Each	Price Each
W21841	8	6	....	5	$ 1.50
W21830	9	6	....	6	2.25
W21842	10	6	....	7	2.75
W21831	12	6	....	8	4.25
W22453	12	6	6	8	4.25
W22487	12	8	....	8	4.25
W22454	14	6	6	14	5.50
W22488	14	7	....	14	5.50
W22489	14	8	....	14	5.50
W22490	16	8	....	18	8.75
W21791	16	8	6	18	8.75
W22492	18	8	6	26	13.00
W22493	20	8¼	....	36	38.00

For globes with top fitters, order ventilators.

VENTILATORS FOR DIFFUSING BALL GLOBES

Trade No.	Description	Wt., Lbs. Each	Price Each
W22557	For globe with 6-inch top fitter	9	$4.00

POTHEADS

With the smaller posts an iron bracket support should be imbedded in the concrete foundation, and the connections to the cable made before raising the column upon its foundation. The larger posts, however, may be furnished with a V-shaped groove in the base to receive the cast iron body of the pothead. Potheads are designed for cable up to 1½-inch diameter.

Disconnecting Pothead with Ground Support

Trade No.	Description	Wt., Lbs. Each	Price Each
W23171	Simple pothead for cables 1-in. diam. or less	10	$3.00
W23172	Simple pothead for cables 1½ to 1-in. diam.	10	3.00
W23697	Disconnecting type pothead for cables 1-inch diam. or less	12	6.00
W23698	Disconnecting type pothead for cables 1½ to 1-inch diam	12	6.00
W23156A	Sealing compound for either of above (1 pound for each pothead)	1	.12
W23156B	Cast iron ground support for either of above potheads	5	.75

FOUNDATION BOLTS

Prices cover square head machine bolts with hexagon nuts. Wrought washers are 10 per cent list extra.

Price, Each

Length Bolt In.	Diameter of Bolts ¾-in.	⅞	1	1¼
8	$0.24	$0.39	$0.54	$0.99
10	.28	.45	.62	1.06
12	.32	.51	.68	1.25
15	.38	.59	.79	1.42
18	.44	.68	.91	1.62
20	....	.74	.98	1.73
24	....	.85	1.14	1.96

Bolt with Primary and One Secondary Expansive Unit

HEAVY DUTY EXPANSION BOLTS

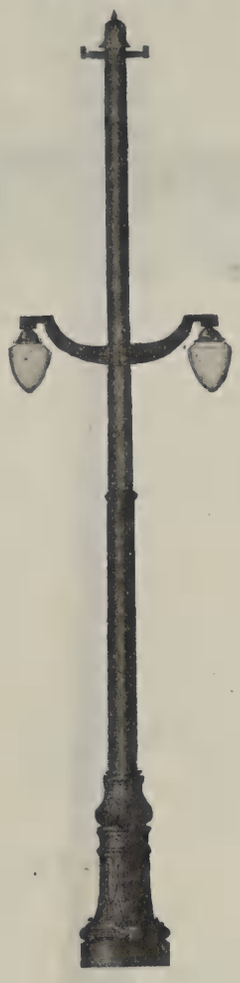
These bolts may be used whenever posts are to be fastened to concrete sidewalks and when brackets are to be mounted on concrete, brick, or stone walls. Their holding power exceeds that of standard machine bolts. They save 50 to 75 per cent of drilling costs. Furnished in sets of four.

Sectional View Showing Bolt with Primary Expansion Sleeve, One Iron Spacing Sleeve, and One Secondary Expansive Unit

Trade No.	Length Inches	Diam. Inches	Ship. Wt., Lbs. per 100	Price per Set
W21122	4½	⅝	70	$1.05
W21123	6	⅝	80	1.25
W21124	9	⅝	90	1.45
W21125	12	⅝	100	1.65
W22361	4 Spacing sleeves extra		20	.15
W22401	4 Sec. expansive units		30	.75

CUTTER ORNAMENTAL POSTS AND BRACKETS

SCHEDULE I—STANDARD PACKAGE QUANTITY, 20 OF ONE STYLE



Broadway Trolley Bracket

Sol-lux Junior Trolley Bracket

BROADWAY TROLLEY BRACKETS

The Broadway Trolley Bracket consists of bracket arm, 8x12-inch acorn globe and Regent Film Series Socket. Wiring and lamps are not included. *Multiple sockets furnished when ordered. Distance from center of pole to center of globe 27 inches.

Single Arm					Double Arm				
Trade No.					Trade No.				
For 5" Pipe	For 6" Pipe	For 7" Pipe	Ship. Wt., Lbs.	Price Each	For 5" Pipe	For 6" Pipe	For 7" Pipe	Ship. Wt., Lbs.	Price Each
W22151	W22153	W22158	75	$17.80	W22057	W22060	W22161	150	$34.00

SOL-LUX JUNIOR TROLLEY BRACKETS

The Sol-lux Junior Trolley Bracket as listed is a complete fixture less lamp and wiring. It is regularly equipped with globe holder, Sol-lux Junior Globe and ventilator, porcelain disc insulator and Regent film series socket. *Multiple sockets furnished when ordered.

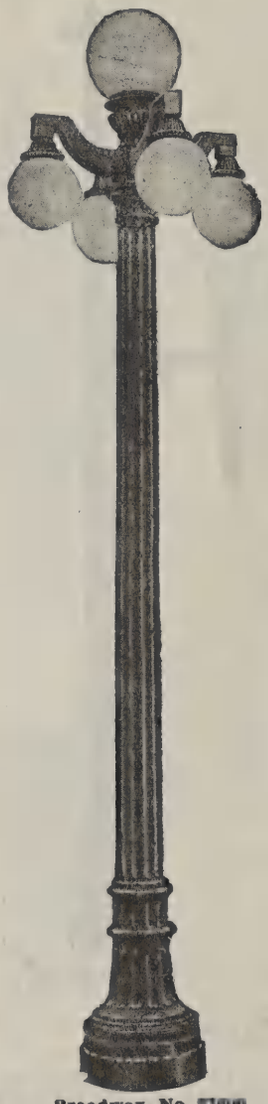
Distance from pole to center of globe, 30 inches. Height over all, 52 inches. Diameter of arm, 2⅞ inches. Distance from center of arm to bottom of scroll, 18 inches.

Trade No.					Trade No.				
For 2½" Pipe	For 3" Pipe	For 4" Pipe	Ship. Wt., Lbs.	Price Each	For 5" Pipe	For 6" Pipe	For 7" Pipe	Ship. Wt., Lbs.	Price Each
W22602	W22603	W22604	155	$35.80	W22605	W22606	W22607	160	$35.80

*If mogul multiple socket is used, deduct $1.00 list for each socket; for medium screw socket deduct $1.30 each list.

CUTTER ORNAMENTAL POSTS

SCHEDULE I—Standard Package Quantity, 20 of One Style



Broadway, No. [illegible]

Base, 20 inches in diameter, [illegible] feet 8 inches (high. Column, 7½ inches in diameter above the base, tapering to 6⅛ inches in diameter near the top. Height from ground to bottom of pendent globes, 11 feet 7½ inches; to top of center globe, 15 feet; to top of globe on 1-light post, 14 feet. Distance from center to center of opposite globes, 32 inches. Pendent globes, 6x12 inches; top globe, 8x16 inches. Globe for 1-light post, 8x16 inches. Use four 1-inch foundation bolts.

Trade No.	No. of Lights	Wt., Lbs. Each	Price Each
W23692	1	560	$56.50
W23693	2	650	62.50
W23694	[illegible]	650	62.50
W23695	4	700	67.50
W23696	[illegible]	700	67.50

Riverside, No. 21105

Base, 18 inches in diameter, 3 feet 6 inches high. Column, 8½ inches largest diameter, tapering to 3½ inches in diameter near the top. Height from ground to bottom of pendent globes, 11 feet; to top of top globe, 14 feet; to top of globe on the 1-light post, 13 feet 2 inches. Distance from center to center of opposite globes, 40 inches. All globes 8x12 inches, except for 1-light post, which is 8x16 inches.

Trade No.	No. of Lights	Wt., Lbs. Each	Price Each
W21105	1	450	$50.00
W21106	[illegible]	500	55.00
W21107	[illegible]	500	55.00
W21108	4	585	60.00
W21109	5	585	60.00

Prices of posts include medium screw sockets, but not the globes, wiring, or foundation bolts.

CUTTER ORNAMENTAL POSTS

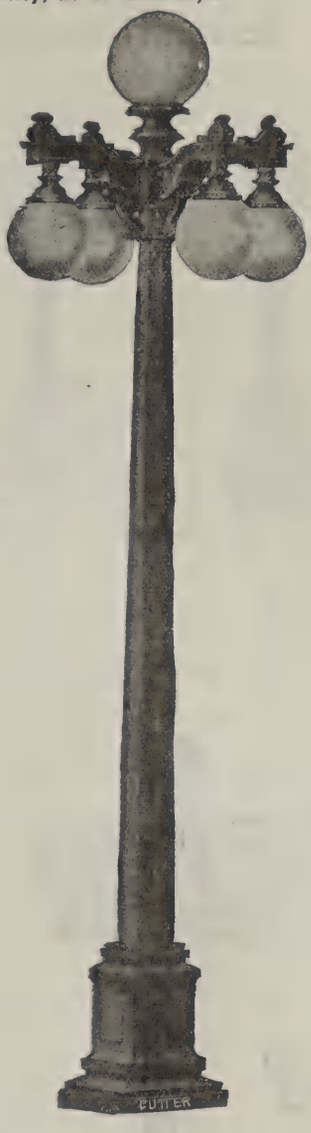
SCHEDULE I—Standard Package Quantity, 20 of One Style

Boulevard No. 21121

Base, 14 inches diameter, 2 feet, 10 inches high. Column, 5½ inches diameter above the base, tapering to 3½ inches diameter near the top. Height, from ground to bottom of pendent globes, 10 feet; to top of top globe, 13 feet 2 inches; to top of globe on the 1-light post, 12 feet 7 inches. Distance from center to center of opposite globes, 32 inches. Pendent globes, 6x10 inches; top globe, 6x12 inches; globe for 1-light post, 8x14 inches. Use four ¾-inch foundation bolts.

Trade No.	No. of Lights	Std. Pkg.	Wt., Lbs. Each	Price Each
W21117	1	20	300	$35.00
W21118	2	20	335	41.50
W21119	3	20	335	41.50
W21120	4	20	375	47.50
W21121	5	20	375	47.50

Prices on posts include medium screw sockets but not the globes, wiring or foundation bolts.



Commonwealth No. 23504

Base, 18 inches square, 2 feet high. Column, 8 inches octagon above the base, tapering to 4 inches octagon near the top. Height from ground to bottom of pendent globes, 11 feet; to top of top globe, 14 feet 3 inches; to top of globe on the 1-light post, 13 feet 6 inches. Distance from center to center of opposite globes, 36 inches. Pendent globes, 6x12 inches; top globe, 8x14 inches; globe for 1-light post, 8x16 inches. Use four 1-inch foundation bolts.

Trade No.	No. of Lights	Std. Pkg.	Wt., Lbs. Each	Price Each
W23500	1	20	475	$55.00
W23501	2	20	560	60.00
W23502	3	20	560	60.00
W23503	4	20	665	65.00
W23504	5	20	665	65.00

Prices on posts include medium screw sockets but not the globes, wiring or foundation bolts.

CUTTER ORNAMENTAL NEWELS

FOR TYPE C LAMPS

SCHEDULE I—STANDARD PACKAGE QUANTITY, 20 OF ONE STYLE

SOL-LUX GATE POST NEWELS

Sol-lux Gate Post Newels

These newels are made of the highest quality grey iron. They are of distinctive design and very appropriate for the lighting of gateways and private grounds, entrances of buildings, etc.

Base, 14 inches in diameter, 24 inches high. Column, 5 inches in diameter above base, tapering to 3½ inches in diameter near the top. Height from base plane to bottom of side globes, 3 feet 8 inches; to bottom of center globe, 4 feet 6½ inches; to bottom of globe of 1-light newel, 3 feet 8 inches. Distance from center to center of opposite globes, 30 inches. Designed for 6x9-inch or 6x10-inch side globes, and 6x12 or 6x14-inch top globe.

Prices below include medium screw sockets for side lamps and Mogul Screw Sockets for center lamps, unless otherwise specified. Prices do not include globes, ventilators, lamps, wiring or foundation bolts. Use three ⅝-inch expansion bolts.

Trade No.	No. of Lights	Wt., Lbs. Each	Price Each
W21817	1	125	$25.00
W21818	2	175	35.00
W21819	3	175	35.00
W21820	4	215	40.00
W21821	5	215	40.00

SOL-LUX BRIDGE NEWELS

Sol-lux Bridge Newels

Similar in design to Sol-lux Gate Post Newel but higher. Base, 14 inches in diameter, 24 inches high. Column, 5 inches in diameter above the base, tapering to 3½ inches in diameter near the top. Height from base plane to bottom of side globes, 6 feet; to bottom of center globe, 6 feet 10½ inches; to bottom of globe on the 1-light newel, 6 feet. Distance from center to center of opposite globes, 30 inches. Designed for 6x9-inch or 6x10-inch side globes and 6x12-inch or 6x14-inch center globes.

Arms may be reversed for pendent clusters.

Prices below do not include globes, ventilators, lamps, wiring or foundation bolts. Use three ⅝-inch expansion bolts, listed on another page. Prices include medium screw sockets for side lamps and Mogul Screw Sockets for top lamps.

Trade No.	No. of Lights	Wt., Lbs. Each	Price Each
W21825	1	175	$32.50
W21826	2	225	42.50
W21827	3	225	42.50
W21828	4	265	47.50
W21829	5	265	47.50

GLOBES

Trade No.	Description	Wt., Lbs. Each	Price Each
W21830	6x9″ Diffusing Ball.....	6	$2.25
W21842	6x10″ Diffusing Ball.....	7	2.75
W21831	6x12″ Diffusing Ball..... (without top fitter)	8	4.25
W22472	6x12″ Diffusing Ball..... (with 6-inch top fitter)	8	4.25
W22473	6x14″ Diffusing Ball..... (with 6-inch top fitter)	9	5.50
W21791	8x16″ Diffusing Ball..... (with 6-inch top fitter)	10	8.75

VENTILATORS

Trade No.	Description	Wt., Lbs. Each	Price Each
W22557	With 6″ fitter.....	9	$4.00

CUTTER BRACKETS, NEWELS AND TRAFFIC POSTS

SCHEDULE I—STANDARD PACKAGE QUANTITY, 20 OF ONE STYLE

Sol-lux Wall Bracket

SOL-LUX WALL BRACKETS

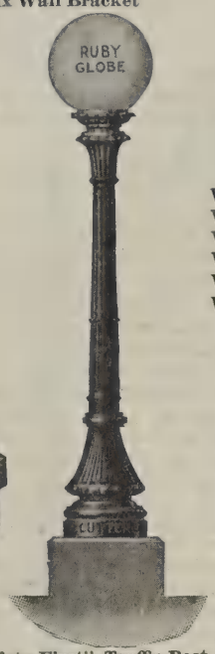
For Mazda C Lamps

A massive bracket of highly artistic design. Wall plate, 2 feet high, 6 inches wide. Distance from wall to center of lamp, 3 feet. Height from bottom of shaft to top of ventilator on Sol-lux Senior globe, 6 feet 6½ inches.

Trade No.	Description	Ship. Wt., Lbs., Ea.	Price Each
W22544	With Sol-lux Senior top, mogul Skt.	375	$68.00
W22545	With Oct. Senior top, mogul Skt.....	380	70.00

For Verde antique finish, add $5.00 list. For weatherproof bronze paint, add $10.00 list.

Metropolitan Newel



"Safety First" Traffic Post

METROPOLITAN NEWELS

A newel of simple but artistic design, adapted for lighting the entrances of buildings or for bridges and public places. Base 14 inches square, 2 feet high. Column 5 inches octagon above the base, tapering to 3½ inches octagon near the top. Height from base to bottom of globe 7 feet; to top of ventilator on octagonal junior globe 8 feet 9 inches. Globe holder has 8-inch fitter. Use four ⅝-inch expansion bolts.

W22446	With Oct. Jun. top, med. screw Skt.	225	48.40
W22447	Same, with mogul screw socket.....	226	48.70
W22448	Same, with Regent film socket.....	227	49.70
W22449	With Sol-lux Jun. top, med. St. Skt.	220	47.40
W22450	Same, with mogul screw socket.....	221	47.70
W22452	Same, with Regent film socket.....	222	48.70

For Verde antique finish, add $5.00 list; for weatherproof bronze paint, add $10.00 list.

"SAFETY FIRST" TRAFFIC POSTS

By marking the centers of intersecting streets the rule of "keep to the right" is always enforced. These traffic posts are silent watchmen, always on the job.

Base, 14 inches in diameter, 24 inches high. Column, 5 inches in diameter above the base, tapering to 3½ inches in diameter near the top. Height from base plane to bottom of globe on the 1-light newel, 8 feet.

Prices of newels do not include globes, lamps, wiring or foundation bolts. These are listed separately below.

W27000	6-in. holder, med. mult. socket.....	175	32.20
W27001	8-in. holder, med. mult. socket.....	176	32.20
W21825	6-in. holder, mogul mult. socket....	176	32.50
W27003	8-in. holder, mogul mult. socket....	177	32.50
W27004	6 in. holder, Regent film socket.....	177	33.50
W27005	8-in. holder, Regent film socket.....	178	33.50
W27006	6x12-in. ruby globe, extra.....	8	10.00
W27007	8x14-in. ruby globe, extra.....	9	12.00
W21831	6x12-in. diffusing ball, extra.....	8	4.25
W22489	8x14-in. diffusing ball, extra.....	9	5.50
	Set of three ¾x12" foundation bolts	.....	.54
W20938	Fixed pin clamp arm.....	6	.80
W20942	Pinless clamp arm	6½	.80

Commerce Newel

COMMERCE NEWELS

A massive newel designed especially for bridges and entrances to large buildings, etc. Base, 21x35¼ inches. Height from ground to bottom of pendent globes 4 feet 6 inches; to top of eagle ornamentation on top globe 9 feet 6 inches; to top of eagle ornamentation on one-light newel, 8 feet. Pendent globes, 8x14 inches; top globe, 8x20 inches; globe for 1-light newel 8x20 inches. Prices below include medium screw base sockets, glassware as above specified and eagle ornamentation, but not foundation bolts. Use four ⅝-inch expansion bolts.

W22556	One-light	475	125.00
W22558	Three-light	550	135.00
W22560	Five-light	625	150.00

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CUTTER ORNAMENTAL BRACKETS

SCHEDULE I—STANDARD PACKAGE QUANTITY, 20 OF ONE STYLE

Midget Bracket

Reversible Bracket

MIDGET BRACKETS

A light cast iron bracket designed for small sizes of lamps which do not require ventilation. Has a threaded stem for attachment to crowfoot or conduit. Diameter of wall canopy, 5¼ inches. Distance from end of stem to center of globe, 8 inches. Equipped with 4¼-inch holder and medium screw socket, but not wired.

Trade No.	Description	Wt., Lbs. Each	Price Each
W21835	With 4x8" Diffusing Globe	12	$4.75
W21836	Without globe	7	3.25

REVERSIBLE BRACKETS

When ventilation is not necessary, this bracket may have the globe hang downward. In this position, the bracket has the same artistic lines and correct proportions as in the position illustrated. Distance from wall to center of globe, 2 feet. Distance between centers of wall plates, approximately 20 inches. Fitted with 8-inch globe holder.

Prices do not include globe, ventilator or wiring.

W21248	Medium screw socket	65	15.00
W21837	Mogul Screw Socket	65	15.30
W21791	8x16-inch Diffusing Ball (with 6-inch top fitter)	19	8.75
W22557	Ventilator, with 6-inch fitter	9	4.00

1-light Commerce Bracket

4-light Commerce Bracket

COMMERCE BRACKETS

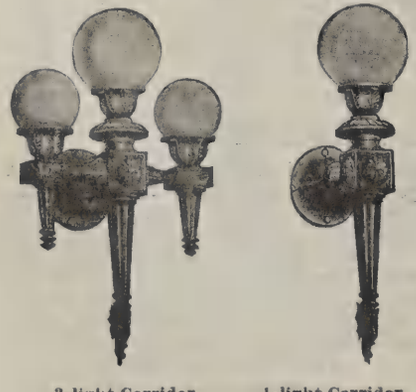
A massive fixture of distinctly artistic and classical design. Particularly adapted for lighting fronts of fine structures, such as banks and office buildings, clubs, libraries, etc.

Wall plate, 9 inches wide, 20 inches high. Distance from wall to center of top globe, 14 inches. Height to bottom of globe of 1-light bracket, 33 inches; to bottom of center globe of 3 and 4-light brackets, 41 inches. Distance from center to center of opposite globes, 30 inches.

For side lamps use 6x9-inch or 6x10-inch globes. For center lamps use 6x12-inch or 6x14-inch globes.

Prices below do not include lamps, globes, ventilators or wiring. Medium screw sockets are furnished for side lamps, Mogul Screw Sockets for center lamps, unless otherwise specified.

W21838	1-light	90	20.00
W21839	3-light	145	30.00
W21840	4-light	155	32.50
W21830	6x 9-inch Diffusing Ball	6	2.25
W21842	6x10-inch Diffusing Ball	7	2.75
W21831	6x12-inch Diffusing Ball (without top fitter)	8	4.25
W22453	6x12-inch Diffusing Ball (with 6-inch top fitter)	8	4.25
W22454	6x14-inch Diffusing Ball (with 6-inch top fitter)	9	5.50
W22557	6-inch ventilator	9	4.00



3-light Corridor Bracket

1-light Corridor Bracket

CORRIDOR BRACKETS

Distance from wall to center of globe of the 1-light bracket, 10 inches. Distance from center to center of opposite globes of the 3-light bracket, 16 inches. Height over all, 40 inches. Globe holders have 6-inch fitters for 6x8-inch side globes and 6x10-inch center globes.

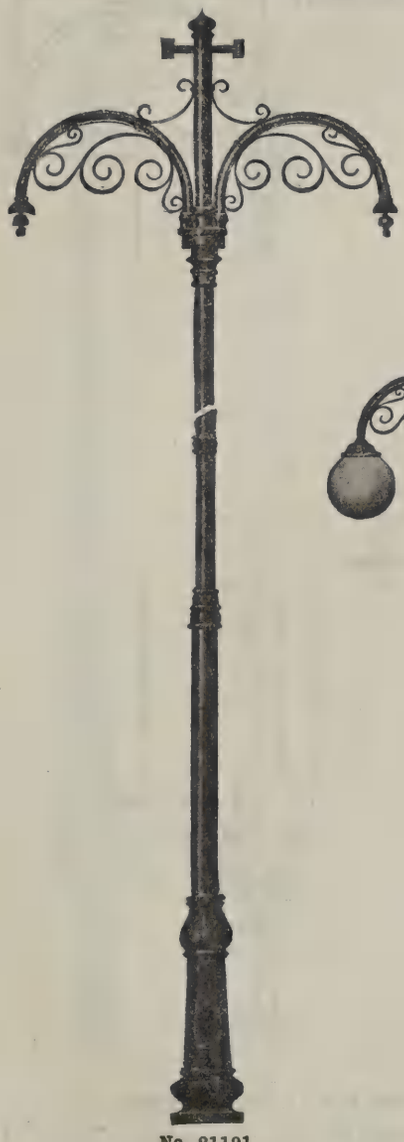
Prices below include globe holders and medium screw sockets, but not the globes or wiring.

W21245	1-light	65	15.00
W21246	3-light	110	21.00
W21247	4-light	135	24.00
W21841	6x 8-inch Diffusing Ball	5	1.50
W21842	6x10-inch Diffusing Ball	7	2.75

CUTTER ORNAMENTAL POSTS

Schedule I—Standard Package Quantity, 20 of One Style

STREET CROOKS AND VILLAGE CROOKS



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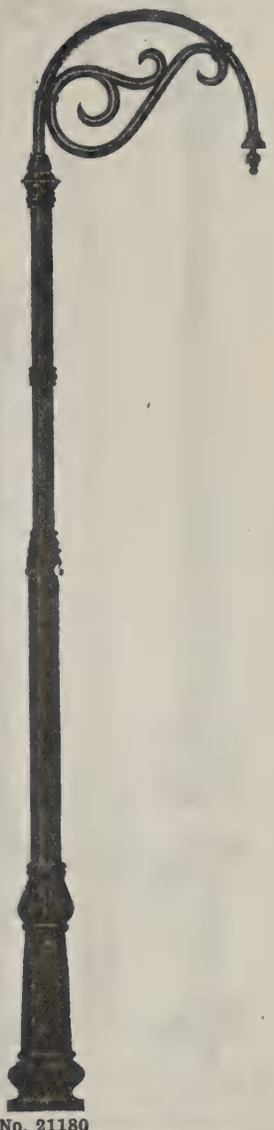
No. 21195



No. 21180

STREET CROOKS

These are well built street lighting poles for supporting arc or incandescent lamps. Height from ground to insulator, 18 feet. Other heights built to order. Diameter of base, 14 inches. Prices below include 5-foot ground section and insulators for arc lamps or 8-inch globe holders with medium screw sockets for 8x12-inch globes. If ground section is not wanted, deduct $11.50.

Trade No. With Insulator	Trade No. With 8-inch Holder	No. of Lights	Wt., Lbs. Each	Price Each	Trade No. With Insulator	Trade No. With 8-inch Holder	No. of Lights	Wt., Lbs. Each	Price Each
W21180	W21184	1	460	$48.50	W21182	W21186	3	510	$58.50
W21181	W21185	2	485	53.50	W21183	W21187	4	535	63.00

VILLAGE CROOKS

Similar to Cutter Street Crooks, but built for overhead wiring. Furnished complete, with clamp arm, ground section and with insulators for arc lamps or 8-inch globe holders and medium screw sockets for 8x12-inch globes. For ladder rest, add $0.80 to the list prices.

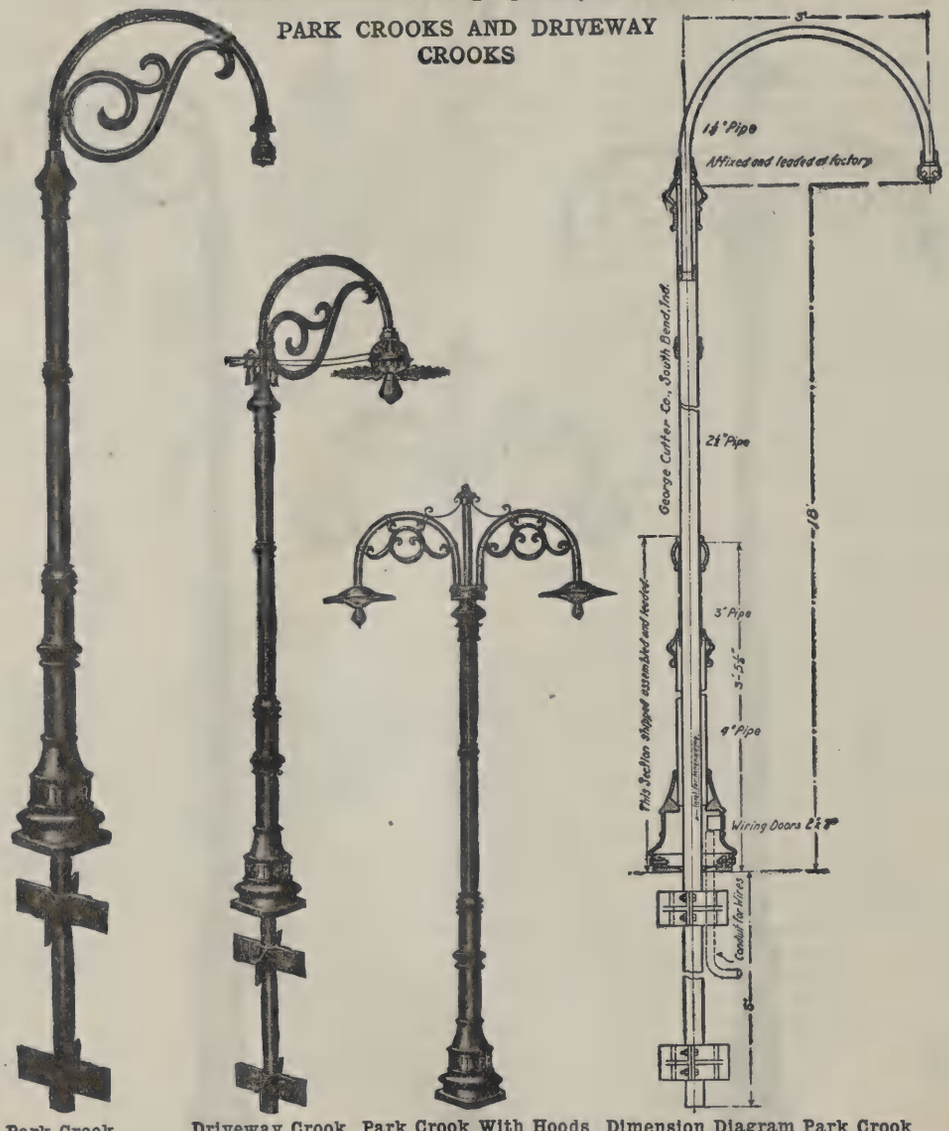
W21190	W21194	1	485	55.00	W21192	W21196	3	535	65.00
W21191	W21195	2	510	60.00	W21193	W21197	4	560	70.00

Prices do not include glassware, lamps or wiring. Use four ⅞-inch foundation bolts.

CUTTER ORNAMENTAL POSTS

Schedule I—Standard Package Quantity, 20 of One Style

PARK CROOKS AND DRIVEWAY CROOKS



Park Crook **Driveway Crook** **Park Crook With Hoods** **Dimension Diagram Park Crook**

Park Crooks are light but substantial poles for supporting arc or incandescent lamps. Standard height from ground to insulator, 18 feet. Other heights built to order. On 14-foot and shorter heights, 4-foot ground sections will be supplied; on greater heights, 5-foot. If ground section is not wanted, deduct $7.50 from list and use four ¾-inch foundation bolts.

TRADE NUMBER With Insulator	With 18-in. Hoods	No. of Lights	Wt. Lbs. Each	Price Each	TRADE NUMBER With Insulator	With 18-in. Hoods	No. of Lights	Wt.. Lbs. Each	Price Each
W21198	W21202	1	340	$37.50	W21200	W21204	3	385	$48.50
W21199	W21203	2	365	43.50	W21201	W21205	4	410	53.50

Driveway Crook, a variation of the Park Crook, built 14 feet from ground to lamp-fitted with 4-foot ground section, clamp carm for overhead wires and 20-inch Flat Radial Street, hood Body with Insulating Joint.

Trade No.	Style Socket	Wt., Lbs. Each	Price Each	Trade No.	Style Socket	Wt., Lbs. Each	Price Each
W21206	Medium Screw	350	$40.00	W21208	Film	350	$41.30
W21207	Mogul Screw	350	40.30	W21209	Without socket	350	39.50

This fixture built for underground wiring at a reduction of $0.80 from list.
Prices do not include lamps or wiring. Use four ¾-inch foundation bolts.

CUTTER ORNAMENTAL POSTS

Schedule I—Standard package quantity, 20 of one style

INTERURBAN AND URBAN CROOKS AND SWAN NECKS

Interurban Crook **Urban Crook** **Interurban Swan Neck**

The column is made of 4-inch and 2½-inch pipe, with the 4-inch pipe extending 4 feet into the ground. The cast iron base has a door to make wiring easy. The crook is made of 1¼-inch pipe and holds the lamp 2 feet, 6 inches from the column. The height to insulator is 14 feet. Prices below include high voltage insulator, or 8-inch globe holder and medium screw socket or 18-inch hood reflector and medium screw socket. If scroll is not wanted, deduct $2.00 from list. For ground anchors, add $5.50 to list.

INTERURBAN CROOKS AND SWAN NECKS

TRADE NUMBER					
With Insulator	With Globe Holder	With 17-inch Hood	Description	Wt., Lbs. Each	Price Each
W21218	W21220	W21222	Crook Bend	225	$29.60
W21219	W21221	W21223	Swan Neck	225	29.60

URBAN CROOKS AND SWAN NECKS

Same as Interurban, but without the base casting.

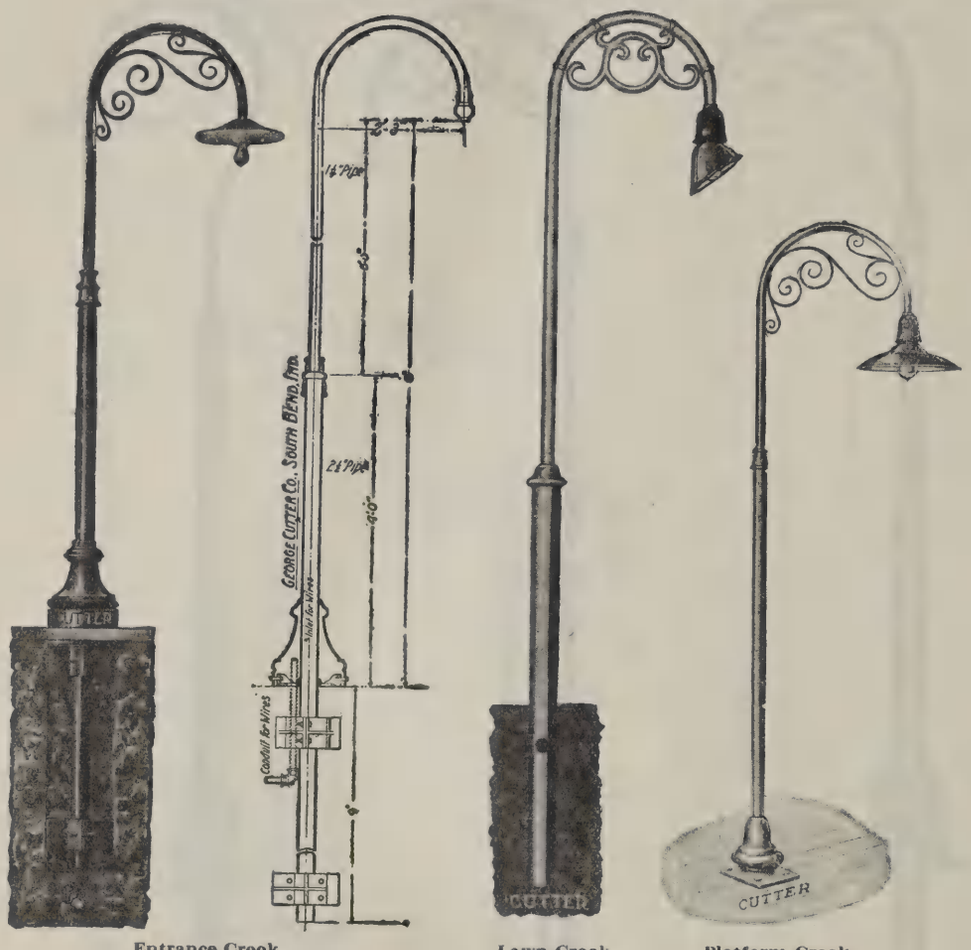
W21224	W21226	W21228	Crook Bend	190	$22.60
W21225	W21227	W21229	Swan Neck	190	22.60

Prices do not include lamps or wiring.

CUTTER ORNAMENTAL POSTS

Schedule I—Standard Package Quantity, 20 of One Style

ENTRANCE, LAWN AND PLATFORM CROOKS



Entrance Crook **Lawn Crook** **Platform Crook**

ENTRANCE CROOKS

Artistic fixtures for lighting entrances to parks, private grounds, etc. The 2½-inch pipe extends 4 feet into the ground. Ground anchors are $5.00 extra; shipping weight 37 pounds extra. If scroll is not wanted, deduct $2.00 from list.

Trade No.	Description	Wt. Lbs. Each	Price Each
W23775	With 18-inch inverted cone hood, medium screw socket	160	$18.75
W23776	With 18-inch radial bowl streethood body, medium screw socket	168	22.55
W23777	Same, with 20-inch flat radial streethood body	167	21.80

LAWN CROOKS

Similar to entrance crooks, but without cast iron base. If scroll is not wanted, deduct $1.50 from list. Holds the lamp 2 feet from the column. Outer end is fitted with 1¼x½-inch reducer and ½-inch nipple with 2¼ or 3¼-inch weatherproof holder to take reflectors having 2¼ or 3¼-inch standard heels. Furnished with other sizes of holders and fittings, when so ordered, at regular catalogue list additions. Prices do not include reflectors. See Schedule H.

W23778	With 2¼-inch holder, medium screw socket	105	14.85
W23779	With 3¼-inch holder, Mogul Screw Socket	107	15.35

PLATFORM CROOKS

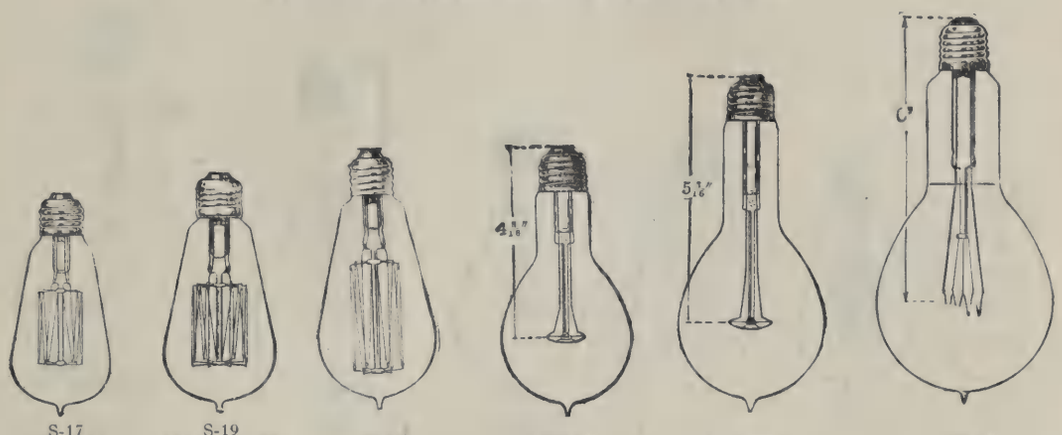
A 1¼-inch pipe with cast iron base and crook bend of ½-inch pipe holds the lamp 8 feet from the floor. If scroll is not wanted, deduct $1.50 from list. Prices do not include reflectors. See Schedule H.

W30468	With 2¼-inch holder, medium screw socket	80	8.85
W30469	With 3¼-inch holder, Mogul Screw Socket	82	9.35

Prices do not include lamps or wiring.

WESTINGHOUSE MAZDA LAMPS

FOR STANDARD LIGHTING SERVICE



S-17 10 AND 15 WATTS | S-19 25, 40 AND 50 WATTS | S-21 60 WATTS | PS-22 75-WATTS | PS-25 100 WATTS | PS-30 200 WATTS

These lamps constitute more than 75 per cent of the usual lamp demand for such service as residence, store and office lighting. The higher wattage sizes are used for various industrial and store lighting purposes. These lamps are for use on 110 to 125 volt and 220 to 250 volt lighting circuits. Proper reflector equipment should be provided to protect the eyes from the extremely bright filaments of Mazda C lamps, especially whenever the lamps are hung low and in the usual line of vision.

110 TO 125 VOLTS

Straight Side Mazda B Lamps								Pear-Shape Mazda C Lamps†							
Size of Lamp in Watts	Lumens per Watt	Type and Size Bulb	Diam. Bulb, Inches	Max. Over All Length, Inches	Screw Base Regularly Supplied	Standard Package Quantity	Our Package Quantity	Size of Lamp in Watts	Lumens per Watt	Type and Size Bulb	Diam. Bulb, Inches	Max. Over All Length, Inches	Screw Base Regularly Supplied	Standard Package Quantity	Our Package Quantity
10	7.52	S-17	2⅛	4⅞	Medium	100	120	75	11.53	PS-22	2¾	6⅛	Medium	50	64
15	8.32							100	12.57	PS-25	3⅛	7⅛	Medium	24	48
25	8.91							150	13.66	PS-25	3⅛	7⅛	Medium	24	24
40	9.24	S-19	2⅜	5¼	Medium	100	100	200	14.61	PS-30	3¾	8⅜	Medium	24	24
50	9.45							300	16.11	PS-35	4⅜	9¾	‡Mogul	24	
								400	16.76	PS-40	5	10	Mogul	12	
60	9.59	S-21	2⅝	5½	Medium	100	80								
								500	17.45	PS-40	5	10	Mogul	12	
								750	18.48	PS-52	6½	13⅜	Mogul	8	
								1000	19.33	PS-52	6½	13⅜	Mogul	8	

220 TO 250 VOLTS

Straight Side Mazda B Lamps								Pear-Shape Mazda C Lamps†							
25	7.62	S-19	2⅜	5¼	Medium	100	....	200	12.57	PS-30	3¾	8⅜	Medium	24	
50	8.43	S-19	2⅜	5¼	Medium	100	....	300	13.66	PS-35	4⅜	9¾	Mogul	24	
								500	14.78	PS-40	5	10	Mogul	12	..
100	9.04	S-30	3¼	7⅞	Medium skirted	24	....	1000	17.45	PS-52	6½	13⅜	Mogul	8	
150	9.45	S-35	4⅜	8¾	Medium skirted	24	....								
250	10.47	S-40	5	10	Medium skirted†	12	....								

220-250 VOLT MILL TYPE MAZDA B LAMPS								110-125 VOLT WHITE MAZDA LAMP							
25	7.10	S-19	2⅜	5¼	Medium	100	....	50	.....	PS-20	2½	5⅛	Medium	80	
50	7.76	S-19	2⅜	5¼	Medium	100	....								

Lamps of voltages of 100 to 109, 126 to 130, 200 to 219 and 251 to 260 inclusive are not regularly carried in stock but may be obtained at the same list prices.

†Orders for Mazda C lamps should specifically state if lamps are for use in other than pendent position.

‡Medium Screw Skirted Base (the lamp having maximum over all length of 10¼ in. and light center 7½ in.) will be supplied at same price if demanded but attention is called to the fact that the use of Mazda C lamps of this wattage in Medium Screw Sockets is contrary to the Rules of the Underwriters.

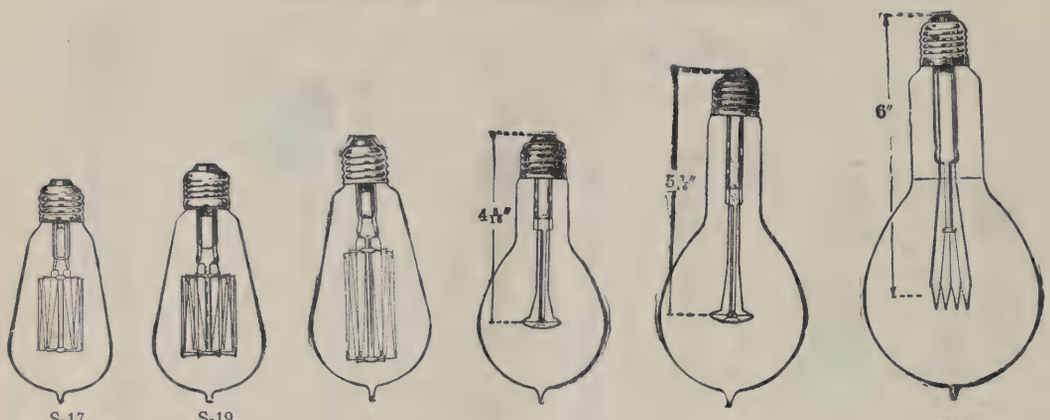
WESTINGHOUSE LAMP COMPANY

165 Broadway, New York, N. Y.

Sales Offices and Warehouses Throughout the Country

FRANKLIN MAZDA LAMPS

FOR STANDARD LIGHTING SERVICE



S-17 10 AND 15 WATTS | S-19 25, 40 AND 50 WATTS | S-21 60 WATTS | PS-22 75 WATTS | PS-25 100 WATTS | PS-30 200 WATTS

These lamps constitute more than 75 per cent of the usual lamp demand for such service as residence, store and office lighting. The higher wattage sizes are used for various industrial and store lighting purposes. These lamps are for use on 110 to 125 volt and 220 to 260 volt lighting circuits. Proper reflector equipment should be provided to protect the eyes from the extremely bright filaments of MAZDA C lamps, especially whenever the lamps are hung low and in the usual line of vision.

110 TO 125 VOLTS

Straight Side Mazda B Lamps								Pear-Shape Mazda C Lamps†							
Size of Lamp in Watts	Lumens per Watt	Type and Size Bulb	Diam. Bulb, Inches	Max. Over All length, Inches	Screw Base Regularly Supplied	Standard Package Quantity	Our Package Quantity	Size of Lamp in Watts	Lumens per Watt	Type and Size Bulb	Diam. Bulb, Inches	Max. Over All Length, Inches	Screw Base Regularly Supplied	Standard Package Quantity	Our Package Quantity
10	7.52	S-17	2⅛	4⅞	Medium	100	120	75	11.53	PS-22	2¾	6⅛	Medium	50	....
15	8.32							100	12.57	PS-25	3⅛	7⅛	Medium	24	....
25	8.91							150	13.66	PS-25	3⅛	7⅛	Medium	24	....
40	9.24	S-19	2⅜	5¼	Medium	100	100	200	14.61	PS-30	3¾	8⅜	Medium	24	....
50	9.45							300	16.11	PS-35	4⅜	9¾	‡Mogul	24	....
								400	16.76	PS-40	5	10	Mogul	12	....
60	9.59	S-21	2⅝	5½	Medium	100	80	500	17.45	PS-40	5	10	Mogul	12	....
								750	18.48	PS-52	6½	13⅜	Mogul	8	....
								1000	19.33	PS-52	6½	13⅜	Mogul	8	....

220 TO 250 VOLTS

Straight Side Mazda B Lamps								Pear-Shaped Mazda C Lamps†							
25	7.62	S-19	2⅜	5¼	Medium	100	....	200	12.57	PS-30	3¾	8⅜	Medium	24	....
50	8.43	S-19	2⅜	5¼	Medium	100	....	300	13.66	PS-35	4⅜	9¾	Mogul	24	....
100	9.04	S-30	3¾	7⅞	Medium skirted	24	....	500	14.78	PS-40	5	10	Mogul	12	....
								1000	16.76	PS-52	6½	13⅜	Mogul	8	....

220–250 VOLT MILL TYPE MAZDA B LAMPS								110–125 VOLT WHITE MAZDA LAMP							
25	7.10	S-19	2⅜	5¼	Medium	100	....	50	.....	PS-20	2½	5⅛	Medium	50	80
50	7.76	S-19	2⅜	5¼	Medium	100	....								

Lamps of voltages of 100 to 109, 126 to 130, 200 to 219 and 251 to 260 inclusive are not regularly carried in stock but may be obtained at the same list prices.

†Orders for MAZDA C lamps should specifically state if lamps are for use in other than pendent position.

‡Medium Screw Skirted Base (the lamp having maximum over all length of 10¼ in. and light center 7⅛ in.) will be supplied at same price if demanded but attention is called to the fact that the use of MAZDA C lamps of this wattage in Medium Screw Sockets is contrary to the Rules of the Underwriters.

Franklin Mazda Lamps are also made for ornamental lighting, sign lighting, electric street railway service, train lighting service, rural lighting and for use in series on street lighting circuits.

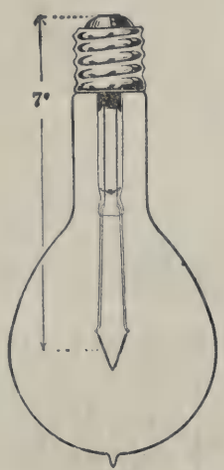
Prices and other information regarding these lamps will be furnished on request.

FRANKLIN INCANDESCENT LAMP WORKS
OF WESTINGHOUSE LAMP COMPANY
165 Broadway New York, N. Y.

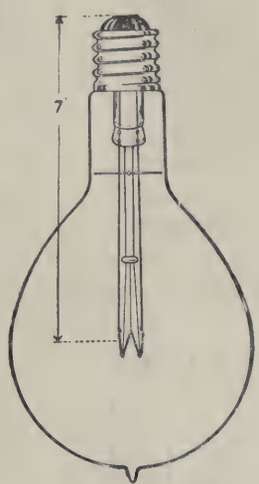
WESTINGHOUSE MAZDA C LAMPS

FOR STREET LIGHTING SERVICE

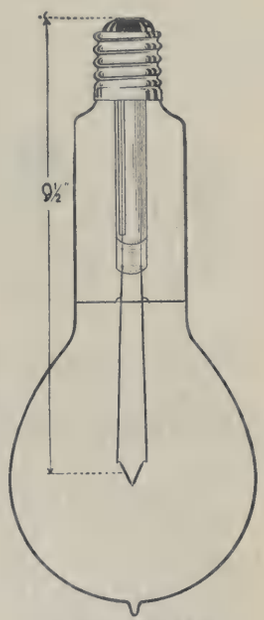
S-24½
60, 80 AND 100 C-P
5.5, 6.6 AND 7.5 AMP.



PS-35
250 C-P.
5.5, 6.6 AND 7.5 AMP.



PS-40
400 C-P.
5.5 AND 6.6 AMP.



PS-40, 400 C-P. 15 AMP.
AND 600 C-P. 20 AMP.
LIGHT CENTER LENGTH IS
8¼ IN. FOR TIP UP BURNING

The following lamps are for use on constant current circuits. A small compensator made for each size of lamp is used with the 15 and 20 ampere lamps to raise the current from 5.5, 6.6 or 7.5 amperes to the 15 or 20 amperes required.

The prices of lamps for rectifier service, which are not included in the following, may be obtained on application.

Amperes	Nominal Rated Candle-Power	Total Lumens	Average Volts	Type and Size Bulb	Diam. Bulb, Inches	Maximum Over All Length, Inches	Screw *Base Regularly Supplied	Standard Package Quantity
6.6	60	600	7.4	S-24½	3 1/16	7¼	Mogul	50
	80	800	9.2	S-24½	3 1/16	7¼	Mogul	50
	100	1000	10.9					
	250	2500	23.5	PS-35	4 3/4	9 3/4	Mogul	24
	400	4000	37.6	PS-35	4 3/8	9 3/4	Mogul	24
	600	6000	56.4	PS-40	5	10	Mogul	12
15.0	400	4000	14.9	PS-40	5	12½	Mogul	12
20.0	600	6000	15.5	PS-40	5	12½	Mogul	12
	1000	10000	25.9	PS-40	5	12½	Mogul	12

Orders for lamps of 250 and higher candle-power should specifically state if lamps are to be burned in other than pendent position.

The light center length of the 15 and 20 ampere MAZDA C lamps shown above is 9½ in. for burning in pendent position and 8¼ in. where ordered for burning tip up.

*Medium Screw Skirted Base also supplied at same price, except for the 400, 600 and 1000 c-p. lamps which are supplied only with Mogul Screw Base as indicated

MAZDA lamps for street series service selected for use on multiple compensators or for any other purpose where a single voltage or a range of voltages closer than standard are required will take a special price which may be obtained upon application.

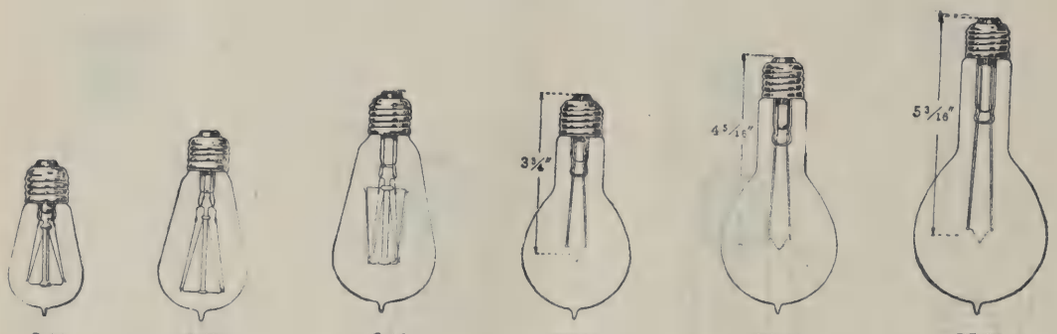
WESTINGHOUSE LAMP COMPANY

165 Broadway, New York, N. Y.

Sales Offices and Warehouses Throughout the Country

WESTINGHOUSE MAZDA LAMPS

FOR RURAL LIGHTING



S-14 5 WATTS | S-17 10 AND 20 WATTS | S-19 40 WATTS | PS-20 50 WATTS | PS-22 75 WATTS | PS-25 100 WATTS

These lamps are generally used on the circuits of country home lighting outfits having 16 cells of acid (lead storage) battery or 24 cells of alkaline battery in connection with a generator. The capacity of country home lighting outfits is usually expressed in number of 20 watt lamps which it will light without overloading batteries and generator. Thus a 50 lamp country home lighting outfit will light fifty 20 watt lamps or twenty-five 40 watt lamps, etc.

28 TO 32 VOLT MAZDA B LAMPS

Labeled Watts (Nominal)	Lumens per Watt	Type and Size Bulb	Diameter Bulb, Inches	Maximum Over All Length, Inches	Screw Base Regularly Supplied	Standard Package Quantity	Our Package Quantity
5	8.73	S-14	1¾	4¼	Medium	100	100
10	9.17	S-17	2⅛	4⅞	Medium	100	120
20	9.74	S-17	2⅛	4⅞	Medium	100	120
40	10.13	S-19	2⅜	5¼	Medium	100	100

28 TO 32 VOLT MAZDA C LAMPS

Labeled Watts (Nominal)	Lumens per Watt	Type and Size Bulb	Diameter Bulb, Inches	Maximum Over All Length, Inches	Screw Base Regularly Supplied	Standard Package Quantity	Our Package Quantity
50	14.78	PS-20	2½	5½	Medium	50	80
75	15.71	PS-22	2¾	6⅛	Medium	50	64
100	16.76	PS-25	3⅛	7⅛	Medium	24	48

NOTE.—The watts per horizontal candle-power of the MAZDA B lamps are as follows: 5 watt 1.14, 10 watt 1.08, 20 watt 1.02, and 40 watt 0.98.

FOR SIGN LIGHTING SERVICE

STRAIGHT SIDE MAZADA B LAMPS

Volts	Size of Lamp in Watts	Lumens per Watt	Watts per Spherical C.P.	Type and Size Bulb	Diam. Bulb, Inches	Maximum Over All Length, Inches	Screw Base Regularly Supplied	Standard Package Quantity
*11 to 12½	5	8.61	1.46	S-14	1¾	4¼	Medium	100
†55 to 65	5	7.26	1.73	S-14	1¾	4¼	Medium	100
‡110 to 125	10	7.26	1.73	S-14	1¾	4¼	Medium	100

Sign lamps are divided into three groups as follows:

11 TO 12½ VOLTS

On alternating current circuits these lamps are generally operated on a transformer circuit where the voltage is reduced from 110-125 to 11-12½ volts. These lamps are available in ½ volt steps from 11 to 12½ volts inclusive.

If direct current only is available these lamps may be burned, if so desired, ten in series on a standard 110 to 125 volt circuit.

55 TO 65 VOLTS

These lamps are generally burned two in series or grouped in series multiple on standard 110 to 125 volt circuit.

110 to 125 VOLTS

These lamps are for use on regular multiple or ordinary lighting circuits.

*Lamps of voltages of 10, 10½ and 13 are not regularly carried in stock but may be obtained at the same list prices.

†Lamps of voltages of 50 to 54 inclusive are not regularly carried in stock but may be obtained at the same list prices.

‡Lamps of voltages of 100 to 109 and 126 to 130 inclusive are not regularly carried in stock but may be obtained at the same prices.

NOTE.—The watts per horizontal candle-power of the above lamps are as follows: 2½ watt 1.20, 5 watt 11-12½ volts 1.15, 5 watt 55–65 volts, 1.35, and 10 watt 1.35.

WESTINGHOUSE LAMP COMPANY

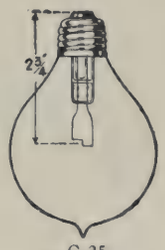
165 Broadway, New York, N. Y.

Sales Offices and Warehouses Throughout the Country

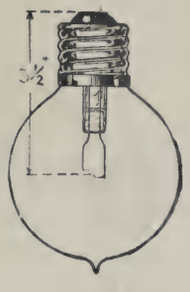
WESTINGHOUSE MAZDA LAMPS

TRAIN LIGHTING SERVICE

G-18½
36 WATTS
5½ & 6 VOLTS



G-25
72 WATTS
5½ & 6 VOLTS
CAN BE BURNED IN ANY POSITION



G-30
108 WATTS
5½ & 6 VOLTS

G-18½
10, 15, 20 & 25 WATTS
30-34 & 60-65 VOLTS

G-30
50-WATTS
30-34 & 60-65

The 30 to 34 and 60 to 65 volt lamps are generally operated from locomotive headlight outfits or 16 and 32 cell battery lighting systems respectively. These lamps are used for ordinary train lighting service.

Total Lumens	Labeled Watts (Nominal)	Lumens per Watt	Type and Size Bulb	Diameter Bulb, Inches	Maximum Over All Length, Inches	Screw Base Regularly Supplied	Standard Package Quantity	Our Package Quantity	Total Lumens	Labeled Watts (Nominal)	Lumens per Watt	Type and Size Bulb	Diameter Bulb, Inches	Maximum Over All Length, Inches	Screw Base Regularly Supplied	Standard Package Quantity	Our Package Quantity
‡30 TO 34 VOLTS STRAIGHT SIDE MAZDA B LAMPS									**‡30 TO 34 VOLTS ROUND MAZDA B LAMPS**								
85	10	9.17	S-17	2⅛	4⅞	Medium	100	120	85	10	8.73	G-18½	2 $\frac{5}{16}$	3¾	Medium	100	125
125	15	9.59							125	15	9.11						
175	20	9.74															
¶125	15	8.16	S-17	2⅛	4⅞	Medium	100	120									
250	25	9.74	S-17	2⅛	4⅞	Medium	100	120	250	25	9.24	G-18½	2 $\frac{5}{16}$	3¾	Medium	100	125
500	50	10.13	S-19	2⅜	5¼	Medium	100	100	500	50	10.30	G-30	3¾	6¼	Med. sk.	24	24
§60 TO 65 VOLTS STRAIGHT SIDE MAZDA B LAMPS									**§60 TO 65 VOLTS ROUND MAZDA B LAMPS**								
85	10	8.73	S-17	2⅛	4⅞	Medium	100	120	125	15	8.73	G-18½	2 $\frac{5}{16}$	3¾	Medium	100	125
125	15	9.11															
175	20	9.24															
250	25	9.24	S-17	2⅛	4⅞	Medium	100	120	250	25	8.85	G-18½	2 $\frac{5}{16}$	3¾	Medium	100	125
500	50	10.13	S-19	2⅜	5¼	Medium	100	100	500	50	10.30	G-30	3¾	6¼	Med. sk.	24	24

30 TO 34 VOLT ROUND—MAZDA C LAMPS FOR LOCOMOTIVE HEADLIGHT SERVICE

	Watts							
...	100	13.96	G-25	3⅛	5	Medium	50	64
...	150	14.78	G-25	3⅛	5	Medium	50	64
...	250	17.95	†G-30	3¾	5½	Medium	24	24

†Can be burned in any position except within 45 degrees of vertically, base up.
‡Lamps of voltages of 25 to 29 inclusive are not regularly carried in stock but may be obtained at the same list prices.
§Lamps of voltages of 50 to 59 inclusive are not regularly carried in stock but may be obtained at the same list prices.
¶34 volts only. For locomotive cab lighting service.

FOR ELECTRIC RAILWAY SERVICE

Nominal Watts	Amperes	Lumens per Watt	Type and Size Bulb	Diameter Bulb, Inches	Maximum Over All Length, Inches	Screw Base Regularly Supplied	Standard Package Quantity	Our Package Quantity
STRAIGHT SIDE MAZDA B LAMPS								
23	0.214	8.43	*S-19	2⅜	5¼	Medium	100	100
36	0.342	8.73	S-19	2⅜	5¼	Medium	100	100
56	0.519	9.52	S-21	2⅝	5½	Medium	100	80
94	0.863	9.89	S-24½	3 $\frac{1}{16}$	7⅜	Medium	50	50

These MAZDA lamps are selected for amperes and labeled for use five in series on the 525, 550, 575, 600, 625 and 650 volt circuits ordinarily used by electric street railway companies.

As considerable voltage fluctuation is sometimes found in this class of circuits, these lamps are manufactured only for six-voltage groups and care should be taken to see that the voltage group of lamps supplied corresponds closely to the average voltage found on the circuit.

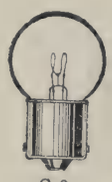
*The bulb for this lamp will eventually be superseded by an S-17 bulb. Only the above lamps which are selected for amperes and for one-fifth the voltage on which they are labeled for use in series will be supplied at these prices.

NOTE.—The watts per horizontal candle-power of the above lamps are as follows: 23 watt 1.16, 36 watt 1.12, 56 watt 1.04, and 94 watt 1.00.

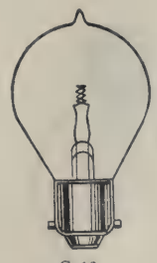
WESTINGHOUSE LAMP COMPANY
165 Broadway, New York, N. Y.
Sales Offices and Warehouses Throughout the Country

WESTINGHOUSE McCANDLESS MAZDA AUTOMOBILE LAMPS

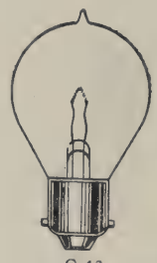
G-6
REAR AND SPEEDOMETER LIGHT
3 CELL (6-8 VOLTS)



G-8
SIDE LIGHT
3 CELL
(6-8 VOLTS)

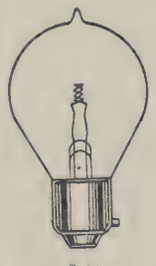


G-12
HEADLIGHT
MAZDA B
3 CELL (6-8 VOLTS)

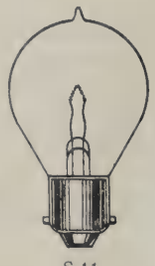


G-12
HEADLIGHT
MAZDA C
3 CELL (6-8 VOLTS)

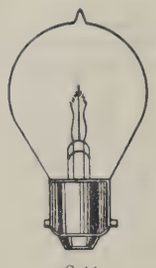
BAYONET
CANDELABRA BASE
(SINGLE CONTACT)



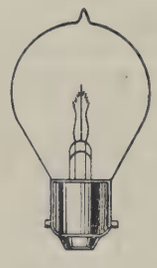
S-11
HEADLIGHT
MAZDA B
FORD CAR MAGNETO



S-11
HEADLIGHT
MAZDA C
FORD CAR MAGNETO



S-11
HEADLIGHT
MAZDA B
6 CELL (12-16 VOLTS)



S-11
HEADLIGHT
MAZDA C
6 CELL (12-16 VOLTS)

BAYONET
CANDELABRA BRACE
(DOUBLE CONTACT)

LAMPS EOR 3 CELL (LEAD TYPE) STORAGE BATTERY— GENERATOR LIGHTING SYSTEMS (6-8 VOLTS)

Description	New Mazda No. S.C.	New Mazda No. D.C.	Volts	Amperes	Approx. Candle Power	Type and Size Bulb	Diam. Bulb In.	Max. over all Length In.	Unit Package Quantity
Rear and Speedometer (2 in series)	Mazda 61	Mazda 62	3- 4	0.84	2	G- 6	¾	1⅜	10
Rear and Speedometer	Mazda 63	Mazda 64	6- 8	0.42	2	G- 6	¾	1⅜	10
Side	Mazda 81	Mazda 82	6- 8	0.84	4	G- 8	1	1¾	10
Mazda B Headlight	Mazda 1125	Mazda 1126	6- 8	2½	15	S-11	1½	2½	10
Mazda C Headlight	Mazda 1129	Mazda 1130	6- 8	2½	21	S-11	1½	2½	10

LAMPS FOR FORD MAGNETO LIGHTING SYSTEM

Mazda B Headlight		Mazda 1136	9	2	18	S 11	1½	2½	10
Mazda C Headlight (2 in series)		Mazda 1138	9	2	27	S-11	1½	2½	10

LAMPS FOR 6 CELL (LEAD TYPE) STORAGE BATTERY— GENERATOR LIGHTING SYSTEM (12-16 VOLTS)

Rear and Speedometer (2 in series)	Mazda 63	Mazda 64	6- 8	0.42	2	G- 6	¾	1⅜	10
Rear and Speedometer	Mazda 67	Mazda 68	12-16	0.26	2	G- 6	¾	1⅜	10
Side	Mazda 89	Mazda 90	12-16	0.42	4	G- 8	1	1¾	10
Mazda B Headlight	Mazda 1139	Mazda 1140	12-16	1	15	S-11	1½	2½	10
Mazda C Headlight	Mazda 1141	Mazda 1142	12-16	1½	21	S-11	1½	2½	10

McCANDLESS MINIATURE LAMP WORKS
OF WESTINGHOUSE LAMP COMPANY
165 Broadway New York, N. Y.

WESTINGHOUSE McCANDLESS MAZDA LAMPS

FOR FLASHLIGHTS

F. E. 3¾
Opal Back
½" Diam.

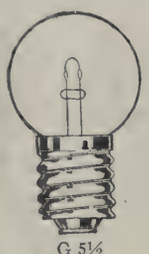
Mazda No.	Volts	Amp.	Base
1	2.5	.30	Min.
2	3.8	.30	Min.

G 4½
Clear
$\frac{9}{16}$" Diam

Mazda No.	Volts	Amp.	Base
19	1½	.60	Min.

G 5½
Clear
$\frac{11}{16}$" Diam.

Mazda No.	Volts	Amp.	Base
31	6.2	.30	Min.



G 5½
Clear
$\frac{11}{16}$" Diam.

Mazda No.	Volts	Amp.	Base
33	1½	.70	Min.
35	2.8	.80	Min.

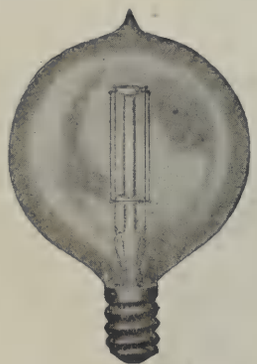
G 4½
Clear
$\frac{9}{16}$" Diam.

Mazda No.	Volts	Amp.	Base
16	2.9	.30	Min.
17	3.8	.30	Min.

G 3½
Clear
$\frac{7}{16}$" Diam.

Mazda No.	Volts	Amp.	Base
11	2.7	.30	Min.

CANDELABRA LAMPS



Style G 16½ Mazda
15 Watts,
Candelabra Base

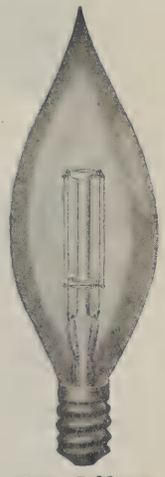
Mazda No.	Volts	Color
190	110	Clear
191	110	Frosted
192	115	Clear
193	115	Frosted
194	120	Clear
195	120	Frosted
196	125	Clear
197	125	Frosted

Style T8 (E) Mazda
15 Watts,
Candelabra Base

Mazda No.	Volts	Color
280	110	Clear
281	110	Frosted
282	115	Clear
283	115	Frosted
284	120	Clear
285	120	Frosted
286	125	Clear
287	125	Frosted

Style D Mazda
15 Watts,
Candelabra Base

Mazda No.	Volts	Color
260	110	Clear
261	110	Frosted
262	115	Clear
263	115	Frosted
264	120	Clear
265	120	Frosted
266	125	Clear
267	125	Frosted



Style B Mazda
15 Watts,
Candelabra Base

Mazda No.	Volts	Color
240	110	Clear
241	110	Frosted
242	115	Clear
243	115	Frosted
244	120	Clear
245	120	Frosted
246	125	Clear
247	125	Frosted

McCANDLESS MINIATURE LAMP WORKS
OF WESTINGHOUSE LAMP COMPANY

165 Broadway New York, N. Y.

EXAMPLES OF CORRECT INTERIOR ILLUMINATION

WESTINGHOUSE-COOPER HEWITT MERCURY RECTIFIER OUTFITS

APPLICATION

These outfits are used for the purpose of changing alternating current to direct current. They cannot be used to change direct current to alternating current or to charge batteries from direct-current supply circuits. They are intended for use only where alternating current is available, to obtain direct current necessary for the following purposes:

Battery charging for automobiles;
Battery charging for igniters for internal combustion engines;
Battery charging for telephone service;
Battery charging for signal and alarm systems;
Battery charging for railroad car lighting;
Battery charging for chemical work;
Battery charging for telegraph;
Battery charging for motor boats;
Arc lamps for projection purposes;
Arc lamps for moving picture machines;
Electrolytic work and electroplating;
Motors with battery for small medical and dental outfits; for graphophones, etc.

ADVANTAGES OF THE RECTIFIER

The mercury rectifier is a true **rectifier.** It acts as a switch, opening and closing alternate paths in such a manner that the two halves of the alternating-current waves are transformed into uni-directional waves, without other loss than the low electromotive force required to overcome the resistance of the bulb.

These rectifiers are easy to install and require little space, and their first cost is low compared with other devices used for changing alternating current to direct current. They are very simple to operate, and have no moving parts. The regulation of current is effected by means of an auto-transformer, so that power is not wasted; the efficiency of operation is therefore high.

PRINCIPLE OF OPERATION

The mercury rectifier consists essentially of a hermetically sealed glass bulb filled with mercury vapor and provided with four electrodes. The two upper electrodes (Fig. 1) are of graphite or other suitable material and the two lower of mercury. The graphite electrodes are the **anodes;** the main mercury electrode is the **cathode;** and the small one is the **supplementary starting** electrode. The mercury pools of the two lower electrodes are not in contact when the bulb is vertical, but the bulb is so mounted that it can be tilted to bring these two pools temporarily in contact for starting.

The bulb contains highly attenuated vapor of mercury, which, like other metal vapors, is an electrical conductor under some conditions. The anodes are surrounded by this vapor. Current can readily pass from either of the solid electrodes to the mercury vapor and from it to the mercury electrode, but when the direction of flow tends to reverse, so that current would pass from the vapor to the solid electrode, there is a resistance at the surface of the electrode, which entirely prevents the flow of current. The alternating-current supply circuit is connected to the two anodes as shown in the diagram (Fig. 1), and as the anodes will allow current to flow in only one direction and oppose any current flow in the opposite direction, the pulsations of the current pass alternately from one or the other of the anodes into the mercury. As these currents cannot pass from the vapor into either anode, they are constrained to pass out all in one direction through the mercury electrode, from which they emerge as a uni-directional current. The anodes of the rectifier thus act as check valves, permitting current to pass into the mercury vapor but preventing it from passing from the vapor to the solid electrodes.

Before the bulb starts to rectify, there is a high resistance at the surface of the mercury, which must be broken down so that the current can pass. This surface resistance is called the **cathode resistance,** and it acts like an insulating film over the entire surface of the mercury. The film must be punctured, or, in other words, the resistance must be overcome before any current can pass. When once started, the current will continue to flow, meeting with practically no resistance as long as the current is uninterrupted. Any interruption of the current, however, even for the smallest instant of time, permits the cathode resistance to re-establish itself, which stops the operation of the bulb.

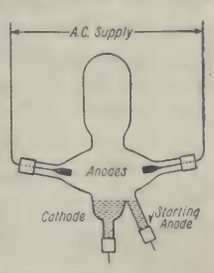


FIG. 1–DIAGRAM OF COOPER HEWITT MERCURY RECTIFIER BULB

In order to overcome this resistance the bulb is tilted or shaken so that the space between the main and supplementary mercury electrodes is bridged by the mercury. Current then passes between the two mercury electrodes from the source of e.m.f., and the little stream of mercury which bridges the space between the electrodes breaks with a spark as the bulb is returned to vertical position. This

PRINCIPLE OF OPERATION—Continued

spark breaks down the cathode resistance, after which the rectifier will continue to operate indefinitely as long as the current supply is uninterrupted and the direct-current load does not fall below the minimum required for the arc.

The action of the rectifier will be better understood by reference to the accompanying diagram, (Fig. 2), of current waves and impressed electromotive force. It should be emphasized that the whole of the alternating-current wave on both sides of the zero line is used. The two upper curves in the diagram show the current waves in each of the two anodes and the resultant curve III represents the rectified current flowing from the cathode. Curve IV shows the impressed alternating-current e.m.f. It is evident that if the part of the wave below the zero line were reversed, the resulting current would be a pulsating direct current with each pulsation varying from zero to a positive maximum. Such a current could not be maintained by the rectifier, because as soon as the zero value was reached the cathode resistance of the rectifier would be reestablished and the circuit would be broken. To avoid this condition, reactance is introduced into the direct-current circuit, which causes an elongation of current waves so that they overlap before reaching the zero value. The overlapping of the rectified current waves reduces the amplitude of the pulsations and produces a comparatively smooth direct current as shown in curve III.

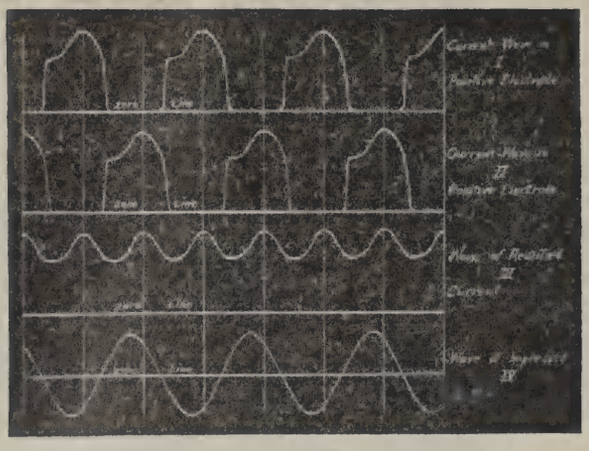


FIG. 2—DIAGRAM SHOWING CURRENT WAVES AND IMPRESSED ELECTROMOTIVE FORCE

The complete circuit of a mercury rectifier such as the type AN, is shown in the accompanying schematic diagram (Fig. 3) of connections for battery charging. The alternating-current supply circuit of either 110 or 220 volts is connected to suitable taps of an auto-transformer whose terminals are connected to the two anodes of the rectifier bulb. From the cathode **C** the current passes through the battery to be charged and the circuit is completed through a connection to the middle point of the auto-transformer. The auxiliary starting electrode **S** is so connected as to make it possible to produce a local current between **S** and **C**. When the bulb is tilted a mercury contact is formed between the electrodes **C** and **S** and a current is established, and when the bulb is returned to the vertical position a spark breaks down the cathode resistance and the bulb starts into operation.

Fig. 4 shows how the same result is attained and at the same time the bulb tilted by means of a magnet. When the two portions of the mercury come together they short-circuit the tilting coil and so reduce its pull to zero. The bulb promptly swings back and breaks the mercury bridge, producing the required spark.

Bulbs—The bulbs used in Westinghouse mercury rectifiers are of glass. The terminals are sealed in and the bulb is charged with mercury, exhausted and sealed. In operation a certain amount of heat

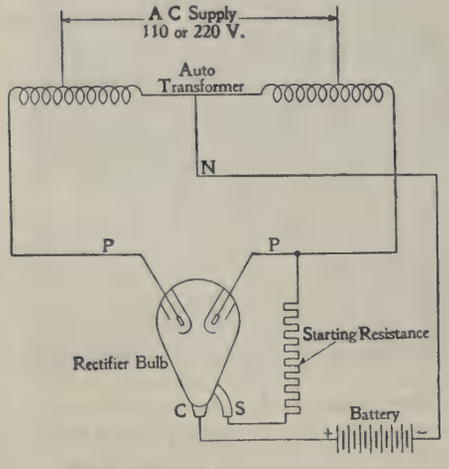


FIG. 3—DIAGRAM OF CONNECTIONS FOR BATTERY CHARGING

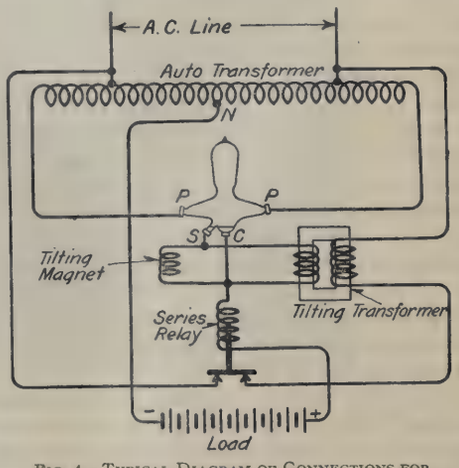


FIG. 4—TYPICAL DIAGRAM OF CONNECTIONS FOR AUTOMATIC STARTING

PRINCIPLE OF OPERATION—Continued

is developed and a portion of the mercury is evaporated. This increases the vapor pressure inside of the bulb. The bulb is made with a sufficient amount of surface to act as a condenser for the mercury vapor, and this condensation serves to maintain a low operating temperature. The bulb is the only part of the rectifier outfit that requires renewal.

The bulb is mounted in a cradle which is connected to a handle or an automatic tilting device. The bulbs are rated by their direct-current voltages and current rating, and can be used on any commercial frequency. The maximum rating of the bulb should not be exceeded. The terminals of the electrodes, outside of the bulbs, are provided with metal caps to which the connections are made.

NOTES ON CHARGING LEAD BATTERIES

The instruction book accompanying the battery should be carefully followed.

The ideal conditions for a lead battery are to have it fully discharged before recharging, yet never to have it remain partly discharged. It deteriorates if allowed to remain partly discharged, yet as each charge causes some deterioration charging ought to be done as infrequently as possible. In practice these conditions are obviously impossible to obtain. It is advisable to recharge the battery whenever it is likely to remain out of use for some time, and not to recharge it if the amount of charge remaining is sufficient for the prospective run.

Charge Characteristic—Battery makers often recommend a high charging rate and a low finishing rate, with one or more steps between. This merely represents a convenient approximation to the ideal charge, the tapering characteristic, as the gradually tapering charge cannot be obtained with most types of charging apparatus. Mercury rectifier outfits produce a tapering charge automatically, and the directions for changing the charging rate may be disregarded.

A constant charging rate, occasionally desirable when a hurry charge is needed, can be obtained by raising the setting of the dial switches as the charge proceeds. No attempt should be made, however, to operate at a higher current than the rating of the outfit.

Termination of Charge—When great precision is required the charge must be stopped when hydrometer, thermometer and voltmeter readings indicate a full charge according to the instructions of battery makers. Where less care is considered necessary the voltmeter readings alone may be used as a guide, though this method should be checked occasionally by more complete readings, probably at the end of the gassing charge, once every two weeks, at which time it is well to inspect all cells.

A third method, which is still less exact, is to set the rectifier so that it will cease to rectify when the cell voltage is near to maximum possible value. If this is done the rectifier should either be disconnected by hand when the charge is complete or by a time switch. In no case should the ability of the rectifier to drop out at the completion of the charge be relied upon without other means for positively disconnecting it from the circuit. This is necessary because of the fact that both the alternating-current line voltage and the condition of the battery are variable and often unknown.

In case entirely automatic charging is desired, the Westinghouse Time Switch Style No. 152526 must be used to end the main charge at a given hour and to prevent accidental overcharge.

FREIGHT CHARGES

To the net price of each outfit and low-tension Cooper Hewitt rectifier bulb delivered, by freight in any zone there must be added the amount shown in the price tables.

The price on all shipments f.o.b. cars Works is the net price plus Eastern zone freight. When express shipment is specified by a customer, the price f.o.b. cars Works or warehouse is therefore the net price plus Eastern zone freight, and the price f.o.b. customer's city is the net price plus Eastern zone freight plus express charges.

Eastern Zone—The Eastern Zone includes all points on or east of the west bank of the Mississippi River and all territory east of a line beginning at the intersection of a point where the 95th meridian of longitude crosses the headwaters of the Mississippi River, thence forth on said meridian to the Canadian boundary.

Central Zone—The Central Zone includes all points in North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, Texas, Colorado, and points in Minnesota, Iowa, Missouri, Arkansas, and Louisana west of the Mississippi River, also the Panama Canal zone including the cities of Colon and Panama.

Western Zone—The Western Zone includes all points in Arizona, California, Idaho, Montana, New Mexico, Nevada, Oregon, Utah, Washington, and Wyoming.

Hawaiian Islands and Alaska—Prices for Hawaiian Islands and Alaska are f.o.b. point of ocean shipment (zone freight being added), the ocean freight to be paid by customer.

DELIVERY

All quotations and sales are f.o.b. cars at zone delivery rates.

TYPE W OUTFITS

FOR CHARGING VEHICLE BATTERIES

Lead or Edison Cells

FRONT VIEW REAR VIEW

TYPE W 30-AMPERE RECTIFIER

Type W rectifier outfits are designed to furnish a small, light inexpensive outfit, for use where frequent adjustment is not necessary, as where the same battery will always be charged.

The type W outfit is not automatic in operation, that is, it will not start itself or stop itself, and if the line voltage fails temporarily the rectifier will not restart itself. To start it the bulb must be tilted by hand by means of the tilting handle.

Adjustment—The regulation link connectors controlling transformer taps are provided by means of which the outfit can be adjusted to deliver approximately normal current to any number of cells within its rating on any line voltage within 10 per cent of normal. The current automatically tapers as the charge progresses, so that the charge finishes at a low rate as recommended by battery manufacturers.

Construction—Type W outfits are so mounted on a solid cast iron frame that the minimum of space is used. The bulb is completely protected from the front as no portion of it extends beyond the frame. The tilting device is easily manipulated the bulb being returned to normal position by a spring which holds it there during operation.

The starting switch, link connectors, terminals and fuses are mounted on a slate panel on the front of the outfit, easily accessible.

These outfits are suited for floor mounting only and are shipped drilled for the mounting of meters. —Use Style No. 185394, type FW ammeter, and Style No. 185403, type FW voltmeter.

PRICES AND RATINGS

List price includes outfit complete with one bulb, ammeter and voltmeter. Style number does not include meters.

Style No.	A. C. Volts	Number of Lead Cells	Number of Edison Cells	D. C Volts	D. C. Amps.	Approx. Wt. Lbs. Net	Shipping	List Price	Add Freight Eastern Zone	Central Zone	Western Zone
233907	110	38 to 46	56 to 66	76 to 120	30	190	280	$225 00	$6 50	$16 00	$27 00
233908	220	38 to 46	56 to 66	76 to 120	30	175	265	225 00	6 50	16 00	27 00

For special ordering instructions see last page.

TYPES AA AND AN OUTFITS
FOR CHARGING LEAD-CELL VEHICLE BATTERIES

TYPE AA OR AN BATTERY-CHARGING OUTFIT

TYPE AA RECTIFIER, COVER REMOVED

The type AN outfit is not automatic in operation; that is, it will not start itself or stop itself, and if the line voltage fails temporarily, the rectifier will not restart itself. To start it, the bulb must be tilted by hand, by means of a tilting handle.

The type AA outfit has the same features as the type AN and in addition a tilting magnet for automatic starting, and a relay circuit-breaker. In case of a failure of the line voltage, which will stop the rectifier, the cutout closes the tilting transformer circuit so that the rectifier is ready to restart itself when the voltage is again applied. In case of excessive direct-current the cut-out coil opens the circuit-breaker contacts.

Charge Characteristic—The reactance for both types is so designed as to give the proper charge characteristic for lead batteries without changing the position of the dial switches during the charge, if the line voltage remains constant. With proper setting, the charging current tapers off from 30 amperes to 5 or 6 amperes as the battery voltage rises. This feature should not be depended on, however, to terminate the charge, because of the uncertainties of alternating-current voltage and variations in the condition of the battery. A positive disconnection of the rectifier, either by hand or by means of a time switch is essential. If the circuit is opened by a time switch and the charge is found to be incomplete, it can be completed in a comparatively short time when attendance is available.

Adjustment of voltage or charging current is made by means of the two dial switches, which control the connections to the reactance coil and to both the primary and secondary of the auto-transformer. Part of the reactance is always in series with the primary circuit and acts as a balance, raising the secondary voltage as the current diminishes.

PRICES AND RATINGS

Style number and price include outfit complete with one bulb. The outfit is enclosed in a properly ventilated iron case and the leads are brought out through suitable bushings. This gives complete protection to the bulb. The rectifier is entirely self-contained and no live parts are exposed. Instruments should be ordered as separate items, if desired, or an instrument panel as listed.

60-Cycle Outfits

Style No.	Type	A.C. Volts	No. of Cells	D.C. Volts	D.C. Amperes	Approx. Wt. Lbs. Net	Approx. Wt. Lbs. Shipping	List Price	Add Freight Eastern Zone	Add Freight Central Zone	Add Freight Western Zone
145578	AN	110	14 to 32	28 to 85	30	385	485	$340 00	$6 00	$14 50	$25 00
145579	AN	220	14 to 32	28 to 85	30	385	485	340 00	6 00	14 50	25 00
145580	AN	110	20 to 44	40 to 120	30	475	575	380 00	6 00	14 50	25 00
145581	AN	220	20 to 44	40 to 120	30	475	575	380 00	6 00	14 50	25 00
145582	AA	110	14 to 32	28 to 85	30	410	520	360 00	6 00	14 50	25 00
145583	AA	220	14 to 32	28 to 85	30	400	510	360 00	6 00	14 50	25 00
145584	AA	110	20 to 44	40 to 120	30	500	600	400 00	6 00	14 50	25 00
145585	AA	220	20 to 44	40 to 120	30	500	600	400 00	6 00	14 50	25 00

For special ordering instructions see last page.

TYPE AE OUTFITS

FOR CHARGING EDISON-CELL VEHICLE BATTERIES

TYPE AE OUTFIT

The type AE rectifier outfits are similar to the type AA but designed particularly for storage batteries of the Edison type. The standard outfits are for use with batteries of 20 to 60 cells.

The rectifier is self-starting like the type AA and must be stopped either manually or by means of a time switch.

A panel, Style No. 159321, containing line switch, fuses and overload circuit-breaker, ready to connect to alternating-current line, is included in style number and list price of the type AE outfit. This panel is mounted on the rectifier.

Charge Characteristic—The outfit is intended for charging Edison cells and the reactance and transformer are proportioned so that a charge which starts at about 50 amperes will finish at between 30 and 35 amperes without change of dial settings.

Adjustment—Very exact current adjustment can be obtained, as the outfit has 49 points of regulation.

PRICES AND RATINGS

Style number and price include outfit complete with one bulb and control panel. The outfit is enclosed in a properly ventilated iron case and the leads are brought out through suitable bushings. This gives complete protection to the bulb. The rectifier is entirely self-contained and no live parts are exposed except on the panel.

Style No.	A.C. Volts	No. of Cells	D.C. Volts	D.C. Amps.	Approx. Wt. Lbs. Net	Shipping	List Price	Add Freight Eastern Zone	Central Zone	Western Zone
154609	110	20 to 60	30 to 120	50	800	1000	$500 00	$10 00	$25 00	$50 00
154610	220	20 to 60	30 to 120	50	800	1000	500 00	10 00	25 00	50 00

TYPE E OUTFITS

FOR CHARGING IGNITION AND LIGHTING BATTERIES

LARGE CAPACITY TYPE E 5 AND 10-AMP. OUTFIT WITH METER

TYPE E 10-AMP. OUTFIT, STYLE NO. 154611 WITH METERS

Type E outfits for charging starting, lighting and ignition batteries, are intended for the use of garage and service stations where the number of batteries to be charged is constantly varying.

Owing to the small size of this type, the outfit is arranged for wall mounting. An iron frame with four feet is provided for this purpose and serves to support a slate panel carrying the bulb, switches, etc. On all except the largest outfit the transformer is also mounted on this frame, thus making the outfit entirely self-contained in one mounting. In the case of the largest outfit listed, the transformer is mounted separately in end caps and a terminal board is provided on the outfit to which it is to be wired, when installed.

All outfits can be used on either 110 or 220-volt circuits by changing link connections on the front of the panel. All are also provided with an alternating-current line switch and a direct-current fuse. A tilting handle is provided for hand-starting and the operation is non-automatic.

The small 5-ampere outfit Style No. 152999, is designed primarily for the individual user or small garage where only one or two three-cell batteries or one six-cell battery need to be charged at once. The low current rate is suited to the smaller size batteries, notably those used on motor-cycles. From one to seven lead cells can be charged by connecting to the proper terminals on the panel. The charging current is maintained automatically at 4½ to 5 amperes throughout the charge.

The small 10-ampere outfit Style No. 154611, is similar except that the current can be adjusted by means of three small dial switches. This outfit will charge 3 to 10 lead cells and is particularly suited to the individual user or the small garage. Three 3-cell lead batteries can be charged at once in series from it. Provision is made for mounting both a type AW voltmeter and ammeter if desired.

The larger 5 and 10-ampere outfits are especially designed for use in garages that have a considerable number of batteries to charge at one time. Because of the widely varying conditions to be met they have been made as flexible in control as possible. No series resistance is used, so the efficiency is higher than could be obtained by any other means for this service.

In the case of the four larger type E outfits provision is made for mounting a type AW ammeter on the panel if desired. No voltmeter mounting is provided for, as the total direct-current voltage is valueless where a number of separate batteries are charged in series. A portable voltmeter (such as the type PW) is recommended for measuring the voltage of the individual batteries.

PRICES AND RATINGS

Style number and price include outfit complete with one bulb. Meter is not included and should be ordered as a separate item if desired.

Style No.	A.C. Volts	No. of Cells	D.C. Volts	D.C. Amps.	Approx. Wt. lbs. Net	Approx. Wt. lbs. Shipping	List Price	Add Freight Eastern Zone	Add Freight Central Zone	Add Freight Western Zone
152999	110 or 220	1 to 7	2 to 16	5	70	130	$100 00	$2 00	$7 25	$11 37
222305	110 or 220	1 to 18	2 to 45	5	100	160	175 00	2 00	7 25	11 37
222306	110 or 220	1 to 36	2 to 85	5	100	160	190 00	2 00	7 25	11 37
154611	110 or 220	3 to 10	6 to 28	10	85	145	155 00	2 00	7 25	11 37
222307	110 or 220	1 to 18	2 to 45	10	100	160	190 00	2 00	7 25	11 37
222308	110 or 220	1 to 36	2 to 85	10	115	175	220 00	2 00	7 25	11 37

Outfits of this type can be furnished for special uses where higher direct-current voltages are required; for instance, for operating small 110-volt direct-current motors. Prices on these special outfits furnished on application.

TYPE AT OUTFITS

FOR CHARGING TELEPHONE BATTERIES

In telephone work it is essential that current pulsations be eliminated as far as possible and that the battery circuit be insulated from the supply circuit so that disturbances due to grounds on the alternating-current line will be avoided. The type AT rectifier outfit has been designed with these points in view. The outfits include damping coils to eliminate all noise due to pulsations of battery voltage during charging. The usual auto-transformer is replaced by a two-winding transformer to insulate the telephone circuit from the supply circuit.

50-AMPERE OUTFIT

Larger Outfits

The 20, 30, 40, and 50-ampere outfits are designed for lead batteries of 11 and 17 cells in series. The rate of the charge can be adjusted and will be practically constant for any setting of the regulating dials. The rectifier is not self-starting.

Regulating dials are provided giving 15 points of current adjustment.

Link connections are also provided for adapting the outfit for use on either 110 or 220-volt circuits.

These outfits are primarily designed and the dial switch steps suitably proportioned for charging one particular number of cells, either 11 or 17 as listed. Link connections are provided which makes possible the use of the outfit for charging either 11 or 17 cells, but the dial steps are especially proportioned for the number of cells for which the outfit is primarily listed, and the regulation of current is not as close on the other number of cells.

10-Ampere Outfits

The 10-ampere type AT outfits are in general appearance similar to the standard type E outfits. A slate panel carrying the control switches, meters, line switch, bulb, etc., is mounted together with the transformer and sustaining coil on a frame arranged for wall mounting. Electrically the outfits are similar to the larger sizes of this type, except that the standard outfit is for 11 cells only. Panels are drilled and wired for meters as in the case with the type E outfits. Two four-point dial switches are provided for current control and snap switches for the alternating-current and direct-current lines. Link connections are provided whereby the transformer connections can be changed for operation on either 110 or 220-volt circuits. A special knife switch is provided which is used to transfer the ammeter from the direct-current circuit of the outfit to the load circuit, thus permitting the reading of both charge and discharge current when the battery is floating on the line.

10-AMPERE OUTFIT

PRICES AND RATINGS

Style number and price include outfit complete with one bulb. The outfit is enclosed in a properly ventilated iron case and the leads are brought out through suitable bushings. This gives complete protection to the bulb. The rectifier is entirely self-contained and no live parts are exposed. Instruments should be ordered as separate items, if desired, or an instrument panel as listed.

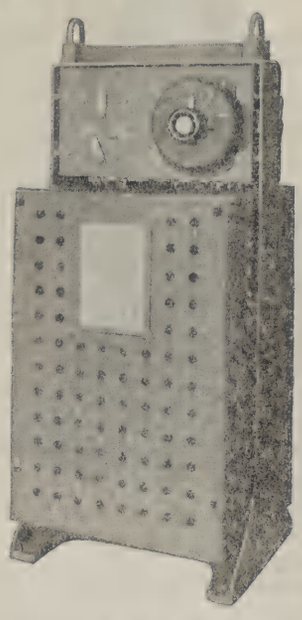
Style No.	A.C. Volts	No of Cells	D.C. Volts	D.C. Amps.	Approx. Wt. Lbs. Net	Approx. Wt. Lbs. Shipping	List Price	Add Freight Eastern Zone	Add Freight Central Zone	Add Freight Western Zone
220241	110 or 220	11 only	22 to 30	10	385	485	$155 00	$6 00	$22 50	$36 65
220243	110 or 220	11 (or 17)	22 to 45	20	385	485	310 00	6 00	22 50	36 65
220244	110 or 220	17 (or 11)	22 to 45	20	385	485	310 00	6 00	22 50	36 65
220245	110 or 220	11 (or 17)	22 to 45	30	450	550	355 00	6 00	22 50	36 65
220246	110 or 220	17 (or 11)	22 to 45	30	450	550	355 00	6 00	22 50	36 65
220247	110 or 220	11 (or 17)	22 to 45	40	775	975	475 00	6 00	22 50	36 65
220248	110 or 220	17 (or 11)	22 to 45	40	775	975	475 00	6 00	22 50	36 65
220249	110 or 220	11 (or 17)	22 to 45	50	700	900	535 00	6 00	22 50	36 65
220250	110 or 220	17 (or 11)	22 to 45	50	700	900	535 00	6 00	22 50	36 65

For special ordering instructions see last page.

TYPES AL AND WL OUTFITS

FOR MOTION PICTURE PROJECTION

TYPE WL RECTIFIER



TYPE AL RECTIFIER

The motion picture industry now recognizes the advantages of direct current over alternating for arc lamps for projection work. The greater ease of focusing, greater light efficiency, less delicate and hence less frequent adjustment of carbons, steadier light, greater economy of carbons, greater maximum light intensity and decreased breakage of condenser lenses are established advantages.

Where the supply is alternating current, the mercury arc rectifier is the most compact, least expensive and most efficient form of converter.

Two types are offered. The type AL outfit is the earlier form, which includes a dial switch for control of arc current and in which all parts are totally enclosed. In the type WL outfit these two features are eliminated for the sake of simplicity and lower first cost. Both are automatic in starting, both are equipped with ready means for operating the arc on A. C. in case of temporary lack of a bulb, and in both the regulation is automatically accomplished without loss of power by means of reactance. While the type WL outfit at a very much lower first cost has a higher efficiency, about 72 per cent, and a higher power factor, about 70 per cent, the type AL outfit still has application because of its greater flexibility and because all parts are enclosed.

PRICES AND RATINGS

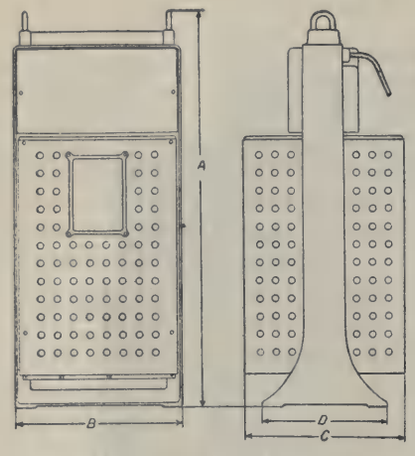
Type AL

Style No.	D.C. Amps.	D.C. Volts	A.C. Volts	Weight Net	Weight Shipping	List Price	East Zone	Cent. Zone	West Zone
111125	30	55	110	510	610	$325 00	$6 00	$14 50	$25 00
111126	30	55	220	510	610	325 00	6 00	14 50	25 00
186049	40	55	110	800	1000	400 00	6 00	14 50	25 00
186050	40	55	220	800	1000	400 00	6 00	14 50	25 00
186051	50	55	110	800	1000	480 00	6 00	14 50	25 00
186052	50	55	220	800	1000	480 00	6 00	14 50	25 00

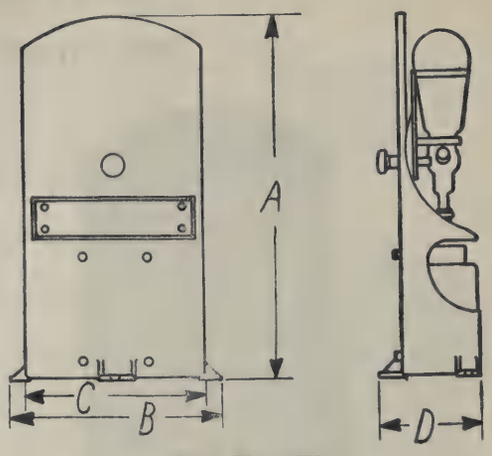
Type WL

252694	30	55	110	250	350	150 00	4 50	8 50	18 00
252695	30	55	220	250	350	150 00	4 50	8 50	18 00
252696	40	55	110	325	425	250 00	4 50	8 50	18 00
252697	40	55	220	325	425	250 00	4 50	8 50	18 00
252698	50	55	110	350	450	260 00	4 50	8 50	18 00
252699	50	55	220	350	450	260 00	4 50	8 50	18 00

OUTLINE DIMENSIONS



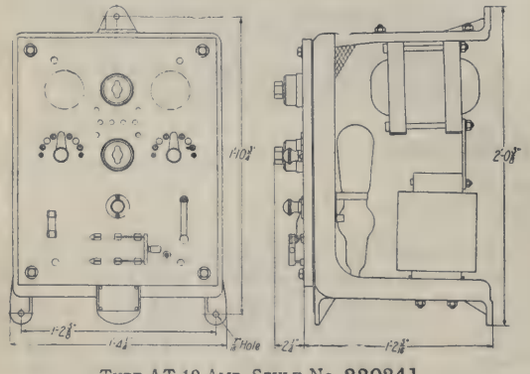
TYPES AA. AE, AL, AN AND AT



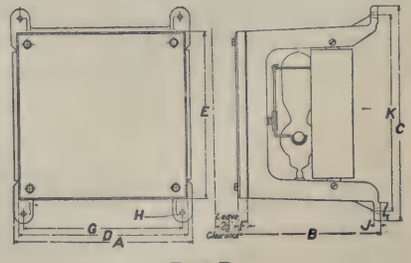
TYPES W AND WL

Type	Style No.	A	B	C	D
AA	145582-A	44 7/16	18 3/4	18 3/8	16
AA	145583-A				
AA	145584-A				
AA	145585-A				
AE	154609-A	56	21 1/8	21 3/4	18
AE	154610-A				
AL	111125-A	44 7/16	18 3/4	18 3/8	16
AL	111126-A				
AL	186049	56	21 1/8	21 3/4	18
AL	186050				
AL	186051				
AL	186052				
AN	145578-A	44 7/16	18 3/4	18 3/8	16
AN	145579-A				
AN	145580-A				
AN	145581-A				

Type	Style No.	A	B	C	D
AT	220243	44 7/16	18 3/4	20 5/8	16
AT	220244				
AT	220245				
AT	220246				
AT	220247	56	21 1/8	21 3/4	18
AT	220248				
AT	220249				
AT	220250				
W	225658	27 1/2	15 1/2	13	7 7/8
W	225659				
W	233907	34 1/2	19 1/2	17	8 3/4
W	233908				
WL	252694	36	20 3/4	18	12 7/8
WL	252695				
WL	252696	45	23 3/4	21	11 1/2
WL	252697				
WL	252698				
WL	252699				



TYPE AT 10 AMP. STYLE NO. 220241

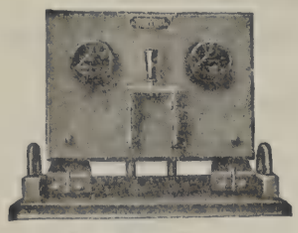


TYPE E

Type	Style No.	A	B	C	D	E	F	G	H	J	K	L
E	152999	13 1/2	10 3/4	16 5/8	13	13	3/4	12 1/4	3/8	1/2	15 1/4	1 3/8
E	154611-A	14 3/8	12 1/4	19	13	13	3/4	12 7/8	3/8	1/2	17 1/2	1 1/2
E	222305	14 3/8	12 1/4	19	13	13	3/4	12 7/8	3/8	1/2	17 1/2	1 1/2
E	222306	14 3/8	12 1/4	19	13	13	3/4	12 7/8	3/8	1/2	17 1/2	1 1/2
E	222307	14 3/8	12 1/4	19	13	13	3/4	12 7/8	3/8	1/2	17 1/2	1 1/2
E	222308	14 3/8	12 1/4	19	13	13	3/4	12 7/8	3/8	1/2	17 1/2	1 1/2

*These dimensions are for reference only; for official dimensions apply to the nearest district office.

ACCESSORIES



INSTRUMENT PANEL

INSTRUMENT PANEL

Measuring instruments are not supplied regularly with rectifier outfits because most electric vehicles are equipped with meters that are sufficiently accurate for charging purposes. Where meters are required with any of the type A rectifiers, an instrument panel should be ordered. This is a neat slate panel equipped with a type AW ammeter, a type AW voltmeter, and a double-pole switch, arranged to be attached to the top of the frame of any of these outfits. The panel may be purchased separately and mounted after the rectifier is installed if desired.

TIME SWITCH

TIME SWITCH

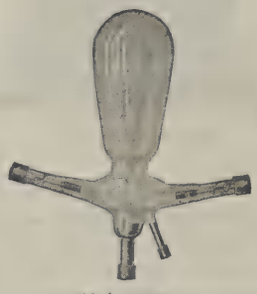
Where batteries are to be charged at night or at times when attendance is not available, a time switch should be used to terminate the charge at a predetermined time. In case it is found that the charge is not complete, it can be completed in a comparatively short time when attendance is available. The switch consists of a 75-ampere type F carbon break circuit-breaker enclosed in a cast-iron case and arranged to be tripped by the alarm mechanism of a clock.

Style No.	Description	List Price
124967	Meter panel for Style Nos. 220243, 220244, 220245, 220246, 145578, 145579, 145582, 145583, 111125, or 111126	$27 00
124968	Meter panel for Style Nos. 145580, 145581, 145584 or 145585	27 00
152526	Time switch for use with all types of rectifier outfits	10 00

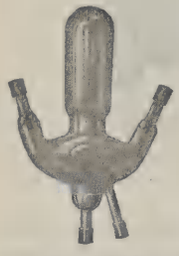
RECTIFIER BULBS AND RENEWALS

The guaranteed average life of the bulb under normal operating conditions is 400 working hours.

30 AMPERES
STYLE NO. 157957



30 AMPERES
STYLE NO. 231580



10 AMPERES
STYLE NO. 222324

5 AMPERES
STYLE NO. 125185

5 AMPERES
STYLE NO. 242127

SPECIFICATIONS AND LIST PRICES

Style No.	Description	List Price	ADD FREIGHT Eastern Zone	Central Zone	Western Zone
125185	Bulb for type E outfit, Style No. 152999	$10 00	75	$1 50	$3 00
125186	Bulb for type E outfit Style No. 154611, 222305 and 7, 220241	11 00	75	1 50	3 00
222324	Bulb for type E outfits Style No. 222306 and 8	11 00	75	1 50	3 00
242127	Bulb for type WI outfit	7 50	20	40	60
222323	Bulb for 15-ampere type W outfit	14 00	75	1 50	3 00
252487	Bulb for 30-ampere type AL outfit	21 00	75	1 50	3 00
231580	Bulb for 30-ampere type W outfit	21 00	75	1 50	3 00
157957	Bulb for 30-ampere type AA, AN, or 20 and 30-ampere type AT outfit	21 00	75	1 50	3 00
114847	Bulb for 50-ampere type AE or 40 and 50-ampere type at AT, AL and WL outfit.	37 00	75	1 50	3 00

SPECIAL ORDERING INSTRUCTIONS

Complete information regarding the source of supply and the type and size of battery to be charged, or the nature of the load if not a battery, should be furnished when ordering a rectifier.

Outfits as listed in this catalogue are for use on 60-cycle circuits. Similar outfits can be furnished for other frequencies on application.

Time Switch—The time switch for terminating the charge at a definite hour should always be ordered **when automatic termination of charge is desired.**

WESTINGHOUSE ELECTRIC FANS

SEASON OF 1920

Westinghouse fans continue to hold the enviable position in the market that they attained on the introduction of drawn-steel construction a few years ago.

Today there are other drawn-steel fans on the market, but Westinghouse still holds first place for beauty of shape and finish, economy, quietness, and low maintenance cost.

The attractive appearance of Westinghouse fans, due to the symmetry of the drawn steel motor and base, is universally conceded. The same feature that gives the pleasing smooth surface and makes possible the attractive finish, gives added strength and a marked reduction in weight—a point of importance from the standpoints of freight and handling.

Low maintenance cost and durability appeal to the thoughtful user. A Westinghouse fan does not trouble the user with maintenance expense. An oiling once a season is all that is required to keep the fan in good condition for years.

In all other respects also—their strong guard, their protecting felt base, covering the entire bottom of the fan, their perfect oiling system, their adaptability for either desk or bracket mounting—Westinghouse drawn-steel frame fans are unquestionably the most completely developed and satisfactory fans on the market.

A New Type of Winding

A notable advance has been made in the design of the single-phase alternating-current induction motors in the 12-inch and 16-inch fans. This new design gives a wider range of operating speeds than has hitherto been found possible even with a split-phase winding, which uses reactance and resistance to secure a modified form of three-phase current, and requires considerable energy in the resistance and reactance coils without a corresponding gain in the efficiency of the motor.

The new Westinghouse design uses a current transformer in the base of the motor in place of a choke coil. The starting winding is energized by this transformer and is in the circuit continuously, no centrifugal switch being used. The proper design of this transformer makes it possible to vary the speed of the motor within wide limits without sacrificing the starting voltage and therefore the starting torque, a deficiency of other types of single-phase fan motors.

This change will be appreciated by fan users, for it renders the motor less liable to injury through lack of attention or careless handling. The centrifugal switch used in the past, with its simple and rugged construction, produced a fan motor requiring less power than other motors of the same size. The new design is a distinct step in advance; the power input is slightly greater but the efficiency is increased accordingly, with the added advantage of greater speed change and the impossibility of burning out the starting winding of the motor, except under the most abnormal conditions.

Discontinued Types

To conserve materials by reducing to a minimum the number of styles of fans to be carried in stock, the manufacture of several styles of fans for which there has been little general demand has been discontinued. These styles will be supplied only until present stocks are exhausted, as noted in the tables.

Packing

All fans are packed in strong substantial boxes, held in place by substantial braces.

Every package contains a gaurantee card and a card giving full instructions for operation and care.

Dimensions of packing cases are given in the following table.

DIMENSIONS OF SHIPPING CASES—INCHES

Type	Diameter Inches	Complete in One Box	
Non-Oscillating	8	10½x 7½x12½	
	10	14¼x10 x14½	
	12	17 x12 x17	
	16	22 x12 x22	
Oscillating	10	14¼x11½x16	
	12	18½x13 x16½	
	16	22 x14 x24	
Exhaust	12	20 x13 x18	
	16	22 x14 x22	
		For Motor Body	For Stem, Etc.
Gyrating	Ceiling	25¾x15¾x19¼	43¼x 3½x3
Ceiling	56	17 x14 x14	44 x 9 x9

Guarantee

The company agrees with the purchaser of each Westinghouse fan to make good by repair or replacement, when delivered at the factory (Newark, N.J.) or at a Westinghouse service repair shop*, transportation prepaid, any defect in material or manufacture of such a fan not caused by misuse or neglect, provided that the original factory nameplate shall be on such fan motor at the time the claim is made and that all defective parts shall be referred to the Company before any claim for repair or replacement shall be allowed. No claim will be considered for defective fans when customers tamper with them, or attempt repairs on them without written authorization from the Company. It is also required that the fan motor shall have been operated on circuits corresponding to the nameplate marking of the motor. This guarantee continues for one year from date of sale to user.

*For addresses, see inside front cover.

WESTINGHOUSE WHIRLWIND 8-INCH FANS

A. C. WHIRLWIND FAN

This is an 8-inch fan at a popular price. Such a fan finds a large field of usefulness in homes and offices where low cost is of importance. It has the same pleasing outlines as the more expensive fans, its low price being due to the absence of speed control switch, highly polished blades, and the omission of other refinements not required for durability.

Construction—Base, motor body and end brackets are of drawn steel, blades and guard of steel.

Finish—Dull black on all parts.

Speeds—One only.

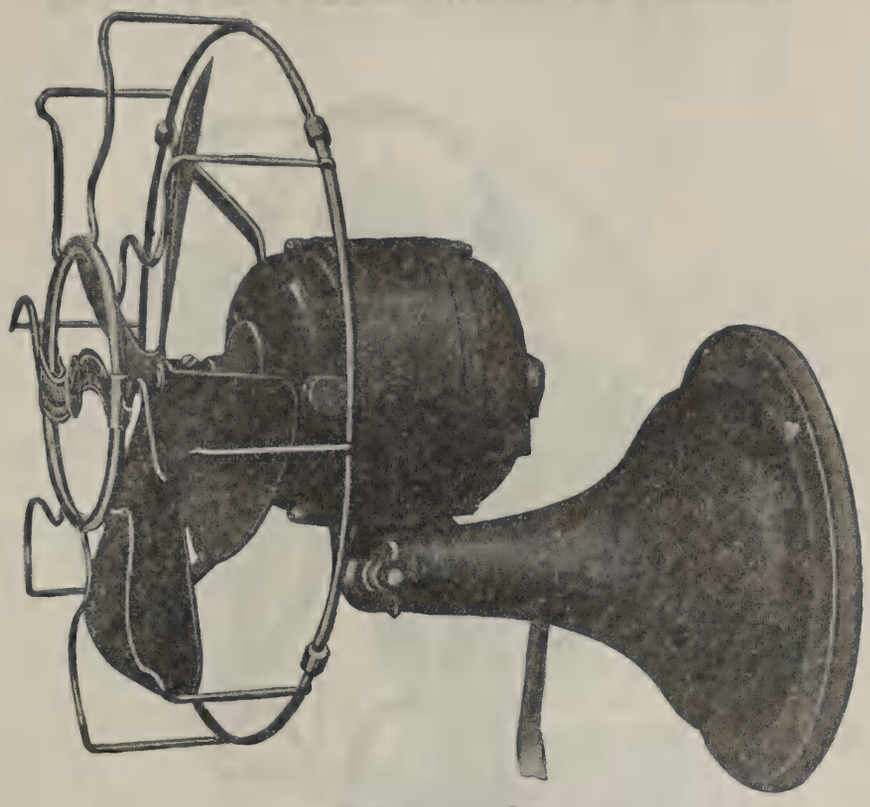
Control—Separable plug to turn current on or off.

Lubrication—Grease cups with spring-operated felt wicks, requiring attention only once a season.

Guard—Of steel supported by pressed steel arms

Hinge Joint—Fan can be tilted 15 degrees forward, or 90 degrees backward for wall mounting. Adjustment clamped by a wing nut.

WESTINGHOUSE WHIRLWIND 8-INCH FANS—Continued



D. C. WHIRLWIND FAN

Packing—Each fan is packed in a separate box. Standard package consists of ten fans. Bulk package consists of five standard packages.

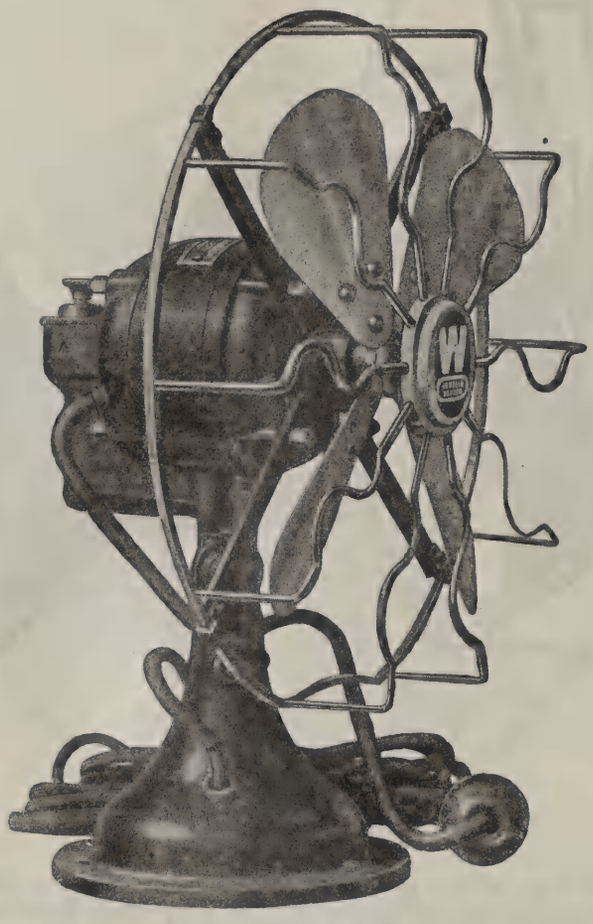
Style Number and Price include fan complete with separable attachment plug and 6-foot cord.

Frequency Cycles	Number of Blades	Volts	Watts at High Speed*	Average R.P.M.*	Cu. Ft. of Air per Minute†	Approx. Wt., Lb. Net	Approx. Wt., Lb. Boxed Each	Style No.	Net Retail Price
60	4	100–120	30	1575	345	5½	11	280598	$11 00
50	4	100–120	27	1900	415	5	11	274733‡	11 00
40	4	110–125	40	1840	405	5	10	280698‡	11 00
25–30	4	100–125	31	1800	395	5	10		
D. C.	4	100–125	33	1950	425	5	10		

*Watts, speed, and air delivery may vary 10 per cent from figures given.
†For method of measuring air delivery see page following Ceiling Fans.
30-Volt D. C. Fans—Fans for 24 to 32 Volts D. C. will be furnished at same prices as 100–125-Volt D. C. fans.
220-Volt Fans { For 220-volt A.C. fans add $2.00 to retail prices given above. • For 220-volt D.C. fan add $2.50 to retail prices given above.
‡These fans have series motors.

Order by Style Number

10-INCH DESK-AND-BRACKET FANS



OSCILLATING 10-INCH A. C. FAN

Construction—Base, motor body and end brackets are each drawn from a disc of 5-64-inch sheet steel, except the frame part of the oscillator in which a die casting forms the motor body and oscillator case. The oscillating mechanism is the same as that on the larger fans, except it is more compact. Induction motors used for 60-cycle fans, series motors for 40-cycle, 50-cycle, and 25-30-cycle A.C. and D.C. fans.

Finish—Standard finish is dull black, smooth and lustrous—no joints, ridges, or rough spots. Fan blades are steel, zinc plated, polished, and lacquered. This new finish must be seen to be appreciated. It is a beautiful blue white, surpassing polished nickel. Guard is steel, finished dull nickel and lacquered.

Speeds—Three—1. Off; 2. High speed; 3. Medium speed; 4. Low speed.

Bearings—On non-oscillator, "Westinghouse Bronze" bushings—cast into housings which are screwed to the motor frame and bracket to assure proper alignment of the rotor. Oscillating fans have bearing cast directly into the frame and bracket.

Lubrication—Grease cups with spring-operated felt wicks, requiring attention only once a season.

Hinge Joint—Non-oscillating fan can be tilted 15 degrees forward or 90 degrees backward. Osillating fan can be tilted 20 degrees forward or backward in desk position, and 20 degrees forward in bracket position, with a set screw to prevent slipping beyond this angle. Adjustment clamped by a wing nut.

Arc of Oscillation—90 degrees as shipped. Can be changed easily to 45 degrees.

Style Number and Price include fan complete with separable attachment plug and 8-foot cord.

10-INCH DESK-AND-BRACKET FANS—Continued

NON-OSCILLATING 10-INCH D.C. FAN

PRICES

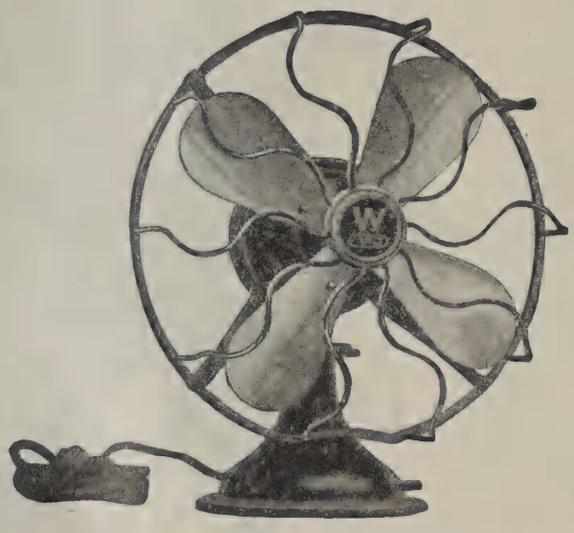
Frequency Cycles	Number of Blades	Volts	Watts at High Speed*	Average R.P.M.*	Cu. Ft. of Air per Minute†	Approx. Wt. Lb. Net	Approx. Wt. Lb. Boxed	Style No.	Net Retail Price
Non-Oscillating Fans									
60	4	100–120	32	1450, 1250, 1000	550	7	16	241842	$22 50
50	4	100–120	33	1550, 1400, 1250	540	7	16	274734‡	22 50
40	4	110–125	25	1400, 1300, 1200	485	6	15	272852‡	22 50
25–30	4	100–125	29	1425, 1275, 1125	495	6	15		
D.C.	4	100–125	33	1650, 1450, 1250	425	6	15		
Oscillating Fans									
60	4	100–120	34	1450, 1250, 1100	550	9	19½	241853	27 00
50	4	100–120	34	1525, 1375, 1225	530	9	19½	274735‡	27 00
40	4	110–125	26	1375, 1275, 1175	475	8½	18½	272854‡	27 00
25–30	4	100–125	30	1400, 1250, 1100	485	8½	18½		
D.C.	4	109–125	35	1625, 1525, 1225	565	8½	18½		

*Watts, speed, and air delivery may vary 10 per cent from figures given.
†For method of measuring air delivery see page following Ceiling Fans.
220-Volt Fans—For 220-volt A.C. fans add $2.00 to retail prices given above. For 220-volt D.C. fans add $2.50 to retail prices given above.
30-Volt D.C. Fans—Fans for 24 to 32 Volts D.C. will be furnished at same prices as 100-125-volt D.C. fans.
220-Volt and 30 volt fans are not usually carried in stock.
‡These fans have series motors.

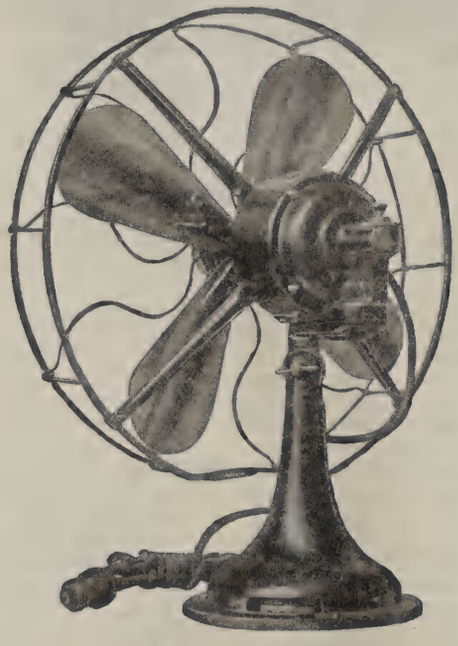
Order by Style Number

12-INCH AND 16-INCH DESK-AND-BRACKET FANS

12-Inch Oscillating Fan



12-Inch Non-Oscillating Fan



16-Inch Oscillating Fan

12-INCH AND 16-INCH DESK-AND-BRACKET FANS—Continued

Construction—Base, motor body and end brackets are each drawn from a disc of 5/64-inch sheet steel. Induction motors used for 60-cycle, 50-cycle and 40-cycle A.C. fans, series motors for 25-cycle A.C. and for D.C. fans.

Finish—Standard finish is dull black, smooth and lustrous—no joints, ridges, or rough spots. Fan blades are polished and lacquered brass.

Speeds—Three—1. Off; 2. Low speed; 3. Medium speed; 4. High speed. Motors start on any speed.

Bearings—"Westinghouse bronze" bushings, cast into housings which are riveted to the motor end brackets, to assure proper alignment of the rotor.

Lubrication—Grease cups with spring-operated felt wicks, requiring attention only once a season.

Guard—Heavy steel, finished in dull black, supported by four pressed steel arms.

Swivel-and-Hinge Joint—The non-oscillating fans can be tilted forward 15 degrees, backward 90 degrees, and rotated 240 degrees. The oscillating fans can be tilted forward or backward 20 degrees in desk position, and 20 degrees forward in bracket position, with a set screw to prevent slipping beyond this angle. Adjustment clamped by a wing nut.

Arc of Oscillation—Arranged for 90 degrees when shipped. Can be changed easily to 45 degrees.

Style Number and Price include fan complete with separable attachment plug and 8-foot cord.

PRICES

Frequency Cycles	Number of Blades	Volts	Watts at High Speed*	Average R. P. M.*	Cu. Ft. of Air per Minute†	Approx. Wt. Lb. Net	Approx. Wt. Lb. Boxed	Style No.	Net Retail Price
12-Inch Non-Oscillating Fans									
60	4	100–120	47	1600, 1400, 1200	855	15	28	162628	$28 00
50	4	100–120	45	1395, 1260, 1130	745	15	28	163537	28 00
40	6	110–125	43	990, 850, 700	800	15½	28½	162624	30 25
25–30	4	100–125	30	1600, 1250, 850	850	13	25	162620	29 50
D. C.	4	100–125	25	1600, 1300, 1000	850	13	25	162637	28 00
12-Inch Oscillating Fans									
60	4	100–120	47	1600, 1440, 1280	850	16½	31	164848	$37 00
60	6	100–120	42	1000, 900, 800	850	17½	31½	164864	37 75
50	4	100–120	45	1390, 1310, 1220	725	17	31	164867	37 00
50	6	100–120	37	925, 875, 825	750	17½	31½	179100	37 75
40	6	110–125	42	1075, 1000, 950	875	17½	31½	164844	39 25
25–30	4	100–125	32	1600, 1250, 850	850	14	27½	164860	38 50
25–30	6	100–115	38	1050, 800, 500	850	15½	28½	179098	39 25
D. C.	4	100–125	27	1600, 1300, 1000	850	14	27½	164854	37 00
D. C.	6	100–115	32	1200, 975, 750	975	15½	29½	164853	37 75
16-Inch Non-Oscillating Fans									
60	4	100–120	89	1540, 1270, 1000	1660	20	37	162631	$33 00
50	4	100–120	69	1390, 1180, 965	1500	20	37	163540	33 00
40	6	110–125	83	1000, 900, 800	1640	20½	37½	162626	35 50
25–30	4	100–125	70	1600, 1250, 950	1725	16	34	162622	34 50
D. C.	4	100–125	63	1600, 1300, 1000	1725	16	33	162639	33 00
16-Inch Oscillating Fans									
60	4	100–120	90	1540, 1330, 1050	1660	21	43½	164851	$42 00
60	6	100–120	85	1050, 975, 900	1725	21½	43½	177109	43 00
50	4	100–120	74	1310, 1230, 1140	1400	21	43	164870	42 00
50	6	100–120	72	925, 875, 825	1525	21½	43½	177107	43 00
40	6	100–125	82	1050, 950, 875	1725	21½	43½	164846	44 50
25–30	4	100–125	72	1650, 1250, 950	1725	18	38	164862	43 50
25–30	6	100–115	72	1050, 850, 650	1725	18½	40½	177105	44 50
D. C.	4	100–125	65	1600, 1300, 1000	1725	18	38	164856	42 00
D. C.	6	100–115	65	1050, 850, 650	1725	18½	40½	177103	43 00

*Watts, speed, and air delivery may vary 10 per cent from figures given.
†For method of measuring air delivery see page following Ceiling Fans.

220-Volt Fans { For 220-volt A.C. fans add $2.00 to retail prices given above. For 220-volt D.C. fans add $2.50 to retail prices given above.

30-Volt D.C. Fans—Fans for 24 to 32 volts D.C. will be furnished at same prices as 100–125-volt D.C. fans.
220-Volt and 30-volt fans are not usually carried in stock.
6-blade fans supplied until stock of parts is exhausted.

Order by Style Number

DETAILS OF DESK-AND-BRACKET FANS

Drawn-Steel Construction—Base, motor body and motor end-brackets of drawn steel*. This gives smooth and lustrous surface without joints, ridges, or rough spots.

High Efficiency—Note in the tables the small amount of power required as compared with the air delivery.

Speeds—Three distinct speeds. Motor will start on any speed.

Substantial Control Switch—Mounted on steel base plate; completely accessible on removing this plate. Switch lever does not open the circuit between points; firmly held at each point by notched metal guide.

Felt Padded Base—Fan rests on a felt pad backed by a steel plate, similar to a telephone base, preventing the marring of polished surfaces and affording mechanical protection to the switch. Felt clamped to bottom and edge of base by a steel ring inside base.

Starting—Fans have exceptionally high starting torque and will start in any position.

Noiseless Construction—Laminations riveted together and pressed into the frame, avoiding the possibility of vibration. Slots of induction motor rotors skewed to insure quiet operation.

Hardened Steel Shafts—Ground to size.

Efficient Lubrication—Grease cups with felt wicks passing through conical guides. Cups filled with vaseline and require attention only once a season. Grease cannot be thrown from bearings. Oil returns provided.

Square Brushes—(For series motors) to give greater contact surface and prevent turning.

Strong Blades—Made of heavy gauge metal, so shaped as to give maximum air delivery and minimum noise.

Parts Phantom View

SWIVEL-AND-HINGE JOINT OF NON-OSCILLATING FAN

*Body of 10-inch oscillator is die cast integral with gear case.

Substantial Guard—So strong and rigid that it is recommended as the means for carrying the fan. Securely fastened to the motor body by pressed steel arms.

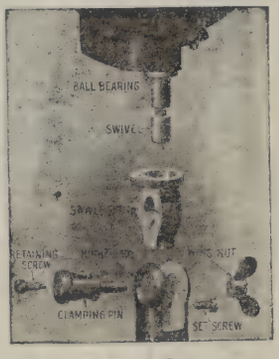
On Non-Oscillating Fans

Swivel-and-Hinge Joints—12-inch and 16-inch fans can be tilted forward 15 degrees, backward 90 degrees, rotated 340 degrees, fastened by a wing nut. Smaller fans have simple hinge, no swivel.

Brushholders (of series motors)—Riveted inside of front bracket, permanently connected to the field leads—not disturbed in removing the armature.

On Oscillating Fans

Oscillating Mechanism—Eight oscillations per minute over an arc of 90 degrees or 45 degrees. Mechanism geared to armature shaft. Worm wheel and worm can be replaced without tools. Oscillation can be stopped and started instantly while fan is running. If guard strikes an obstruction the fan stops oscillating but continues to operate without overturning or burning out the motor. This is due to automatic safety clutch.



PARTS OF HINGE JOINT OF OSCILLATING FAN

Hinge Joint—Fans can be tilted 20 degrees forward or backward in either desk or bracket position. Arranged for bracket mounting by removing a set screw, turning back to position and replacing set screws. When mounted in bracket position, **fan should not be tilted farther forward than the set screw allows when fully inserted.**

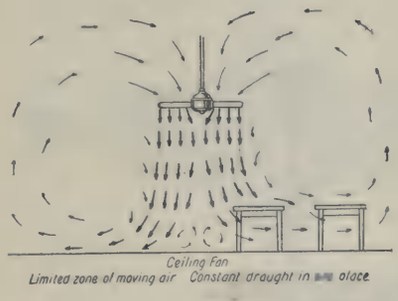
Lubrication—Oscillating mechanism is entirely enclosed and cannot drop oil if packed with proper lubricant. Motor shaft and oscillator crank shaft are both grooved spirally to return surplus lubricant to reservoir in top of case. For directions for oiling see page on Fan Motor Oil.

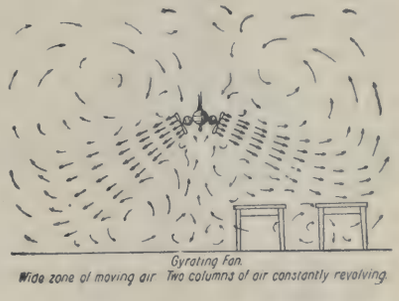
Flexible Cable—Special flexible cable carries current from the base to the motor body. The flexibility of this cable is important.

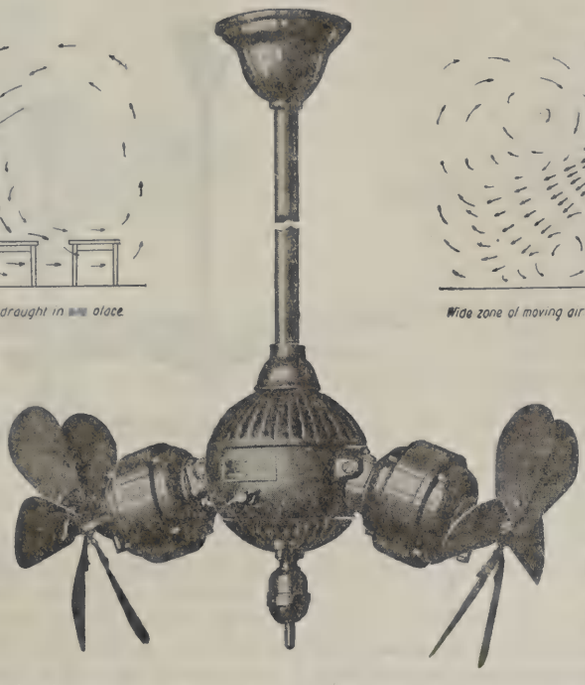
Brushholders (on series motors)—Riveted inside of rear bracket as position of oscillating mechanism makes it necessary to remove armature from the front. Permanently connected to the field leads.

Removable lead cap is provided to make repair of oscillating lead simple, should it break. Not necessary to dismantle motor to repair.

GYRATING FANS







With a Westinghouse Gyrating Fan all the air is kept moving, but without a strong draught. Each of the two fans produces a continuous flow of air outward, at any desired angle from the horizontal, and the direction of the flow is continuously gyrating about the central axis.

The diverging current from the fans sweeps about and causes air movements in all parts of the place, so that at any point the air feels fresh and cool. All the patrons receive the benefit—not only the fortunate ones who can secure places near the fan. The gyrating fans have a wind sweep of 20 to 25 feet and can be spaced that far apart with excellent results.

Construction—The fans used on the gyrators are Westinghouse 12-inch fans with drawn-steel frames. Special bearings are provided that absolutely prevent the escape of oil. As the fans are hung high, no guards are necessary; the absence of guards makes the fans quieter and more effective. Information on column fans on request.

Gyrating Mechanism—One of the fan motors is geared to a mechanical drive operating on a stationary central pulley. The drive is therefore positive and does not vary with the air reaction. The mechanism does not slow down, and cannot revolve at excessive speed—an exclusive feature of Westinghouse Gyrators. Current is conducted to the moving part by two carbon brushes in contact with slip rings. Practically no friction is developed in the revolving part, as it is carried on a ball-bearing.

Adjustment—Breeze at any angle desired, from horizontal to 35 degrees below horizontal, can be had, by a positive wing-nut adjustment at the side of the gyrating body. Turning this wing-nut raises or lowers the angle of both fans simultaneously. There is no possibility of tilting one fan more than the other and thus deranging the balance. The fans revolve about seven times a minute. At gyrating speeds higher than this the fans would tend to churn the air, restricting the distribution. The mechanical drive prevents a higher gyrating speed.

Ceiling Type—Ceiling type gyrating fans should be so mounted that, with the fans tilted to their limit, the lowest point of the blades is 7½ feet from the floor. Standard fans, including hanger rod, measure 55 inches from ceiling to lowest point of blades, suitable for 12-foot ceilings. Where ceilings are higher additional length of hanger rod should be ordered. The convenient pull switch on these fans can be operated from the floor.

Finish—Standard finish of all gyrating fans is dull black for all parts except blades which are polished and lacquered brass.

Style number and price include fan complete with suspension details as lis ed on another page

PRICES

Frequency	Volts	Watts	Average R.P.M.*	Cu. Ft. of Air per Minute†	Approx. Wt. Lb. Net	Approx. Wt. Lb. Boxed	Style No.	Net Retail Price
60	100–120	88	1050	1700	48½	103½	221499	$70 00
50	100–120	74	925	1500	48½	103½	221497	70 00
40	110–125	84	1075	1750	48½	103½	221495	73 00
25–30	100–125	76	1050	1700	48½	103½	221493	73 00
D. C.	100–125	64	1050	1700	46	101	221491	70 00

*Watts, speed and air delivery may vary 10 per cent from figures given.
†For method of measuring air delivery see page following Ceiling Fans.

220-Volt Fans { For 220-volt A.C. fans add $2.00 to retail prices given above.
{ For 220-volt D.C. fans add $2.50 to retail prices given above.

220-Volt fans are not usually carried in stock.

Order by Style Number

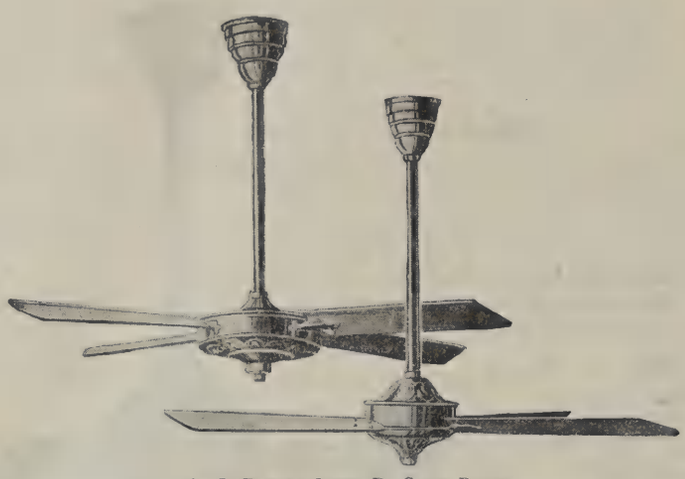
ating Appli-ances
Ranges
Indus-trial Heating
Motors and ontro

56-INCH CEILING FANS

The 56-inch ceiling fans are for use in large rooms, such as theatres, restaurants, large offices and stores.

Distinctive Features—Westinghouse ceiling fans move a large volume of air with very small current consumption. They operate quietly and require little attention. Their construction is simple and their appearance handsome.

Direction of Air Flow—Standard fans throw the air downward, but if desired, the blades can be arranged to draw the air upward (reverse air flow), a desirable arrangement in places where the fan might disturb papers, as in offices and banks. Fans arrranged for reverse air flow are not carried in stock, but are supplied on special order without extra charge.



A. C. Fan at Left, D. C. at Right

Finishes—The standard finish is black enamel. Special finishes can be supplied at an advance in price, and subject to approximately fifteen days additional time for delivery.

Construction—Alternating-current motors are of the induction type; direct-current motors are series-wound.

Alternating-current motors have external rotors which results in neater outlines, simpler construction and lighter weight, as compared with motors with internal rotors. The speed-control coils are placed inside the motor or in projections above or below the motor.

Ball bearings are used in the alternating-current motors. The balls are held in retainers, which keep them properly spaced, prevent noise, and hold them together in case the motor must be dismantled. The ball-race consists of two hardened steel plates between which the balls roll. The shafts of all motors are of hardened steel, and with proper care will give long service without appreciable wear.

The direct-current fans have a combination fibre and tool-steel thrust bearing immersed in oil. The low current consumption of these fans proves the small amount of friction in this bearing.

The lubricating system of the motors deserves special mention. Oil is poured in through an oil hole at the top of the motor and runs into a reservoir around the bearings. The bearings are, therefore, immersed in oil. When the motor is in operation the oil is pumped upward along the shaft by means of a spiral groove on the shaft and flows back into the reservoir again. By this means a circulation of the lubricant is assured and one oiling suffices for the season.

Blades—Each fan has four blades. Two-bladed fans are not recommended by the Westinghouse company because of their small output. The blades are of wood, with mahogany finish.

Style Number and price include fan complete with suspension details noted on next page.

PRICES

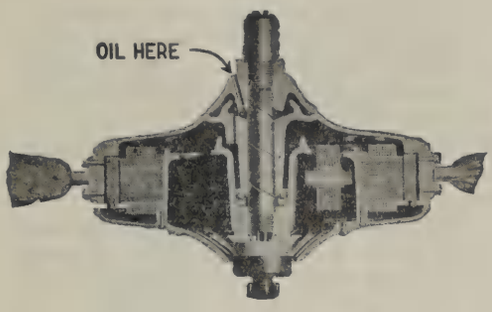
Frequency Cycles	Volts	Watts at High Speed*	Average R.P.M.*	Cu. Ft. of Air per Minute†	Approx. Wt. Lb. Net	Approx. Wt. Lb. Boxed	Style No.	Net Retail Price
60	100–115	150	225, 160	7500	53½	84	115725	$58 00
50	100–115	160	225, 160	7500	53½	84	164300	58 00
40	100–115	170	195, 160	6500	53½	84	115729	59 50
25–30	100–115	155	225, 165	7500	53½	84	115727	59 50
D. C.	100–125	110	225, 160, 100	7500	50	81	196122	58 00

220-Volt Fans—For 220-volt A.C. fans add $2.00 to the retail prices given above. For 220-volt D.C. fans add $2.50 to the retail prices given above. 220-Volt fans are not usually carried in stock.

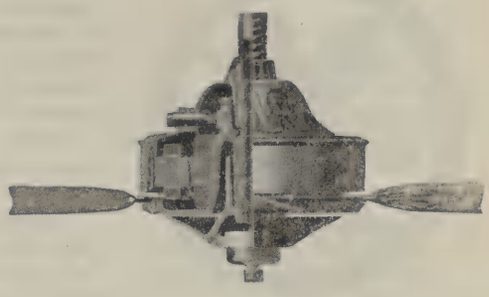
*Watts, speed and air delivery may vary 10 per cent from figures given.

†For method of measuring air delivery see next page.

Order by Style Number



CROSS SECTION—56-INCH A. C. FAN



CROSS SECTION—56-INCH D. C. FAN

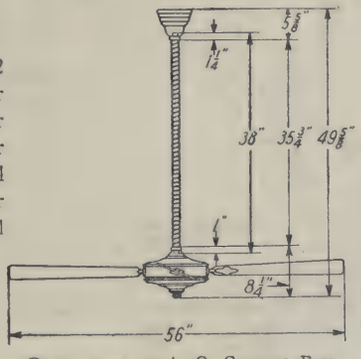
SUSPENSION DETAILS OF GYRATING AND CEILING FANS

Canopy, Hanger and Hook—Every ceiling fan is furnished with a ceiling canopy, ceiling hook, and insulating hanger. The canopy is always finished to match the hanger rod of the fan.

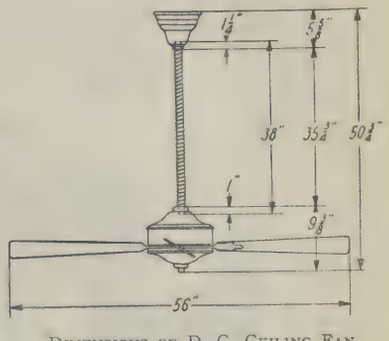
Gyrating Fans are furnished with a 38-inch plain iron hanger pipe finished dull black, suitable for a 12-foot ceiling.

Ceiling Fans are shipped without any hanger rod. Ordinary black iron conduit is suitable for this purpose; use ¾-inch. It can be supplied with fans at an addition of 20 cents retail per foot or fraction thereof.

If ceilings are higher than 12 feet, order extra length of hanger pipe and allow 40 cents retail per foot or fraction thereof for nickel plate or white enamel finish, and 20 cents retail per foot or fraction thereof for dull black finished hanger pipe



DIMENSIONS OF A. C. CEILING FAN



DIMENSIONS OF D. C. CEILING FAN

AIR DELIVERY OF ELECTRIC FANS

Air delivery provides a reliable method of comparing the effectiveness of different fans. The current consumed is of itself of little use in determining the efficiency of a fan, as a fan consuming more current may be more efficient—if it moves comparatively more air. For this reason the amount of air delivered by each fan listed is published in this catalogue. In comparing efficiencies it must be remembered that efficiency must be sacrificed to some extent to obtain distinct speed changes.

The figures for air delivery given in this catalogue include only the air passing through the fan, and are the result of tests made close to the fan. If tests are made at a distance, considerable entrained air is included, showing a much larger volume of moving air but at reduced velocity. Attention should be paid to this point in comparing the air deliveries of various fans. Westinghouse fans are tested as follows·

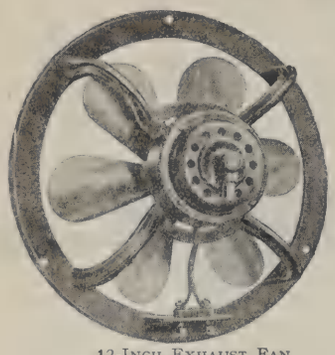
Desk-and-Bracket Fans—Measurements are made with a 1½-inch target type anemometer placed six inches in front of the blades and at every inch across the diameter of the column of moving air, in four quadrants. The volume of moving air in each ring one inch wide is calculated from the average of the four readings and the various volumes added together.

Gyrating Fans—Same as desk-and-bracket fans

Ceiling Fans—Measurements are made with a 4-inch moving vane anemometer placed two feet below the blades, and at every four to six inches across the diameter of the column of moving air, in four quadrants. Results are then summed up as in the case of desk-and-bracket fans.

Exhaust Fans—Tests are made as on the desk-and-bracket fans except with the fan blowing through a wall one foot thick, the hole in the wall being 1½ inches larger than the diameter of the blades.

EXHAUST FANS



12-Inch Exhaust Fan

Westinghouse Electric Exhaust Fans are the most efficient means for removing foul air and odors from kitchens, lavatories, theatres, restaurants, school-rooms, and other places requiring ventilation.

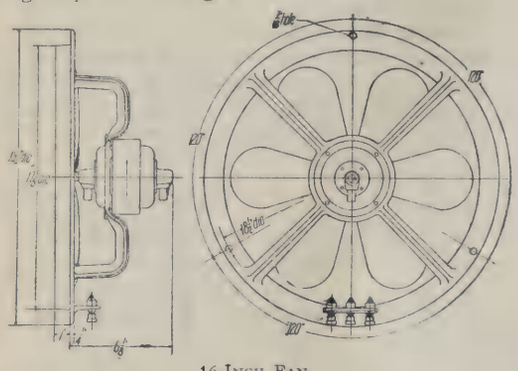
Installation—These fans should be mounted in walls or partitions. They should discharge directly into open spaces. Intake and exhaust pipes should be avoided; if such pipes are necessary they should be made as short and straight as possible.

Blades—The 25-30-cycle fans (and 133-cycle fans when furnished) are supplied with four blades, and the 40, 50 and 60-cycle fans are supplied with six blades.

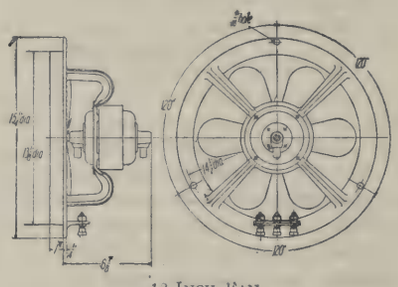
Speed Regulator—These motors are single-speed but a speed regulator can be supplied for the fans as listed below. The regulator is mounted separately from the fan at any convenient location. The regulator is operated by means of a lever.

Finish—The motor and frame are finished in black enamel. The blades are finished in dull black.

Lubrication—Self-lubricating bearings have been adopted for the vertical exhaust fans. These bearings require no oiling or other attention.



16-Inch Fan



12-Inch Fan

PRICES

Frequency Cycles	Number of Blades	Volts	Watts at High Speed	Average R.P.M.*	Cu. Ft. of Air per Minute†	Approx. Wt. Lb. Net	Approx. Wt. Lb. Boxed	Style No.	Net Retail Price
12-Inch Fans—Horizontal Delivery									
60	6	100–120	42	1050	860	18	35	251415	$30 00
50	6	100–120	46	900	725	18	35	251413	30 00
40	6	110–125	43	1000	840	18	35	251411	31 50
25–30	6	105–115	36	1050	850	16	33	251409	31 50
D. C.	6	100–115	32	1150	935	16	33	251407	30 00
12-Inch Fans—Vertical Delivery									
60	6	100–120	40	1070	720	18	35	270796	32 00
D. C.	6	100–120	32	1090	735	16	33	270795	32 00
16-Inch Fans—Horizontal Delivery									
60	6	100–120	93	1000	1665	25	47	251425	35 00
50	6	100–120	86	900	1480	25	47	251423	35 00
40	6	110–125	90	1000	1670	25	47	251421	36 50
25–30	6	105–115	70	1050	1725	22	44	251419	36 50
D. C.	6	100–115	63	1050	1725	22	44	251417	35 00
16-Inch Fans—Vertical Delivery									
60	6	100–120	90	1040	1500	25	47	270799	37 00
D. C.	6	100–120	62	1070	1530	22	44	270798	37 00

220-Volt Fans—For 220-volt A.C. fans add $2.00 and for D.C. $2.50 to retail prices given above. 220-volt fans are not usually carried in stock.

*Watts, speed and air delivery may vary 10 per cent from figures given.

†For method of measuring air delivery see preceding page.

Speed Regulators for 110-Volt Exhaust Fans

Regulator Style No.	For Fan Style No.	Fan Speed	Additional Speeds with Regulator	Regulator Retail Price	Regulator Style No.	For Fan Style No.	Fan Speed	Additional Speeds with Regulator	Regulator Retail Price
251428	251407	1150	925–675	$5 50	251442	251421	1000	900–800	$5 50
251430	251409	1050	800–500	5 50	251444	251423	900	750–600	5 50
251432	251411	1000	850–700	5 50	251446	251425	1000	850–650	5 50
251434	251413	900	800–700	5 50	251428	270795	1150	925–675	5 50
251436	251415	1050	850–680	5 50	251436	270796	1050	850–680	5 50
251438	251417	1050	850–650	5 50	251438	270798	1050	850–650	5 50
251440	251419	1050	850–650	5 50	251446	270799	1050	850–650	5 50

Approximate net weight 5 pounds; shipping 8 pounds.
Speed regulators for 220-volt fans are same price as 110-volt speed regulators.

Order by Style Number

RAILWAY-COACH FANS

12-Inch Fan With Switch

Coach Fans are used on private cars, sleepers, parlor cars, diners, and day coaches, where the railroad company realizes that to make the journey comfortable is the best way of pleasing its passengers and increasing travel over its lines.

Westinghouse railway coach fans embody all the excellent features of the standard Westinghouse fans. They differ from the standard fans in the details noted below.

Voltage—Two ratings of fans are listed: one that can be connected for operation on either 30 or 60 volts, the other for use on one voltage only. The change of connection for the 30 or 60-volt fans is simple. Fans for any special voltage can be furnished on special order.

NON-OSCILLATING BRACKET FANS

A tooth joint with thumb-screw adjustment positively prevents the fan from tilting while the car is in motion. The fan can be readily removed from the bracket if desired.

View of Three-Speed Non-Oscillating Fan, Showing Location of Resistor and Connections to Base. Terminals are of Different Sizes to Prevent Mistakes

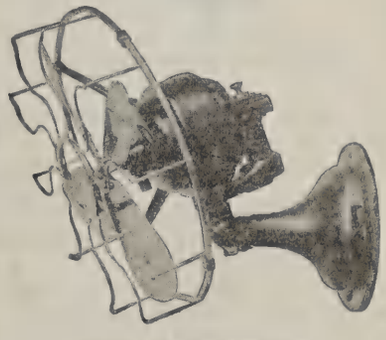
The three-speed fan has a small controlling resistor attached to the lower part of the motor shell, where it is not noticeable. Being heat treated, this resistor is not subject to deterioration due to exposure to the air, and will need no repairs. Two styles of fans are supplied; one without a switch and the other with a switch mounted directly on the base.

Without Switch—These fans are generally mounted on the sides or ends of the car, or in the smoking compartment and the lavatory. It is the usual practice to locate the control switch near the porter's cupboard, and for this reason the switch is not an integral part of these fans.

With Switch—These fans have a switch mounted on their base. They are used where it is desired to have the control switch at the same place as the fan.

OSCILLATING BRACKET FANS

On the 30-60-volt fans the switch in the base serves as a terminal board for making connections either for 30-volt or 60-volt operation. A three-conductor cable carries the current from the switch to the motor body.



Oscillating Bracket Fan

Adjustments—A special hinge joint permits the fan to be tilted either 10 or 20 degrees forward, the position being locked at these points by a pin operated by the wing nut and seating in drilled holes in the tilting part. The fan is thus positively prevented from tilting due to motion of the car.

GYRATING CEILING FANS

The revolving carrier and lower casting containing the brushholders are attached to the ceiling casting by a combination joint, and a pin is provided in both ceiling casting and carrier, over which the hooked end of a rod may be placed, thus holding the fans for convenient inspection. Sufficient extra cable is supplied to allow the fans to be so lowered without disturbing the connections. This arrangement obviates the necessity of removing the ceiling casting from its permanent fastening.

RAILWAY EXHAUST FANS

Exhaust fans can be installed either in the ceiling or the sides of the car. Intake and exhaust pipes should be avoided; if such pipes are necessary, they should be short and straight.

Lubrication—The vital point in a vertical exhaust fan used in car roof is the provision for proper lubrication and this feature has been very carefully considered. After careful tests, self-lubricating bearings have been adopted, which require no oiling or other attention.

GYRATING CEILING FAN

ELECTRIC RAILWAY FANS
Direct-Current 500-600 Volts

Any of the foregoing types of fans are furnished for use on electric railway cars, including subway, surface, elevated, and interurban, where 500 to 600 volts is the prevailing voltage. They are the standard railroad coach fans, without switch, wound for 300 volts and insulated for 600 volts. They have one lead grounded to prevent shock to any person coming in contact with the fan.

VERTICAL EXHAUST FAN
Requires Opening 13⅜ INCHES

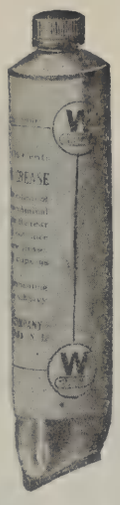
In operation two fans are connected in series. In the case of gyrating fans, the two motors of each fan are put in series. As all types of fans are insulated for 600 volts each, neither fan will burn out should one fail in service, as the remaining fan will merely run at double speed until discovered and turned off.

PRICES

Diameter of Blades Inches	Volts§	Watts at High Speed*		Approximate Speed R.P.M.*	Cu. Ft. of Air per Minute†	Approximate Weight—Lb. Net	Boxed	Style No.	Retail Price ‖
				Stationary Bracket Fans					
				Without Switch					
9	30 or 60	25–45		(1) 1600	800	13	25	186025	$28 50
12	30 or 60	25–45		(1) 1600	850	13	25	186026	31 00
9	30	26	(3)	1600, 1300, 1000	800	13	25	186027	32 00
12	30	26	(3)	1600, 1300, 1000	850	13	25	186028	32 00
12	550	32‡		(1) 1600	850	18	30	238579‡	33 00
				With Switch					
9	30 or 60	25–45		(1) 1600	800	13½	25½	186029	31 00
12	30 or 60	25–45		(1) 1600	850	13½	25½	186030	33 00
9	30	26	(3)	1600, 1300, 1000	800	13½	25½	186031	34 50
12	30	26	(3)	1600, 1300, 1000	850	13½	25½	186032	34 50
				Oscillating Bracket Fans					
12	30 or 60	30–45		(1) 1600	850	15	29	238209	36 00
12	30	30	(3)	1600, 1300, 1000	850	15	29	238211	36 50
				Gyrating Ceiling Fans					
12	30 or 60	60–90		(1) 1050	1700	49	104	238058	72 00
				Exhaust Fans					
				Vertical Delivery					
12	30 or 60	30–45	(1)	1150 or 1190	800	17½	28½	270797	32 00
				Horizontal Delivery					
12	30	25		1075	725	25	42	186033	30 00

WESTINGHOUSE FAN-MOTOR OIL AND GREASE

WESTINGHOUSE
FAN-MOTOR OIL



WESTINGHOUSE
FAN-MOTOR GREASE

FAN-MOTOR OIL

Use—Westinghouse fan-motor oil is intended for fan motors, fractional horsepower motors, and all light machinery, where a light high-grade oil is required and will lubricate properly at a temperature as low as zero degrees Farenheit.

Applying the Oil—The motor bearings of desk and bracket fans should be re-oiled each season. Before re-oiling, all old grease should be removed, and the end of the wick, which may have become hardened from rubbing on the shaft, should be trimmed off. After filling the oil cups, they should be screwed tightly into the bearings, so that the oil from the return ducts will not leak through the threads. When oiling ceiling fans, only one-half ounce (one tablespoonful) should be used after all the old oil has been removed. Exhaust fans, which are run almost continuously, should be re-oiled every four to six months. *Do not attempt to oil exhaust fans that are equipped with self-lubricating bearings.*

FAN-MOTOR GREASE

Use—Westinghouse fan-motor grease is intended for lubrication of the oscillating mechanism of mechanical-oscillating fans, and of gears, and other machinery requiring a heavy high-grade grease that does not become too thin in warm weather.

Applying the Grease—The gear case on the rear of the motor should be cleaned out once each season. and re-packed with new grease. *Do not* use this grease in the *oil cups* as it will not feed through the wicks properly. *Do not* use vaseline as it becomes too thin in warm weather.

PRICE

Description	Quantity	Style No.	Net Retail Price
Westinghouse Fan-Motor Oil	½ pint can	246851	$0 20
Westinghouse Fan-Motor Grease	1 ounce tube	247597	10

Order by Style Number

Cool Breezes—Anywhere!

In the hot weather, when it's sultry and breezeless, a Westinghouse Fan makes your work a pleasure whether in the office or the shop — and your wife's work a pleasure in the home.

How much more enjoyable is a good dinner on a hot night if the gentle zephyrs of a Westinghouse Fan help you forget the high temperature.

You must sleep well to be well. The first requirement for refreshing, health building sleep is fresh air — and plenty of it.

Keep breezes blowing in the kitchen — in the dining-room — in the bedroom — and wherever else you need it.

There's a heap of summer satisfaction in Westinghouse Fans.

THREE-POUND IRONS

The three-pound iron, while designed especially for the use of travelers, will be found convenient for all kinds of light pressing, such as laces, handkerchiefs, waists and other lingerie. It is also found very useful in the sewing room and in millinery establishments (for feathers and hat trimmings), and numerous other industries. The base casting is flared to give greater ironing surface, which makes the iron particularly easy to use on laces, lingerie, and other such pressing when a projection is required to work under tucks and folds. The iron is finished in highly polished nickel with a black ebonized handle. The handle is permanently attached, and is shaped to fit the hand.

The heating element consists of resistance ribbon wound on a mica form, and insulated with a plate of mica on each side.

The cord equipped with standard parallel blade and separable attachable plug, is permanently attached to the iron, and is reinforced by a non-kink spring.

The terminal consists of a moulded asbestos terminal block in which the connections are made. The terminals are enclosed by a metal cover which is held in place by a machine screw.

A separate fireproof stand is furnished, which has an opening between the top and middle plates in which an old-style curling iron may be heated.

Style number and price include the iron with fireproof stand, flexible cord, and attachment plug.

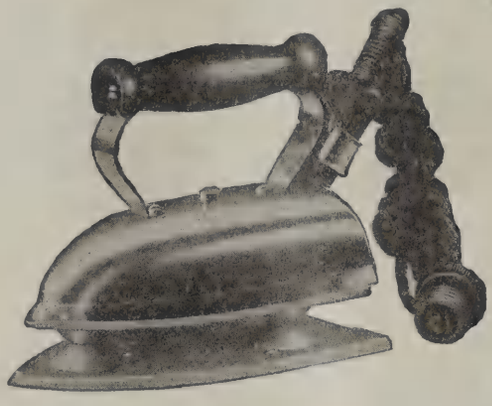
Standard Package, 12 irons of one style number.
Bulk Package, 36 irons (any three standard packages).

Volts	Watts	Weight, Pounds: Net	Boxed Each	Standard Package	Style No.	Net Retail Price
100-125	250	3	4	65	238887	$6 00
200-240	250	3	4	65	238888	6 00

Order by Style Number and Specify Exact Voltage

HOUSEHOLD AND LAUNDRY IRONS

SIX AND ONE-HALF POUND—TYPE M



The six and one-half pound irons are used for general household work and laundry service. They permit rapid work and save many steps between the ironing board and the stove.

Special Features: 1. Reliability — Practically indestructible. Has but few parts, which are simple and rugged; no delicate parts. **2. Heating Element** — Totally enclosed sheeted type which makes it very easy to replace if found necessary. **3. Efficiency**—Radiation from the top is prevented by dead-air space. Practically all heat is given off at ironing surface. **4. Heat Storage** — The heat storage plate stores the heat not being taken by the ironing surface; this makes the iron stay hot longer. **5. Heat Distribution** — The heating element is so designed as to heat uniformly over the entire ironing surface. "The whole iron irons." **6. Weight** is accurately balanced to make handling easy. **7. Comfortable handle** just fits the hand and is always cool. **8. Shape** of face and point are just right. Base is flanged to give greater ironing surface. **9. Detachable Cord** — Current can be turned off without a snap switch by pulling connector away from terminals. A non-kink spring prevents sharp bends in cord. The terminals are strong and rugged. **10. Finish** — The iron has a beautifully polished nickel finish that protects it from rust and corrosion. **11. Stand** — Iron is furnished with separate fireproof stand.

Style number includes iron complete with fireproof stand, cord with separable attachment plug and receptacle.

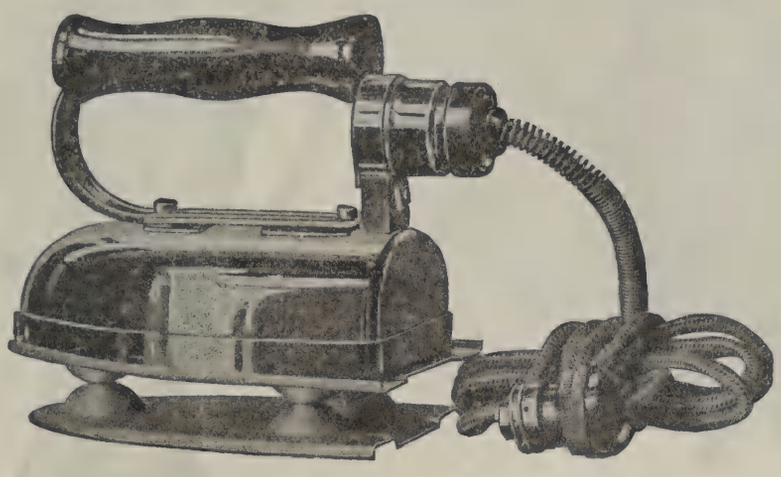
Standard package, 12 irons of one style number.
Bulk package, 36 irons (any three standard packages).

	Weight Lb.			Style No.				
Watts	Net	Boxed Each	Standard Package	100-110 Volts	111-120 Volts	210-230 Volts	231-250 Volts	Net Retail Price
550	6½	7½	105	283429	283430	283431	283432	$7 50

Order by Style Number and Specify Exact Voltage

HOUSEHOLD AND LAUNDRY IRONS

EIGHT POUND—TYPE E



These irons are used for heavy pressing in general household work and laundry service where an iron heavier than a six and one-half pound iron is desired.

Ruggedly built, these irons are practically indestructible, having but very few parts, with no delicate pieces to get out of order. The heat radiation from the top is prevented by dead-air space between the heat-storage plate and the iron shell. Practically all heat is retained at the ironing surface. Whatever heat is not being taken by the ironing surface is stored in the heat-storage plate. This retention of the heat makes the iron stay hot longer.

The heating element is wound in a manner that distributes the heat evenly over the ironing surface; therefore there are no hot spots to scorch the clothes—"The whole iron irons."

The weight of the iron is accurately balanced so as to make handling easy. The handle is correctly shaped to fit the hand and is always cool.

The bottom plate ironing surface is ground very smooth. This enables the iron to glide easily over the pieces that are ironed. The ironing surface is quite large and allows each stroke to do more ironing than can be done with the lighter weight irons.

The cord furnished with the iron is detachable and the current can be turned off by merely pulling the connectors away from the terminals. The iron is provided with a non-kink spring to prevent sharp bending of the cord.

Style number and price includes iron complete with fireproof stand, flexible cord and separable attachment plug.

Standard package, 12 irons of one style number.
Bulk package, 36 irons (any three standard packages.)

Watts	Weight* Lbs. Net	Boxed, Each	Standard Package	Style No. 100—107 Volts	108—115 Volts	116—125 Volts	Net Retail Price
635	8	9	140	230476	230477	230478	$5 50
6-inch spring (to support cord during ironing.)					Style No. 102805		25

*Net weight includes iron only. Boxed weight includes stand and is approximate.

Order by Style Number and Specify Exact Voltage

Ranges
Industrial Heating
Motors and Control

COFFEE PERCOLATORS

7-Cup Panel Urn

Loving Cup

Every coffee lover knows that a percolator makes the best coffee. With an electric percolator coffee can be made at the table; the heat can be turned off at just the right time; no danger or bother from alcohol; cheaper to use than alcohol-heated percolators.

Special Features—These percolators begin to operate promptly. Coffee is finished in 10 to 20 minutes depending on strength desired. The heat is concentrated so that only a small quantity of water needs to be heated at a time, making it act quickly. Coffee basket can be removed and the vessel used to boil water.

Construction—All percolators listed have a vessel made of spun sheet metal. The pot type has a sheet metal spout and black ebonized handle; the urn and loving cup styles have a neat metal spigot and are equipped with black ebonized handles. The glass top, made of specially heat-treated glass, is easily removed from the lid. The coffee basket is made of aluminum and the valve of nickel-silver.

The heater for 110-volt percolators consists of resistance wire wound on a lava composition core and insulated with a special cement, both of which withstand very high temperatures. It sets snugly in a small cylindrical casing which projects up from the bottom of the vessel into the liquid being heated. Therefore, as the source of the heat is almost in actual contact with the liquid, a very high efficiency is obtained.

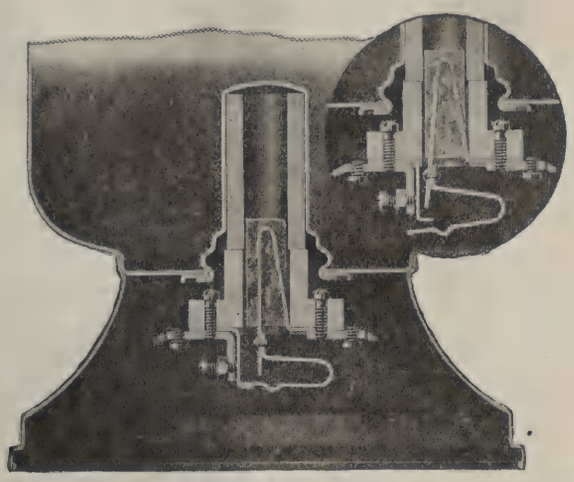
The Heater for 220-volt percolators consists of resistance wire wound on a mica form and insulated by mica on each side of the heater.

6-Cup Plain Pot

5-Cup Plain Pot

COFFEE PERCOLATORS—Continued

7 Cup Panel Pot



Detail Views of Cutout and Heating Element
Cutout is Shown Closed in Lower View: In Inset, it is Shown Open

Cutout—The percolator should never be operated when the heater is not completely covered by liquid. To guard against possible burnouts due to the percolator accidentally becoming dry, all percolators are listed with an automatic cutout. This is enclosed in the base of the percolator, and it is so adjusted that it will open the circuit when the temperature of the heater approaches the danger point. For 110-volt percolators only, the cutout is a simple, durable, mechanical device that can be reset by anyone without the use of tools—simply remove the base of the percolator, press the cutout spring back into normal position (see illustration) and replace base. The 220-volt percolators are equipped with a fusible metal plug cutout which will melt and disconnect the circuit when the temperature of the heater approaches the danger point.

Finish—All outside metal parts are highly nickel-plated and polished. The inside of the vessel is heavily tinned.

Style number and price include percolator complete with flexible cord, separable attachment plug, and receptacle.

Combination Package—Any of these percolators can be included in a "Combination Package" of six devices.
Bulk Package—Four Combination Packages.

Description	Watts	Approx. Shipping Weight, Lbs. Each	Standard Package	Style No. 108-115 Volts	Style No. 200-220 Volts	Net Retail Price
5-Cup plain pot	380	4½	40	283874	.....	$13 00
6-Cup plain pot	420	6	42	.....	283837	14 00
7-Cup panel pot	380	5½	40	283881	.....	15 00
7-Cup panel urn	380	6	42	283876	.....	18 00
7-Cup loving cup	380	6	42	280737	.....	20 00

12-Inch Trays for Coffee Percolators

Finish	Style No.	Net Retail Price
Nickle	151466	$4 00

Order by Style Number and Specify Exact Voltage

TURNOVER TOASTERS

The turnover toaster makes toast at the table. The toast is turned by simply turning an insulated knob—there is no danger of burning the fingers.

The "turnover" feature consists of a swinging rack on either side, hinged at the bottom. The operation is shown graphically in the illustrations above. It is unnecessary to touch the bread from the time it is first put on the rack until it is taken off toasted.

Construction—The toaster is substantially built of pressed sheet steel, finished in highly polished nickel. It presents a very attractive appearance.

A flat surface on top of the toaster may be used to keep the toast warm or it may be used to heat plates, keep the coffee pot warm, etc.

A flexible cord with a separable attachment plug is attached to the toaster by means of a heavy white porcelain connector.

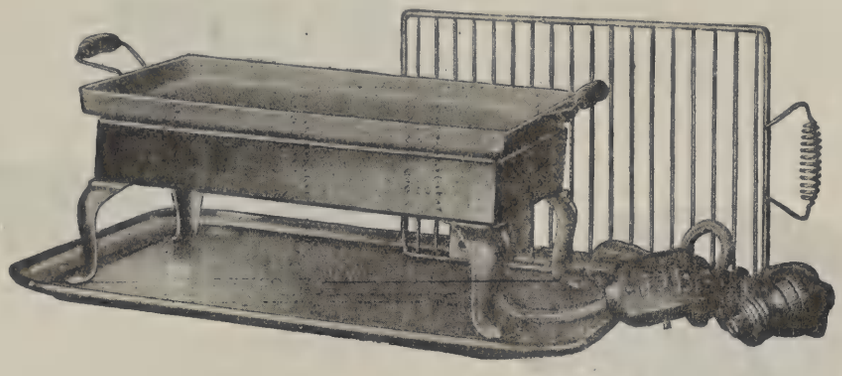
Style number and price include toaster and flexible cord with connector and separable attachment plug.

Standard package, 6 turnover toasters.
Bulk Package, 18 turnover toasters (any three standard packages).

Watts	Approx. Shipping Weight, Lbs. Each	Approx. Shipping Weight, Lbs. Standard Package	Style No. 100—120 Volts	Style No. 200—240 Volts	Retail Price
550	3½	52	266963	266965	$7 00
Add to retail price for snap switch in cord					1 00

Order by Style Number and Specify Exact Voltage

STANDARD TOASTER-STOVES



The toaster-stove is not merely a toaster but a complete and practical stove that will cook anything that can be cooked on a double-burner gas stove. Its wide range of usefulness makes it the most popular electric cooking device on the market. It will broil meat, fry eggs, ham, potatoes, make toast and griddle cakes; it is an excellent device for roasting marshmallows, popping corn, making candy and many other dainties in leisure moments.

By using the toaster-stove the meal can be cooked at the table, in fact the food may be cooked even while the meal is in progress. For breakfast and hurry lunches the toaster-stove is particularly valuable, as with the aid of a coffee percolator the entire meal can be prepared at the table and served piping hot.

The frame and legs are made of pressed steel heavily nickel plated and polished.

The griddle is made of heavy gauge sheet aluminum and is equipped with a coiled wire handle on each end.

The wire toasting screen is also equipped with coiled wire handle at each end and is finished in dull nickel.

The tray is made of cold rolled steel heavily nickel plated.

The flexible cord is permanently connected to heavy brass terminals inside the stove. A through switch is provided and it is therefore unnecessary to rise from the table to turn the current on or off.

The toaster-stove and all equipment is artistically finished throughout, harmonizing with and enhancing any table service.

Dimensions—9-inches by 5¼-inches by 3⅝-inches high.

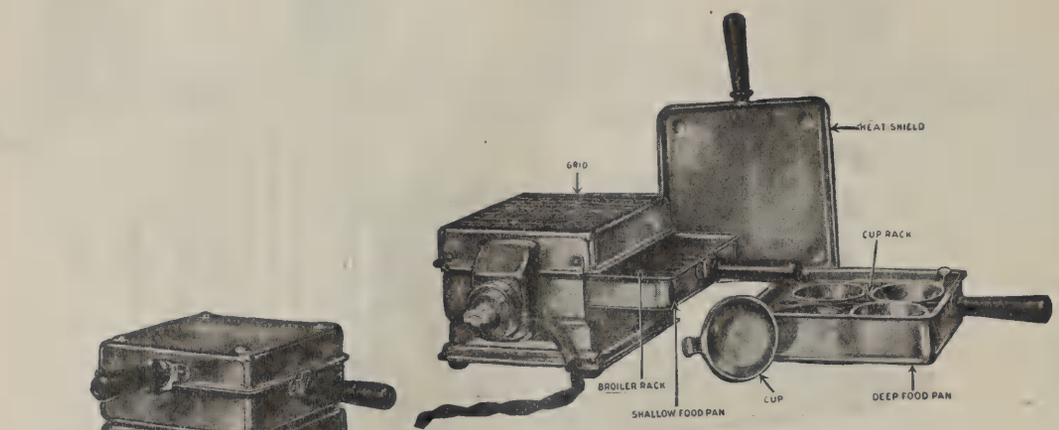
Style number and price include toaster-stove toasting grid, aluminum griddle and frying plate, tray, and flexible cord with through switch and separable attachment plug.

Standard package, 6 toaster-stoves of the style number.
Bulk Package, 18 toaster-stoves (any three standard packages).

Watts	Approx. Shipping Weight, Lbs. Each	Standard Package	Style No. 100—120 Volts	Style No. 200—240 Volts	Net Retail Price
500	7	50	196158	214903	$10 00

Order by Style Number and Specify Exact Voltage

TABLE STOVES



PARTS OF TABLE STOVE

TABLE STOVE COMPLETE

The Westinghouse electric table stove has been built and designed to meet the need of a cooking unit that will perform the operations of a range and yet do the work right at the table.

A special feature of the table stove is its compactness, occupying the small space of seven by seven inches. A combination of food pans allows broiling, boiling, toasting, steaming and frying. Broiling s done on a metal rack placed in either of the food pans. The egg cups fit into a metal holder which in turn fits into a food pan. Equipped with a snap control switch and heat indicator, the stove is controlled right at the table, without a waste of heat, without a loss of time, and no trouble. Its economic advantages cannot be overestimated. Besides saving considerable heat and time, its convenience and compactness, coupled with the neatness of its design, makes these table stoves a utility of considerable value. In time of gas shortages, the table stove can be depended upon to do its duty.

Construction—It is durably built of sheet steel, with polished ebonized handles. Frame and base of polished nickel with small wooden feet to prevent injury to polished surfaces.

Two food pans 1⅞ inches deep, one food pan ½-inch deep and four egg-poaching or custard cups all of aluminum are supplied with the stove, also a flexible cord and standard parallel-blade separable attachment plug. A snap control switch mounted on the stove provides three different heats suitable for all cooking operations.

Dimensions—7 inches square and 5½ inches high.

Style number and price includes stove and all vessels described above.

Standard Package, 4 table stoves on one style number.
Bulk Package, 12 table stoves (any three standard packages).

Watts	Approx. Shipping Weight, Lbs. Each	Approx. Shipping Weight, Lbs. Standard Package	Style No. 100–110 Volts	Style No. 111–120 Volts	Style No. 210–230 Volts	Style No. 231–250 Volts	Net Retail Price
165–330–660	8	60	280112	280113	283914	283915	$15 00

Order by Style Number and Specify Exact Voltage

CHAFING DISHES

TYPE C CHAFING-DISH COMPLETE WITH STOVE AND TRAY

(The Disc Stove and Tray are not included in the style number and list price and must be ordered separately)

The type C chafing dish consists of a stand, water pan, food pan and cover. The heater is a standard six-inch disc stove with the feet inserted in reversed position.

For frying and stewing or any cooking that requires a high temperature, the water pan may be omitted and the food pan placed directly upon the stove.

The disc stove may be used by itself if desired. It will do any light cooking and heating that a single-burner gas stove will do.

Finish—Type C vessels are finished in highly polished nickel or copper.

Style number and price include vessel complete only. Six-inch disc stove must be ordered separately.

A 12-inch tray finished to match the vessel, while not necessary in the operation of cooking, adds greatly to the appearance of the outfit and protects the furniture from any food which may be accidentally spilled. This tray is not included with the chafing dish but is listed separately.

Combination Package—These chafing dish vessels can be included in a "Combination Package" of six devices.
Bulk Package—Four Combination Packages.

Finish	Pints	Approx. Shipping Weight, Lbs. Each	Standard Package	Style No.	Net Retail Price
Type C Vessels Only					
Style number and price include water pan, food pan, cover and stand.					
Nickel		5	30	252146	$8 00

12-Inch Trays

Finish	Style No.	Net Retail Price
Nickel	151466	$4 00

Order by Style Number

HOT PLATES

TYPE 22 HOT PLATE

TYPE 32 HOT PLATE

TYPE 21 HOT PLATE

TYPE 31 HOT PLATE

These hot plates are small electric stoves for hotel, restaurant, cafe, and domestic service.

Special Features—No special flat-bottomed utensils needed; the radiant heaters, with all the heat at the top, are very efficient with ordinary cooking vessels. Non-corrosive material used for the heat-elements; water or food spilled over the heater will not damage it. The porcelain brick on which the heating element is assembled will stand rough usage. Deflector plates below the heaters prevent scorching the table, protect the connection and increase the heaters' efficiency.

Heat Control—the type 31 has a three-heat switch; the type 32 is one heat only. In the 10-inch heater three separate switches are used. These light up an area 6 inches, 8 inches, or 10 inches in diameter. Each 10-inch heater is therefore really three plates in one.

Style number and price include hot plate with switches as illustrated, but no cord except the type 32 which includes cord, plug, and push button switch in cord.

Combination Package—Any of these Hot Plates can be included in a "Combination Package" of six devices.
Bulk Package—Four combination Packages.

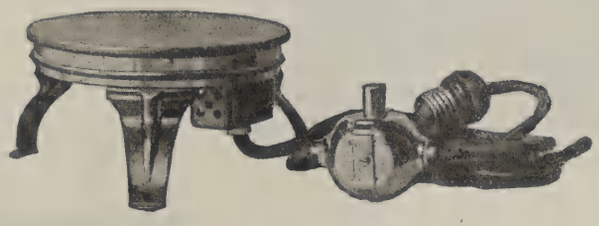
Type	Heaters	Heats	Watts	Approx. Shipping Wt., Lbs.	Style No. 100-120 Volts	Style No. 200-240 Volts	Net Retail Price
22	One 8" / One 10"	3	3000 Max.	30	266968	266970	See Section 8-D
21	One 10"	3	2000 Max. / 1334 Med. / 667 Low	18	266972	266974	$21 00
31	One 8"	3	1000 Max / 500 Med. / 250 Low	15	231562	231564	14 25

Type	Heaters	Heats	Watts	Approx. Shipping Wt., Lbs.	100—110 Volts	111—120 Volts	210—230 Volts	231—250 Volts	Net Retail Price
32	One 8"	1	660	8	231566	231567	231568	231569	6 50

Order by Style Number and Specify Exact Voltage

500-9A

DISC STOVES



THREE-HEAT STOVE

Useful for a great variety of purposes in the home, factory and laboratory. The housekeeper uses it for light cooking of all kinds, for making tea, heating water, etc. The dentist finds it convenient for gold annealing, packing plates, making bridges, and baking investments. It provides the ideal form of heat for the chemical laboratory and for many industrial operations.

Features—Heater supported on a metal stand. Cord permanently attached with push-button switch for heat control. Reversible feet to adapt it for any chafing dish.

Style number and price include stove complete with flexible cord and separable attachment plug; also indicating push switch with three-heat stoves.

Combination Package—Any of these Disc Stoves can be included in a "Combination Package" of six devices.
Bulk Package—Four combination packages

Heats	Finish	Watts	Approx. Shipping Weight, Lbs. Each	Standard Package	Volts	Style No.	Net Retail Price
			6-inch				
1	Nickel	600	4½	35	100–120	189204	$8 00
3	Nickel	150–300–600	5	40	100–120	189198	9 00
1	Nickel	600	4½	35	200–240	270701	8 00

Order by Style Number and Specify Exact Voltage

CURLING IRONS

The Westinghouse electric curling iron is simple, reliable, and economical. Being self-heating it stays hot as long as current is turned on—it is therefore free from flame and soot, and a very uniform, and easily controlled heat is obtained.

For those who prefer it, this iron can also be used with stored heat, as with the flame-heated iron, by removing the swivel plug, which disconnects the cord and electric circuit after the iron is properly heated. When used with continuous heat the swivel plug enables the user to grasp the iron in such a way that it can be freely rotated without twisting the cord It can be used with or without the hair clamp, which is removable.

Construction—The heating element is in the form of a rod inserted directly in the barrel, and can be readily removed. The swivel plug, which fits in the end of the handle, is moulded of specially prepared composition and will not break if dropped. Strong spring contacts in the plug assure a good connection. The cord is attached to these contacts within the swivel plug—there are no exposed terminals and hence no exposed live parts.

Finish—All metal parts are nickel plated and polished; the wooden handle is black ebonized.

Style number and price include curling iron complete with mercerized cotton cord and separable attachment plug. Packed in neat box with outer pasteboard mailing box.

Standard Package, 4 curling irons of one style number.
Bulk Package, 12 curling irons (three standard packages).

Description	Volts	Watts	Approx. Shipping Wt. Each Oz.	Approx. Shipping Wt. Std. Package Lb.	Style No.	Net Retail Price
Complete Outfit	100 to 125	15	9	8	185143	$6 00
Complete Outfit	200 to 240	15	9	8	289374	6 50
Complete Outfit	32	15	9	8	289373	6 50

Order by Style Number

WARMING PADS

12 x 15 Inch Warming Pad

9 x 12 Inch Warming Pad

The electric warming pad is the modern equivalent of the hot-water bottle but is vastly superior in all respects. It is so soft and pliable that it may be applied to any part of the body and is so light that its weight is hardly appreciable. Its heat is constantly supplied as long as it is connected in the circuit—there is no gradual cooling off. For this reason, the electric warming pad is especially valuable in treating those pains for which a prolonged application of heat affords the greatest relief.

Two sizes of pads are supplied: 12 inches by 15 inches and 9 inches by 12 inches. Both sizes are incased in fawn-colored felt covers.

Heat Control—The large pad is equipped with a three-heat switch; the small pad has only one heat and is not equipped with a switch, the current is turned on and off at the socket.

To prevent overheating, automatic thermostats are mounted inside these pads. These thermostats automatically cut off the current before the temperature has become excessive and automatically close the circuit again when the pad has cooled off to normal temperature. As a "safety-first" principle two cutouts are located in different parts of the pad so that if, for any reason, the one fails to operate, there is another to perform its duty.

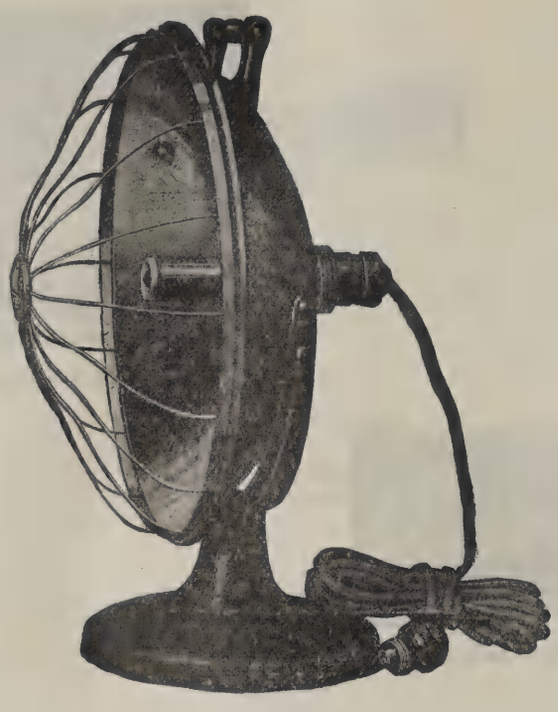
Style and price include warming pad, flexible cord and separable attachment plug, and, on the larger size pad only, a three-heat switch.

Standard package, 4 warming pads of one style number.
Bulk package, 12 warming pads (any three standard packages).

Size Inches	Volts	Watts	Approx. Shipping Wt., Lbs. Each	Std. Pkg.	Style No.	Net Retail Price
9x12	32	48	3	25	283923	$ 6 00
9x12	95-125	[illegible]	3	25	258418	[illegible] 00
12x15	32	65	3	25	283922	10 00
12x15	95-125	65	3	25	258417	10 00
12x15	200-240	65	3	25	283921	10 00

Order by Style Number and Specify Exact Voltage

COZY-GLOW RADIATORS



The Westinghouse Cozy-Glow Radiator shown here, has been designed to satisfy a well recognized demand for a substantially built heating appliance that will throw heat in any direction. Just as the electric fan throws breezes in any direction, so the electric Cozy-Glow radiators emanate rays of heat wherever desired. For use in the nursery and bath rooms on chilly mornings, the radiator is unexcelled. Ticket booths, watchmen's boxes, waiting rooms, etc., are a few of the many places the Cozy-Glow radiators can serve to good effect. They may also be used to keep frost from store windows.

A feature of the radiator is the pleasing, soft mellow glow it produces when in operation.

A trunnion yolk allows adjustibility and control of heat rays.

The Cozy-Glow radiator is built for stability, utility and efficiency. A heavy cast-iron base insures firmness, yet allowing the radiator to be easily moved from place to place. The heating unit, easily removable, is wound on a porcelain cylinder and is protected by a stout copper-wire guard, which can be removed for cleaning the reflector. The reflector, which aids in the proper spread of the heat rays, is built of polished copper, neatly finished.

Style number and price include radiator complete with a 10 foot flexible cord and separable attachment plug.

Standard package, 3 Cozy-Glows of one style number.
Bulk package, 3 standard packages.

Style No.	Watts	Volts	Approx. Shipping Weight, Lbs. Each	Std. Pkg.	Net Retail Price
278758	550	100-120	11	40	$12 00
278759	550	200-240	11	40	12 00

Order by Style Number

TYPE D AIR HEATERS

1000-WATT SIZE

2000-WATT SIZE

3000-WATT SIZE

Electric Air Heaters are adapted for the heating of residences or buildings. They are particularly useful in the heating of isolated rooms or small buildings which can not conveniently or safely be heated by other methods. These heaters afford the most ideal way for heating a building or residence throughout the winter. Where the cost of power makes their continuous use prohibitive, they may be economically applied for heating during the chilly days of fall and spring when only a small amount of heat is required,—not too much, but just enough, without the moisture produced by the gas fire or the soot and dirt of a coal fire.

Special Features—Heating element is fully protected from electrical and mechanical injury. Heats by circulation of air and radiation. Substantial terminals and heavy copper connections.

Finished in black Japan with polished aluminum trimmings, no heavy castings—lightest construction possible.

Style number and price include heater complete with a three-heat snap switch, but no attachment plug—wall receptacle of ample size should be used.

Combination Package—Any of these air heaters can be included in a "Combination Package" of six devices.
Bulk Package—Four combination packages.

Watts			Approx. Dimensions Inches			Approx. Weight Lb.		Style No.		Net Retail Price
High	Med.	Low	Length	Width	Height	Net	Boxed	100 to 120 Volts	200 to 240 Volts	
1000	500	250	11 3/4	7 1/4	13 5/8	9	15	280532	280533	$17 00
2000	1000	500	18 3/4	7 1/4	14	12	22	280534	280535	26 00
3000	1500	750	26 1/4	7 1/4	15	16	27	280536	280537	36 00

Order by Style Number and Specify Exact Voltage

MANTEL OR FLUSH-TYPE LUMINOUS RADIATORS

STYLE NO. 218042

STYLE NOS. 218049 AND 218050

STYLE NOS. 218047 AND 218048

STYLE NOS. 218045 AND 218046

For use in fireplaces or mounted flush in walls. Adapted for intermittent service, particularly for removing the chill before or after the heating system is in use. Ideal for nurseries, bathrooms, reception halls, etc.

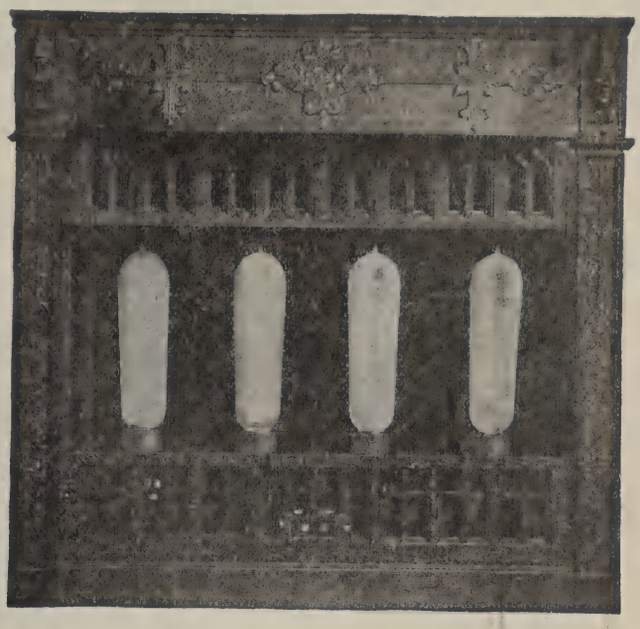
Special Features—Ornamental appearance. Safety from danger of fires or fumes.

Construction—Each radiator consists of a handsomely finished ornamental front with polished copper and two, three or four heating units which are readily removable.

Finish—The fireplace radiators are furnished in polished brass, antique brass, oxidized copper, or practically any electro-plating finish desired. The finish desired must be specified in the order otherwise polished brass will be furnished. Bathroom radiators Style No. 218119 will be finished only in polished nickel.

MANTEL OR FLUSH-TYPE LUMINOUS RADIATORS*—Continued

STYLE NOS. 218043 AND 218044



STYLE NOS. 218051 AND 218052

Capacity—The frames are suitable for 10-amperes. If it is desired to use 500-watt heating units in any of the 100–125 volt 3-unit or 4-unit frames, an additional switch should be ordered, net retail price $1.75.

Style number and price include radiator frame with single-heat flush push-button switch (except the bathroom type) but without heating units or portable cord. In some cases, as shown in the illustrations, the switch is mounted directly in the radiator front. Order heating units as a separate item, specifying style number and quantity desired.

Combination Package—Any of these radiators can be included in a "Combination Package" of six devices.

Bulk Package—Four combination packages.

STYLE NO. 218119

Volts	Finish	Dimensions, Inches	Tiles	Units	Style No.	Net Retail Price
Mantel Type Frames						
100–125	†	24x26	..	3	218042	$25 00
100–125	†	24x30	16	3	218043	25 00
100–125	†	30x30	17	4	218044	30 00
100–125	†	30x30	17	4	218045	25 00
100–125	†	24x30	16	3	218046	25 00
100–125	†	30x30	17	4	218047	30 00
100 125	†	24x30	16	3	218048	25 00
100–125	†	30x30	17	4	218049	30 00
100–125	†	24x30	16	3	218050	25 00
100–125 } 200–250 }	†	30x30	17	4	218051	30 00
100–125 } 200–250 }	†	24x30	16	3	218052	30 00
Bathroom Type Frames						
100–125 } 200–250 }	Polished Nickel	15½x18	..	4	218119	15 00

†See paragraph above on "Finish."

Luminous Units

Standard Package, 12 luminous units of one style number.
Bulk Package, 36 luminous units (any three standard packages).

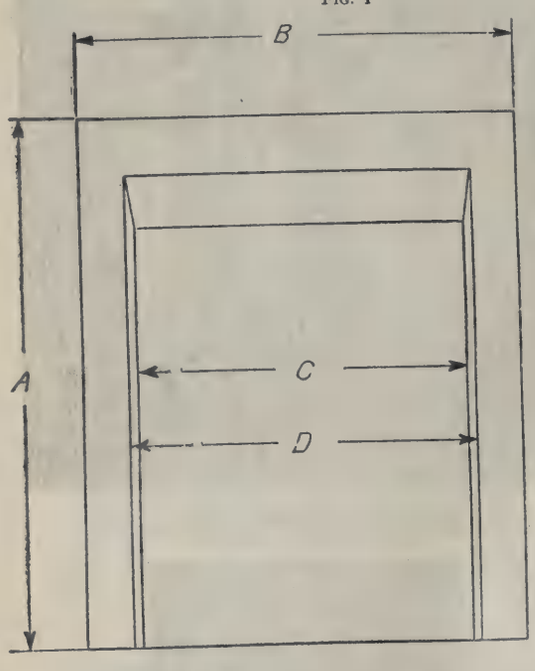
Watts	Approx. Shipping Lbs. Wt.	110–112 VOLTS Style No.	110–112 VOLTS Net Retail Price	113–125 VOLTS Style No.	113–125 VOLTS Net Retail Price	200–225 VOLTS Style No.	200–225 VOLTS Net Retail Price	226–250 VOLTS Style No.	226–250 VOLTS Net Retail Price
250	4	102746	$2 00	102747	$2 00	222108	$2 00	222109	$2 00
500	4	222110	2 00	222111	2 00	222112	2 00	222113	2 00

Order by Style Number and Specify Exact Voltage

MANTEL OR FLUSH TYPE LUMINOUS RADIATORS—Continued

OUTLINE DIMENSIONS

FIG. 1



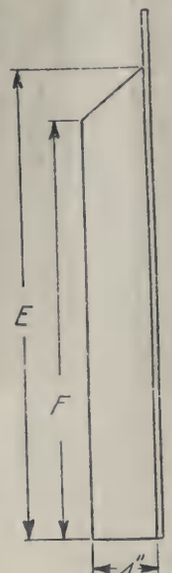
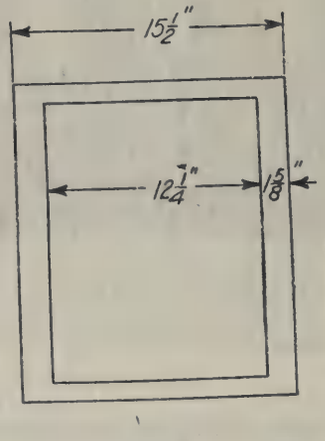
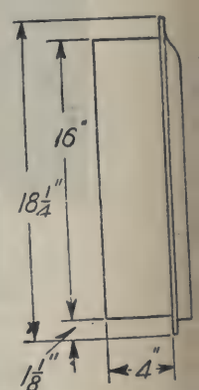


FIG. 2



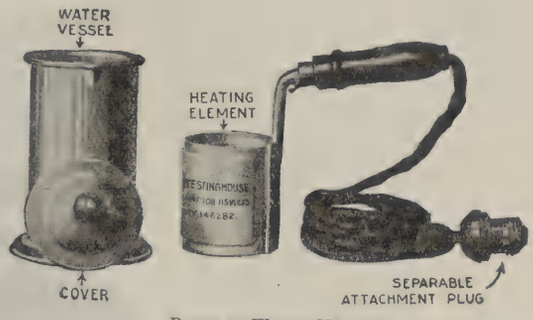


Style No.	Fig No.	Dimensions in Inches Corresponding to Letters In Outline Views A	B	C	D	E	F
218043	1	30½	24½	18	19	27	24
218044	1	30½	30½	24	25	27	24
218045	1	30¼	30½	24	25	27	24
218046	1	30¼	24⅜	18½	19½	27	24
218047	1	30¼	30½	25	26	27	24
218048	1	30½	24⅜	20	21	27	24
218049	1	30½	30½	26	27	27	24
218050	1	30½	24⅞	20	21	27	24
218051	1	30¼	30⅞	26	27	27	24
218052	1	30¼	24⅞	20	21	27	24
218119	2	Dimensions are shown on view.					

NOTE:—Dimensions are accurate within manufacturing limits. If the box or portion projecting into the wall is not of size necessary, dimensions may be modified to suit requirements, if changes are specified on order when placed.

WATER HEATERS

WATER HEATER ASSEMBLED



PARTS OF WATER HEATER

The water heater holds one pint and will boil his quantity of water in six minutes. Excellent for heating water for shaving, and will be found exceedingly useful around the home or laboratory.

Special Features—Vessel formed of heavy sheet copper tinned on the inside. Clip on handle of heater engages with projection on vessel thus permits the vessel to be carried by the handle when heated. Vessel has lip for convenient pouring.

Style number and price includes vessel, heater cover and flexible cord with separable attachment plug.

Combination Package—These water heaters can be included in a "Combination Package" of six devices.
Bulk Package—Four combination packages.

Volts	Watts	Approx. Shipping Weight Lbs. Each	Std. Pkg.	Style No.	Net Retail Price
100–125	500	4	20	170996	$10 00

ACCESSORIES FOR WATER HEATERS

HYGEIA MILK BOTTLE

A standard Hygeia milk bottle can be supplied to fit the pint water heater and makes an excellent addition to the nursery equipment. Milk can be heated in four minutes by setting the bottle in the water heater in which a small quantity of water is placed. The water bath prevents scorching the milk. After use the bottle and nipple can be sterilized in the water heater.

The addition of the sterilizer basket to the water heater makes a complete and practical sterilizer for the use of dentists, doctors and hospital attendants. Basket is heavily tinned.

STERILIZER BASKET

Standard package, 12 Bottles with nipples, and baskets, assorted.
Bulk package, any 4 standard packages.

Style No.	Description	Approx. Shipping Weight, Lbs. Each	Std. Pkg.	Net Retail Price
146284	Milk Bottle and Nipple	1	12	$ .50
162123	Sterilizer Basket	½	6	1 00

Order by Style Number

BELL-RINGERS

A Westinghouse bell-ringer replaces dry- or wet-cell batteries for operating door bells, buzzers, miniature lamps, and other purposes. The bell-ringer reduces the 110-volt alternating current of the lighting current to the voltage required for bells, buzzers, etc. *Cannot be used on direct-current circuits.*

Special Features—Light in weight and compact in size. The secondary terminals can be short-circuited continuously without causing overheating. Westinghouse bell-ringers are **absolutely fireproof** and practically **indestructible.**

Construction — The best materials obtainable are embodied in these bell-ringers. The windings are covered with pressed sheet-steel end caps. The primary leads, which are connected to the 110-volt source of supply, issue through a porcelain bushing. The connections to the bell are made with binding posts, which are mounted on a porcelain support.

Capacity — The bell-ringer has a rating of 10-volt amperes. It delivers on open circuit 12 volts and it replaces several dry cells under ordinary conditions.

Standard package, 10 bell-ringers.
Bulk package, 30 bell-ringers.

Primary Volts	Frequency Cycles	Height Inches	Width Inches	Depth Inches	Shipping Weight, Lb. Ea.	Shipping Weight, Lb. St. Pkg.	Style No.	Price Each
110	60	2¾	2⅛	2¼	1	11	284615	$2 00

Order by Style Number

AUTOMOBILE-ENGINE HEATERS

Westinghouse automobile-engine heaters fill a need long felt by nearly every automobile owner for a simple, economical and effective method for keeping his automobile engine and carburetor warm during the freezing days of winter. It is the ideal method of keeping the engine warm while the car stands in the garage. Thus, on cold mornings no difficulty will be experienced when starting the engine, as the temperature of the engine will always be well above that of the outside air.

1. **Simple Construction** — The Westinghouse automobile-engine heater is ruggedly built and practically indestructible. The heating unit is protected by a strong perforated sheet-metal guard entirely surrounding the heater. A rigid metal hook allows the heater to be hung anywhere under the hood. The flexible cord is long and the plug can be attached to any lamp socket. Altogether it is a well-built heater with no delicate parts to get out of order.

2. **Efficient**—The heater can be placed where it will do the most good. Instead of heating the garage, the heat is delivered only where it is needed —near the engine and carburetor.

3. **Economical**—The Westinghouse automobile-engine heater consumes only 100 watts. The initial cost and the cost while in use are both so small as to be almost insignificant.

Style number and price includes heater complete with flexible cord and separable attachment plug.

Standard package, 4 engine heaters
Bulk package, 12 engine heaters

Volts	Height Inches	Diameter Inches	Weight Lb. Ea.	Weight Lb. Std. Pkg.	Style No.	Price Each
100-120	8½	3	1½	20	283395	$5 00

• *Order by Style Number*

"Why I Use Westinghouse Appliances"

"In the home, electric cooking and heating apparatus has found favor for four essential reasons: It saves numberless unnecessary steps; it is clean because it does away with soot, ashes and fumes; it is safe as it requires no flame; it is economical, effecting a saving in fuel.

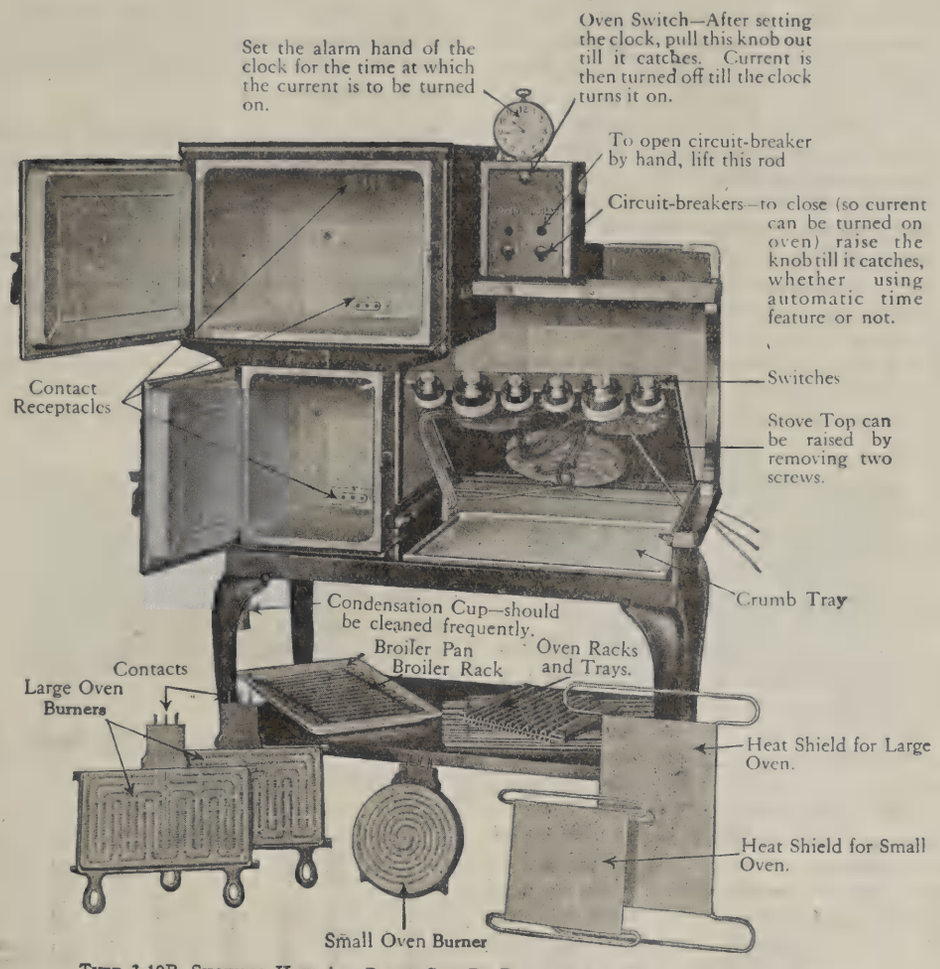
"To secure the greatest efficiency, an appliance for heating or cooking should be both durable and economical. The materials embodied in Westinghouse appliances are selected with the aim towards greatest efficiency and durability. The workmanship is the application of years of experience, and the designs are the result of a study of modern household needs.

"To secure the full benefit from the use of electrical apparatus, it must be thoroughly reliable. Westinghouse Electric Ware has won an enviable reputation for reliability, based on careful construction, good materials and thorough tests.

"To secure the most pleasure out of such apparatus in the home, it must be ornamental as well as useful. Westinghouse Electric Ware is handsome in appearance and beautifully finished. It is in the same class with fine table ware, and I take great pride in showing it to my friends."

WESTINGHOUSE AUTOMATIC ELECTRIC RANGES

TYPE 3-19B


Set the alarm hand of the clock for the time at which the current is to be turned on.
Oven Switch—After setting the clock, pull this knob out till it catches. Current is then turned off till the clock turns it on.
To open circuit-breaker by hand, lift this rod
Circuit-breakers—to close (so current can be turned on oven) raise the knob till it catches, whether using automatic time feature or not.
Contact Receptacles
Switches
Stove Top can be raised by removing two screws.
Crumb Tray
Condensation Cup—should be cleaned frequently.
Broiler Pan
Broiler Rack
Oven Racks and Trays.
Contacts
Large Oven Burners
Heat Shield for Large Oven.
Heat Shield for Small Oven.
Small Oven Burner

TYPE 3-19B, SHOWING HOW ALL PARTS CAN BE REMOVED FOR THOROUGH CLEANING AND ACCESSIBILITY OF STOVE TOP CONNECTIONS

These are full size family cooking ranges for domestic use, and have reached their high perfection in convenience and economy through many years of experimenting and experience. In addition to the cleanliness, safety, saving in food, and general desirability of cooking with electricity, they have the further advantage of saving a great deal of care, trouble and expense by the aid of the Westinghouse exclusive economical features of full automatic control by attached clock and thermostats.

DISTINCTIVE FEATURES

Westinghouse Ranges are **approved by the National Board of Fire Underwriters** and by the Good Housekeeping Institute.

Meals cooked automatically—without personal supervision. Clock turns current on, and thermostat turns the current off.

Economical in operation—automatic control saves current.

Ovens properly ventilated—no disagreeable odors.

All parts accessible for cleaning and repairs.

Ovens can be kept clean and sanitary, as all equipment can be easily removed.

Ovens have special aluminized finish.

All oven burners removable.

Ovens heat-insulated with highest grade of mineral wool.

Tight fitting oven doors with compression latches.

Positive sure-acting thermostats and thermometers.

Three-heat snap switches for all burners.

All switches nickel plated. Gun metal dials with white enamel letters to show switch position, and porcelain buttons lettered in black to show burner controlled.

No dirt, soot, or fumes.

Saving in weights of food cooked.

Superior flavor of electrically cooked dishes.

All ranges are finished in black baked Japan. This gives a very neat and attractive appearance.

OPERATION

In the automatic ranges the current for the ovens is either turned on by hand or automatically turned on by the clock, and is turned off automatically by the thermostat and circuit-breaker according to the temperature setting. Food is placed in the ovens, the clock is set for the time desired to turn on the current, the thermostats are set for the desired temperature, and the circuit-breaker is closed. No attention is necessary, as the clock turns on the current, and as soon as the desired temperature is reached the current is **automatically** cut off by the thermostats, while the food continues to cook on **stored heat.** It is impossible to use more current than is needed to bring the ovens to the desired temperature, and the result is great economy. It is furthermore impossible to burn the food, as the thermostat, when properly set, prevents the heat from rising to a harmful point.

Cooking with the Westinghouse Automatic Range is an exact science, and one does not even have to be awake or at home to cook a meal. This is an exclusive feature found in no other range.

After a little practice it will be found unnecessary to frequently open and close the oven while cooking.

The ovens utilize the heat storage principle. Current brings the oven up to the desired temperature, after which the cooking is carried on by stored heat, no further current being required. The good results obtained in the modern types of gas ranges can be surpassed by the electric range, owing to the improved internal ventilating of the ovens and the efficient application of heat. Meats, breads, cakes, pies, etc., can be evenly browned to any degree, top, bottom and sides. Surplus moisture is carried off, condensed and deposited in drip cups provided for the purpose, but no heat is allowed to escape.

The stove top burners are not provided with automatic control, but each is equipped with a three-heat switch, a turn of which brings the burners to a red-hot heat almost instantly. Cooking can be done on these burners with the same ease and rapidity as with any other fuel, without the many disagreeable features.

For broiling steaks, chops, etc., only the top burner of the large oven is used. The broiler pan rests on racks directly beneath the burner, and owing to the fact that the heat can be regulated to three different degrees, the searing can be controlled perfectly. Meats broiled electrically are free from taint of fuels, and have an attractive flavor, the radiant heat searing the surface and retaining the juices.

Boiling can be more economically accomplished in the small oven or boiler with the aid of the heat storage principle, than on the stove top. In boiling slow-cooking vegetables use very little or no water. Use the Clover Leaf Set and Cooker Pot in boiling.

Attachment plug—A receptacle is provided only on the circuit-breaker box of the automatic ranges for attaching a percolator, iron or other appliance. Any appliance connected to this receptacle can also be operated by the clock at any given time, either in conjunction with the ovens or separately.

Current Consumption—Monthly current consumption varies with the requirements of different families. A careful average for many families of four to six persons each, places the current used between 75 and 100 killowat-hours per month, which includes ordinary lights. The tabulation below shows the current used by twenty-four families over a six months' period.

Tabulation of Current Consumption

Consumer	June	July	Aug.	Sept.	Oct.	Nov.	Total	Av. per Mo.
1	174	10	10	119	32	197	542	90
2	100	108	95	87	107	100	597	99
3	88	105	77	88	85	100	543	90
4	100	91	100	100	99	100	590	98
5	...	114	106	138	143	175	676	135
6	82	100	105	100	159	126	672	112
7	184	78	97	100	96	100	655	109
8	60	71	82	89	74	113	489	82
9	97	97	100	97	74	100	565	94
10	...	...	...	...	43	91	134	67
11	102	96	96	77	85	98	554	92
12	...	...	...	...	...	91	91	91
13	129	125	122	126	129	144	775	129
14	95	91	100	97	73	75	531	89
15	128	95	118	98	101	107	647	108
16	96	89	100	97	93	105	580	97
17	...	100	141	179	155	170	745	149
18	114	128	104	35	100	49	530	88
19	100	100	98	77	86	97	558	93
20	72	83	77	104	53	138	527	88
21	100	100	70	71	82	98	521	87
22	98	93	100	62	58	...	411	82
23	65	101	...	...	...	...	165	83
24	...	...	...	...	...	68	68	68

Total, 24 consumers 1 month 2320
Average, 1 consumer 1 month 97

CONSTRUCTION OF BURNERS

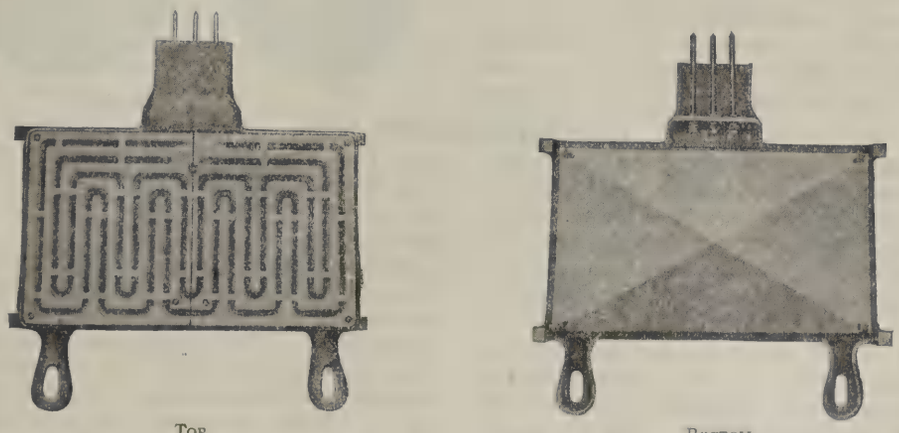
All burners are of the radiant type.

The heating wires are laid in deep grooves of a molded porcelain brick that will not check or crack under extreme heat, and is impervious to water, acids and alkalis.

By a special construction of the grooves the coils are prevented from creeping up when heated and coming in contact with the cooking vessels. They are perforated in many points with small openings, which readily allow any liquid which may be spilled on the burner to pass through. Any food that does not pass through the openings will be rapidly burned off and leaving the burner clean and white.

These burners respond very quickly to applied current, and heat directly any vessels placed upon them regardless of contact. In case of a burnout they are so simple in construction that any user may replace the burned out coil with a new one in a few minutes time with a pair of pliers and a screw-driver.

Oven Burners



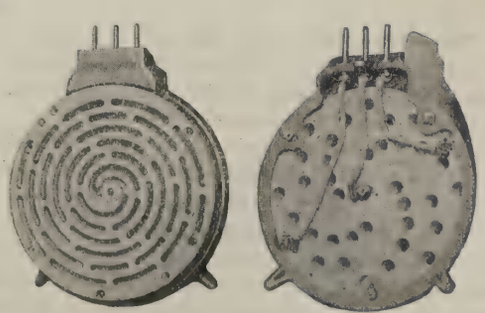
TOP BOTTOM

LARGE OVEN BURNER

Perfect baking has long been considered the true test of any stove's efficiency—this being placed even before economy. The oven burners used in the Westinghouse Ranges are 100 per cent perfect under this test, and have many other strong features to commend them.

Each large oven has two large rectangular burners of 1000 watts each and a small oven or boiler, 1 round burner of 1000 watts.

Each burner is controlled separately by a 3-heat switch, giving three separate and distinct ranges of heat; high, medium, and low. The advantage of this arrangement lies in the fact that one can set the burners in the oven at different temperatures, which will permit either a slow or quick heat, but when the predetermined temperature is reached the current will be automatically cut off by the circuit breaker. Such flexibility of heat control in the ovens permits the operator to apply the heat at both top and bottom for baking and roasting at just the desired temperature. This arrangement also avoids the danger of scorching food from concentration of heat, and warping utensils or the linings of the oven. All oven burners on the automatic ranges are further controlled and mastered by the circuit-breaker.



TOP BOTTOM

SMALL OVEN BURNER

Stove-Top Burners

The stove-top or platform burners embody the same principles of construction used in the oven burners. They are round in shape, two being 8 inches in diameter and one 10 inches in diameter. Each 8-inch burner takes 1000 watts on high heat, 500 watts on medium heat, and 250 watts on low heat. They are separately controlled by three-heat switches.

The 8-inch burners embody two heating coils each. These coils are laid in grooves, staggered, with the result that with any position of the switch, either low, medium or high, the heat applied is evenly distributed over the entire surface of the burner. This further results in a uniform application of heat to vessels placed upon the burner.

The large, 10-inch, burner employs three heating coils arranged in a manner to give three distinct areas of heated surface. It is controlled by a three-heat switch giving three distinct inputs of current with corresponding distinct areas of heating surface. High heat uses 2000 watts and heats the entire surface, medium heat uses 1332 watts and heats an area 8 inches in diameter, while low heat uses 666 watts and heats an area 6 inches in diameter. This arrangement of coils makes it possible to comform the heated surface of burners to the size of vessel used, and results in a considerable saving of current as no uncovered portion of the burner is subject to useless radiation of heat.

Top Bottom

8 Inch Stove-Top Burner

GENERAL CONSTRUCTION

All parts of the range are of metal. The legs, door frames, etc., are castings; other parts are selected sheet steel. The range is sturdy and well constructed throughout; parts are practically unbreakable and cannot work loose. Every part is quickly accessible for thorough cleaning and repairs.

Ovens are built of rust resisting sheet steel, and are covered on both sides with a special aluminum paint, which increases the efficiency and further protects the oven from rusting. They are heavily insulated with the finest grade of mineral wool to reduce to a maximum the loss of heat. A heat shield especially designed, produces an even temperature. All joints are double seamed, and steam tight. Glides fit over studs inside of the ovens and are easily removable. Receptacles for the burner contacts are located at the rear above the floor of the oven; they are steam tight and need not be removed for cleaning.

Everything can be removed from the oven instantly for cleaning purposes.

Switches—All burners are equipped with three-heat switches with gun metal dials, having indications marked with white enamel lettering which makes them easy to read at a considerable distance from the range. The porcelain switch buttons are lettered to show which burner each particular switch controls.

The circuit-breaker on the automatic range has carbon arcing tips, which allow the metal part of the switch to open before contact is broken on the carbon points. This prevents the metal contact from corroding and pitting due to arcing, and results in good clean contacts at all times, insuring uniform delivery of current. The circuit-breaker is made in strict accordance with the Underwriters requirements, is easily accessible, and can be readily taken apart for inspection or repairs.

Accessibility of Connections—The panel at the rear of the stove is easily removed, uncovering all receptacles, contacts, wires and connections. The back of the circuit-breaker box is removed in the same manner, making accessible all working parts of the circuit-breaker, clock, switch, and every wire terminating in this box.

Stove Top—By removing two small screws the top can be lifted up and back for repair or inspection, disclosing every contact and connection to the burner and switches.

FINISH

These ranges with their clear cut and well balanced lines present an exceedingly attractive appearance and a harmony of color, which is thoroughly appreciated by the discriminating buyer.

All sheet metal used on the outside of the range is of the best grade obtainable, and has a very high grade baked black Japan finish. The thermometer plates, clock, snap switches, shelf trimming, and corner supports, are nickel plated and polished. The side and back splashers, broiler pan, crumb tray, and door panels, are of white porcelain enamel, for easy cleaning.

COMBINATION GAS AND ELECTRIC RANGES

For localities having such a high cost of current that the use of the straight electric range would possibly be prohibitive, the type 3-19B and 2-19B can be furnished with combination gas and electric equipment. These are exactly the same as the straight electric, with the exception of the stove top burners, which in the combination ranges are replaced by four gas burners. This makes possible the use of gas burners on the stove top, and electricity for the ovens.

One gas burner is extra large, known as a giant burner, in the center of which is a separate and distinct burner of very small capacity used for simmering. Each burner on the range is controlled by an individual lever valve which permits the regulation of each one separately.

An automatic gas lighter is located in the center of the four burners, controlled by a button valve on the front of the stove. This enables any of the four burners to be lighted instantly by pressing down the valve which throws the flame over all four burners, and does away with the necessity of using matches around the stove. This lighter, though it burns constantly, consumes such a small amount of gas that the expense does not exceed the cost of matches.

The oven equipment of the combination range is identical in every respect with the straight electric. The automatic control features are exactly the same. All extras such as warming shelves, etc., as outlined for the straight electric can be supplied and used on the combination.

GUARANTEE

All Westinghouse ranges are guaranteed against mechanical and electrical defects, and defective parts will be repaired or replaced free of charge within one year from date of purchase by the user.

The Westinghouse Electric & Manufacturing Company have throughout the country, service representatives who render "service" on Westinghouse apparatus. In all cases, apparatus for repairs should be referred to these representatives, and where in line with our guarantee the service rendered will be free of charge.

In no event do we hold ourselves liable for any damage other than allowing for or furnishing without charge parts to replace defective parts as herein stated.

INSTRUCTIONS

A complete and comprehensive instruction book, No. 5173C, is furnished with each range. To secure all the benefits of electric equipment, and to make cooking thoroughly satisfactory, we urge that the few simple directions given in this book be followed.

Complete wiring diagram is pasted on the back of every range. There is also furnished with each range instruction card No. 856, embodying a few "don'ts" concerning the proper use of the range.

TYPE 3-19B AUTOMATIC ELECTRIC RANGES

TYPE 3-19B AUTOMATIC ELECTRIC RANGE

Heating Equipment

	Number of Burners	Watts, Each Burner — High	Medium	Low
Large Oven	2	1000	500	250
Small Oven	1	1000	500	250
Stove Top	1-10"	2000	1332	666
	2-8"	1000	500	250

Total Maximum Input—7000 watts.
Average Maximum Demand—3500 watts.
Heat Control—Three-heat indicating snap switch for each burner.
Automatic Features—Automatic time and temperature control for ovens.
Dimensions of Range—43 by 25 inches—59 inches total height.
Height of Cooking Surface—31 inches.
Size of Ovens—Large, 18½ by 13½ inches—16 inches deep;
Small, 10⅜ by 13½ inches, 11½ inches deep.

PRICES

Style No. — Ovens at Left	Ovens at Right	Approx. Shipping Wt., Lbs.	Wiring	Volts	Circuit	Net Retail Price
266931	266933	440	3	100–120	A.C. or D.C.	$195 00
266932	266934	440	2	200–240	A.C. or D.C.	195 00

Order by Style Number and Specify Exact Voltage

TYPE 3-19B SEMI-AUTOMATIC ELECTRIC RANGES

TYPE 3-19B SEMI-AUTOMATIC ELECTRIC RANGE

Heating Equipment

	Number of Burners	Watts, Each Burner — High	Medium	Low
Large Oven	2	1000	500	250
Small Oven	1	1000	500	250
Stove Top	1–10″	2000	1332	666
	2– 8″	1000	500	250

Total Maximum Input—7000 watts.

Average Maximum Demand—3500 watts.

Heat Control—Three-heat indicating snap switch for each burner.

Automatic Features—Automatic thermometers for ovens connected to call bell, but no clock or circuit-breakers.

Dimensions of Range—43 by 25 inches—59 inches total height.

Height of Cooking Surface—31 inches.

Size of Ovens—Large, 18½ by 13½ inches—16 inches deep;
Small, 10⅜ by 13½ inches—11½ inches deep.

PRICES

Style No. — Ovens at Left	Ovens Right	Approx. Shipping Wt., Lbs.	Wiring	Volts	Circuit	Net Retail Price
266935	266937	440	3	100–120	A.C.	$180 00
266936	266938	440	2	200–240	A.C.	180 00
278604	278606	440	3	100–120	D.C.	180 00
278605	278607	440	2	200–240	D.C.	180 00

Order by Style Number and Specify Exact Voltage

RANGES SHOWN ON THIS PAGE SUPPLIED ONLY UNTIL STOCK IS EXHAUSTED.

TYPE 3-19B COMBINATION GAS AND ELECTRIC RANGES

TYPE 3-19B AUTOMATIC COMBINATION RANGE

Heating Equipment

	Number of Burners	Watts, Each Burner — High	Medium	Low
Large Oven	2	1000	500	250
Small Oven	1	1000	500	250
Stove Top	4	Artificial gas burners, one extra large with simmering burner. All equipped with automatic gas lighter.		

Total Maximum Electrical Input—3000 watts.
Heat Control—Three-heat indicating snap switch for each electric burner.
Automatic Features—Automatic ranges have automatic time and temperature control for ovens.
Dimensions of Range—43 by 25 inches—59 inches total height.
Height of Cooking Surface—31 inches.
Size of Ovens—Large, 18½ by 13½ inches—16 inches deep;
Small, 10⅜ by 13½ inches—11½ inches deep.

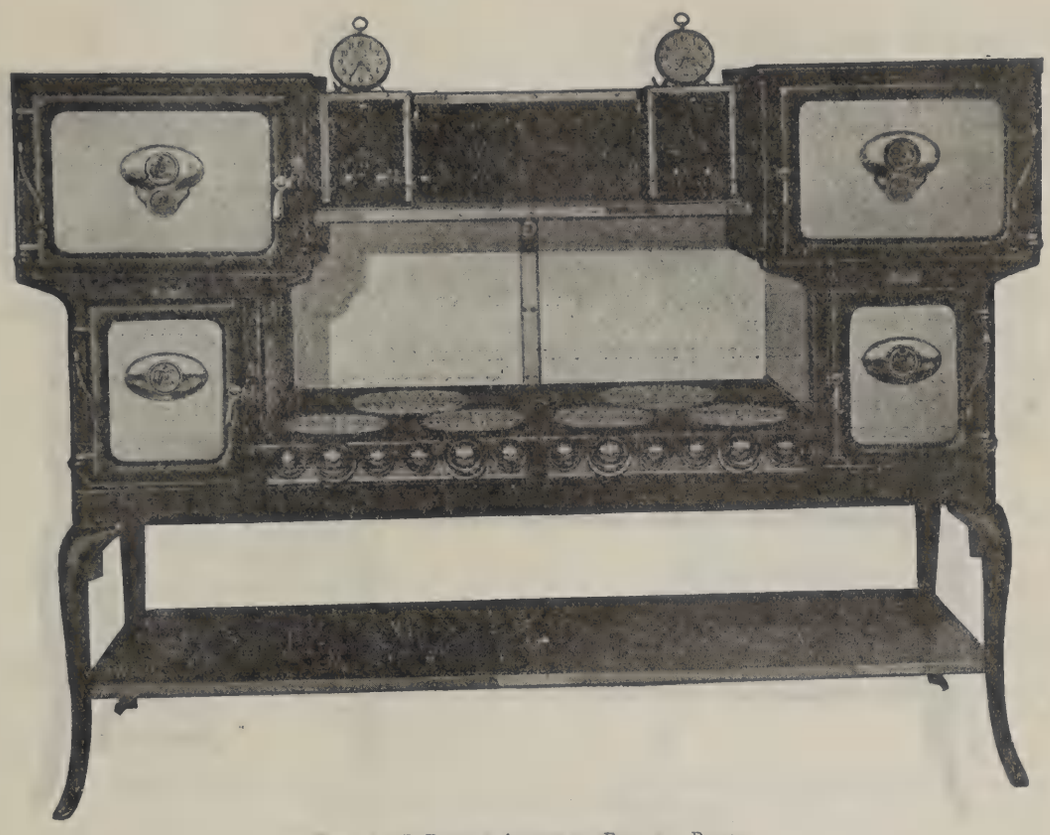
PRICES

Style No. Oven at Left	Style No. Oven at Right	Description	Approx. Shipping Wt. Lbs.	Wiring	Volts	Circuit	Net Retail Price
266947	266949	Automatic	440	2	100–120	A.C. or D.C.	$195 00
266948	266950	Automatic	440	2	200–240	A.C. or D.C.	195 00

Semi-automatic ranges to be operated on 25 cycle current must be ordered special.

Order by Style Number and Specify Exact Voltage

TYPE 3-19B DOUBLE ELECTRIC RANGES



TYPE 3-19B DOUBLE AUTOMATIC ELECTRIC RANGE

Heating Equipment

	Number of Burners	Watts, Each Burner		
		High	Medium	Low
Each Large Oven	2	1000	500	250
Each Small Oven	1	1000	500	250
Stove Top	2–10″	2000	1332	666
	4– 8″	1000	500	250

Total Maximum Input—14000 watts.
Average Maximum Demand—7000 watts.
Heat Control—Three-heat indicating snap switch for each burner.
Automatic Features—Automatic ranges have automatic time and temperature control for ovens.
Dimensions of Range—84 by 28 inches—61 inches total height.
Height of Cooking Surface—31 inches.
Size of Ovens—Large, 18½ by 13½ inches—16 inches deep;
Small, 10⅜ by 13½ inches—11½ inches deep.

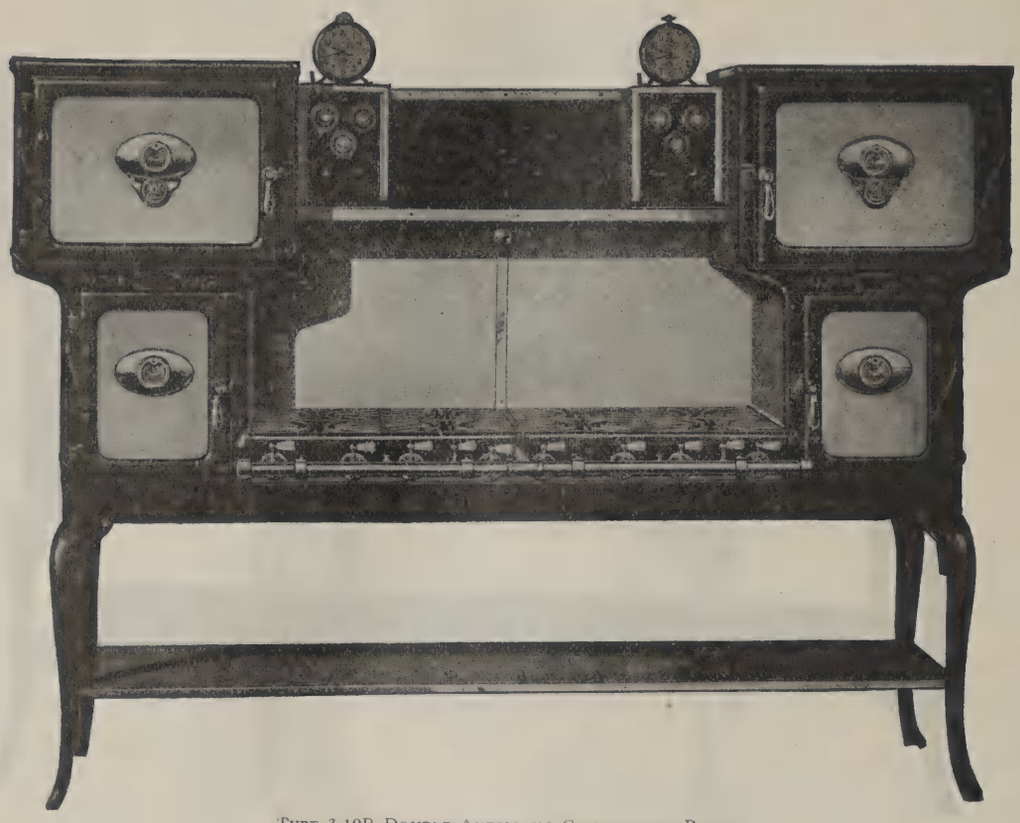
PRICES

Style No.	Description	Approx Shipping Wt., Lbs.	Wiring	Volts	Circuit	Net Retail Price
266939	Automatic	860	3	100–120	A.C. or D.C.	$390 00
266940	Automatic	860	2	200–240	A.C. or D.C.	390 00

Semi-automatic Ranges for operation on 25 cycles must be ordered special.

Order by Style Number and Specify Exact Voltage

TYPE 3-19B DOUBLE COMBINATION GAS AND ELECTRIC RANGES



TYPE 3-19B DOUBLE AUTOMATIC COMBINATION RANGE

Heating Equipment

	Number of Burners	Watts, Each Burner—High	Medium	Low
Each Large Oven	2	1000	500	250
Each Small Oven	1	1000	500	250
Stove Top	8	Artificial gas burners, one extra large with simmering burner. All equipped with automatic gas lighter.		

Total Maximum Electrical Input—6000 watts.
Heat Control—Three-heat indicating snap switch for each burner.
Automatic Features—Automatic ranges have automatic time and temperature control for ovens.
Dimensions of Ranges—84 by 28 inches—61 inches total height.
Height of Cooking Surface—31 inches.
Size of Ovens—Large, 18½ by 13½ inches—16 inches deep;
Small, 10⅜ by 13½ inches—11½ inches deep.

PRICES

Style No.	Description	Approx. Shipping Wt., Lbs.	Wiring	Volts	Circuit	Net Retail Price
266955	Automatic	860	3	100–120	A.C. or D.C.	**$390 00**
266956	Automatic	860	2	200–240	A.C. or D.C.	**390 00**

Order by Style Number and Specify Exact Voltage

TYPE 2-19B HALF-AUTOMATIC ELECTRIC RANGES

Showing Interior of Oven

Range With High Back Warming Shelf (Extra)

TYPE 2-19B HALF-AUTOMATIC ELECTRIC RANGE

Heating Equipment

	Number of Burners	Watts, Each Burner — High	Medium	Low
Oven	2	1000	500	250
Stove Top	1–10"	2000	1332	666
	2– 8"	1000	500	250

Total Maximum Input—6000 watts.
Average Maximum Demand—3000 watts.
Heat Control—Three-heat indicating snap switch for each burner.
Automatic Features—Automatic temperature control for oven.
Dimensions of Range—32 by 24½ inches—34 inches total height.
Height of Cooking Surface—34 inches.
Size of Oven—18½ by 13½ inches—16 inches deep.

PRICES

Style No.	Approx. Shipping Wt., Lbs.	Wiring	Volts	Circuit	Net Retail Price
266943	275	3	100–120	A.C. or D.C.	$140 00
266944	275	2	200–240	A.C. or D.C.	140 00

Extra

Style No.	Description	Net Retail Price
246232	High Back Warming Shelf, White Porcelain Enamel	$10 00

Order by Style Number and Specify Exact Voltage

Indus-trial Heating

Motors and Contro

TYPE 2-19B SEMI-AUTOMATIC ELECTRIC RANGES

TYPE 2-19B SEMI-AUTOMATIC ELECTRIC RANGE

Heating Equipment

	Number of Burners	Watts, Each Burner — High	Medium	Low
Oven	2	1000	500	250
Stove Top	1–10″	2000	1332	666
	2– 8″	1000	500	250

Total Maximum Input—6000 watts.

Average Maximum Demand—3000 watts.

Heat Control—Three-heat indicating snap switch for each burner.

Automatic Features—Automatic thermometers for ovens connected with call bell, but no clock or circuit-breaker.

Dimensions of Range—32 by 24½ inches—34 inches total height.

Height of Cooking Surface—34 inches.

Size of Oven—18½ by 13½ inches—16 inches deep.

PRICES

Style No.	Approx. Shipping Wt., Lbs.	Wiring	Volts	Circuit	Net Retail Price
266945	275	3	100–120	A.C.	$130 00
266946	275	2	200–240	A.C.	130 00
278617	275	3	100–120	D.C.	130 00
278618	275	2	200–240	D.C.	130 00

Extra

Style No.	Description	Net Retail Price
246232	High Back Warming Shelf, White Porcelain Enamel	$10 00

Order by Style Number and Specify Exact Voltage

RANGES SHOWN ON THIS PAGE SUPPLIED ONLY UNTIL STOCK IS EXHAUSTED.

TYPE 2-19B COMBINATION GAS AND ELECTRIC RANGES

Showing Interior of Oven

Range With High Back Warming Shelf

TYPE 2-19B HALF-AUTOMATIC COMBINATION GAS AND ELECTRIC RANGES

Heating Equipment

	Number of Burners	Watts, Each Burner — High	Medium	Low
Oven	2	1000	500	250
Stove Top	4	Artificial gas burners, one extra large with simmering burner. All equipped with automatic gas lighter.		

Total Maximum Electrical Input—2000 watts.
Heat Control—Three-heat indicating snap switch for each burner.
Automatic Features—Automatic ranges have automatic temperature control for ovens.
Dimensions of Range—32 by 24½ inches—34 inches total height.
Height of Cooking Surface—34 inches.
Size of Oven—18½ x 13½ inches—16 inches deep.

PRICES

Style No.	Description	Approx. Shipping Wt., Lbs.	Wiring	Volts	Circuit	Net Retail Price
266959	Automatic	275	2	100–120	A.C. or D.C.	$140 00
266960	Automatic	275	2	200–240	A.C. or D.C.	140 00

Extra

Style No.	Description	Net Retail Price
246232	High Back Warming Shelf, White Porcelain Enamel	$10 00

Order by Style Number and Specify Exact Voltage

TYPE 2-19B AUTOMATIC TIME SWITCH

Type 2-19B Half-Automatic Ranges have automatic temperature control but no automatic time control to turn on the current at a predetermined time. To provide this feature the type 2-19B Automatic Time Switch is supplied.

The outfit consists of a single-pole double-throw knife switch contained in a metal wall box, and a clock. All parts are interchangeable.

The outfit mounts on the wall directly above and to the right of the range. It occupies only $7\frac{3}{16}$ by $7\frac{5}{8}$ inches and is so light that it involves no difficulties in mounting.

The Automatic Time Switch operates exactly like the time switch on the type 3-19B automatic ranges.

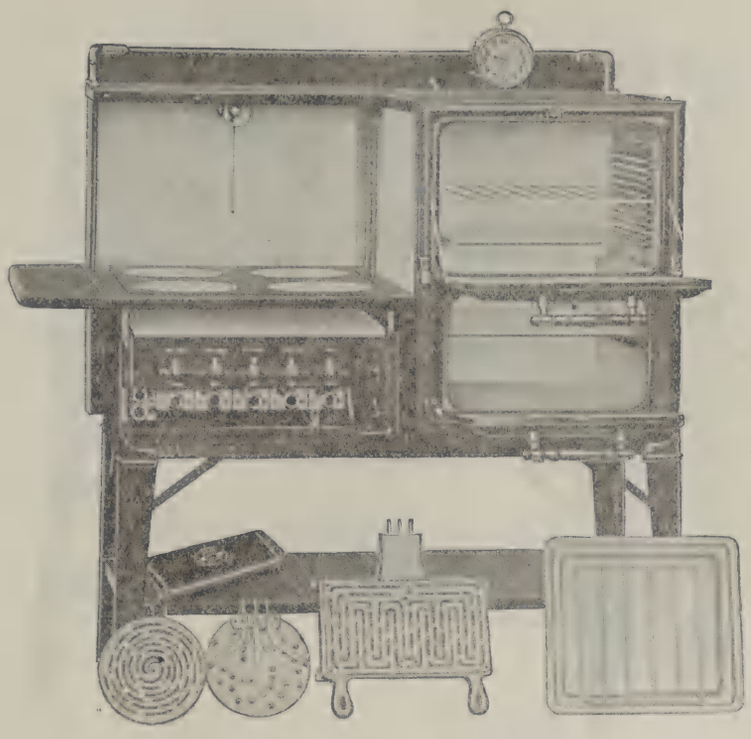
For Water Heating—As the switch is double-throw, one side can be connected to the oven and the other side to an electric water heater. When the current is turned on the range it is cut off of the water heater, thus limiting the total load on the supply circuit. When connected in this manner it is impossible to use the water heater while the oven is in circuit, and vice versa.

Application to Standard Ranges—The use of this switch involves some changes in the wiring of the range. If the switch is ordered with the range the necessary changes will be made in the range at the factory without charge, and diagram of proper connections will be furnished.

Style No.	Description	Net Retail Price
269231	Automatic Time Switch and Clock	$12 50

Order by Style Number

TYPE M-1 ELECTRIC RANGES



TYPE M-1 AUTOMATIC RANGE
(The Half Automatic Range differs in having no clock or automatic tripping mechanism)

The Type M-1 electric range is a new addition to the line of Westinghouse Electric ranges, and comprises the best features of other Westinghouse ranges, with a number of added features.

The Type M-1 Electric Range is built in three distinct types:

1. **Full Automatic Electric Range,** having the clock to turn the oven burner on and a thermostat to turn it off.
2. **Half Automatic Electric Range,** having only a thermostat to turn off the oven burner.
3. **Non-Automatic Electric Range,** which has no automatic features.

SPECIAL FEATURES

All sheet metal—light, but durable.

Black baked japan—makes a very neat and attractive finish, prolongs the life, and is rust resisting.

Oven and cooking top interchangeable, making it possible to put the oven on either side of the range, for right-hand or left-hand oven.

All circuits individually fused.

Fuses, switches and circuit-breaker located in a box under the cooking top, easily accessible.

Fuse cover removable.

All switches have rotating dial, with white marking located on a switch cover plate.

Double pole switch, a new feature, not found in any other range.

All switches are of 20 ampere rating.

All burners removable for cleaning and repairing.

Oven burner of 2000-watt capacity, is used also for broiling. High input makes broiling quick and successful.

The wiring to the thermometer is carried in through the hinges on the door. There is no wiring to change should the door or thermometer be replaced.

Terminal box provided for connecting the service wires.

Lamp socket located under shelf. The lamp can be used for illuminating, or the socket to plug in percolator, toaster stove, or any other electrical appliance.

White porcelain splashers at side and back of shelf.

Aluminum composition-coated sheet metal linings of ovens.

TYPE M-1 ELECTRIC RANGES—Continued

CONSTRUCTION

The all-steel construction of the type M-1 range makes it a durable, yet light range. All parts are easily accessible for cleaning and any eventual repair. All burners are removable, a new feature of Westinghouse Electric ranges. All circuits are individually fused, with the switches and fuses on one base. The ovens are well insulated with mineral wool.

Oven Equipment—The oven is fully equipped with aluminum broiler pan, wire racks for roasting, baking, drying or for preserving fruits, vegetables, etc. Rack glides on the side allow for arrangements of racks in varied spacings. A heat shield gives even distribution of heat throughout the oven.

Thermometer—Each range is equipped with heat-indicating thermometer or thermostat fitted in the door, which enables the user to tell at a glance the degree of heat in the oven and insures uniform duplication of previous successful operations.

Burners—The oven and broiler is equipped with one burner only, of 2000-watt rating. The stove-top equipment consists of four 8-inch burners, two of 1500-watt capacity, and two of 1000-watt capacity. All burners are open-coil type, and heat immediately when the current is turned on.

Heat Control — Each burner is controlled by a three-heat double-pole indicating switch, marked "high," "medium," "low," and "off." Each switch is also marked for the particular burner it controls. All switches are conveniently arranged at the front of the stove, and below the stove-top platform. All switches are of 20-ampere capacity, and the parts are interchangeable.

Finish—The metal on the outside is finished in black baked japan. The inside ovens are finished in aluminum composition coated sheet metal.

Testing and Packing—All heaters are tested at the works as to the proper voltage, wattage, etc. All other parts are tested for any defects in material. Installation instructions and wiring diagram are permanently attached to the range. These ranges are very easily taken apart and are especially adapted for knock-down shipments.

Guarantee—Each range is fully guaranteed against mechanical or electrical defects for a period of one year from date of purchase by the user. Should any part prove defective within one year, it will be replaced free of charge. In all cases, apparatus requiring repairs should be referred to our local service representatives, and where in line with our guarantee, the service rendered will be free of charge.

TYPE M-1 ELECTRIC RANGES—Continued

TYPE M-1 NON-AUTOMATIC RANGE

Heating Equipment

	Number of Burners	Watts, Each Burner — High	Medium	Low
Oven Broiler	1	2000	1332	666
Stove Top	4	2–1000 2–1500	500 750	250 375

Total Maximum Input—7000 watts.
Average Maximum Demand—4000 watts.
Heat Control—Three-heat indicating snap switch for each burner.
Dimensions of Range—52 inches long, 26½ inches wide, 52 inches high.
Height of Cooking Surface—33 inches.
Size of Oven—17 inches deep, 12 inches high, 18 inches wide.
Size of Broiler—17 inches deep, 9¼ inches high, 16 inches wide.

PRICES

Style No. — Ovens at Left	Style No. — Ovens at Right	Approx. Shipping Wt., Lbs.	Wiring	Volts	Circuit	Net Retail Price
Automatic Ranges						
283697	283702	275	3	100–120	A.C. or D.C.	$184 00
283717	283722	275	2	200–240	A.C. or D.C.	184 00
Half Automatic Ranges						
283700	283705	275	3	100–120	A.C. or D.C.	176 00
283720	283725	275	2	200–240	A.C. or D.C.	176 00
Non-Automatic Ranges						
283701	283706	275	3	100–120	A. C. or D.C.	170 00
283721	283726	275	2	200–240	A. C. or D.C.	170 00

Order by Style Number and Specify Exact Voltage

TYPE 515 ELECTRIC RANGE

TYPE 515 ELECTRIC RANGE
With High-Back Warming Shelf (Extra)

Construction—The 515 range is light but durable. All parts are easily accessible for cleaning and making any necessary repairs. The switch bracket is cast-iron; all other parts are sheet steel. The oven sides and top are lined with two layers of asbestos, separated by dead air spacing; the door and bottom are packed with mineral wool. The mineral wool and asbestos with which the oven is lined creates a heat retaining chamber, which means a great saving of current.

Oven Equipment—The oven is fully equipped with broiling pan, racks for roasting, baking, drying or for preserving fruits and vegetables; glides on the side allow for arrangement of racks for varied spacing between upper and lower burners. The heat shield gives an even distribution of heat throughout the oven.

Thermometer—The range is also equipped with heat-indicating thermometer in the oven door, enabling the user to tell at a glance the degree of heat in the oven and insuring uniform duplication of previous successful operations.

TYPE 515 ELECTRIC RANGE—Continued

TYPE 515 ELECTRIC RANGE
(Oven Interior)

TYPE 515 ELECTRIC RANGE

Burners—The oven is equipped with permanently attached burners, upper and lower units, being 1000 watts rating each. The upper unit is splendid for broiling. The stove-top equipment consists of two eight-inch burners of 1500 watts rating each. All burners have open coils, and heat immediately when the current is turned on.

Heat control—Each burner is controlled by a three-heat switch, marked high, medium, low, and off. Each switch is also marked for the particular burner it controls.

Finish—The outside metal is finished in black baked japan. The inside of the ovens is treated with special aluminum paint baked on at a high temperature to insure better service under severe usage.

Testing and Packing—All heaters are tested at the factory as to proper voltage and wattage; all other parts for any defect in material. Carefully packed in individual extra strong cases insuring delivery in best condition to the user. Installation instructions come permanently attached to the range and are readily accessible at any time.

Guarantee—Every Westinghouse range is fully guaranteed against mechanical and electrical defect, for a period of **one year** from date of purchase by the user. Should any part prove defective within one year it will be replaced free of charge.

Total Maximum Input—5000 watts.

Average Maximum Demand—2500 watts.

Dimension of Range—31 inches high—top 24½ x 16½ inches.

Height of Cooking Surface—31 inches.

Size of Oven—12 x 16 x 12 inches deep.

PRICES

Style	Weight—Net	Weight—Shipping	Wiring	Volts	Net Retail Price
278673	80	95	3	100–120	$75 00
278674	80	95	2	200–240	75 00
283367	High-Back Warming Shelf				10 00

NOTE—Unless otherwise specified these ranges are equipped for 110-220-volt, 3-wire or 110-volt 2-wire alternating-current service. Can be used on 110-120 volts. For information and prices on 220-volt, 2-wire ranges, apply to nearest district office.

HOT PLATES

TYPE 22 HOT PLATE

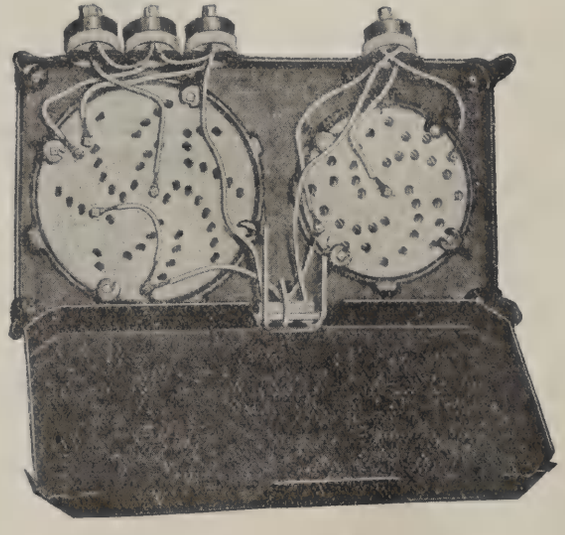
These hot plates are small electric stoves for hotel, restaurant, cafe, and domestic service.

Special Features—No special flat-bottomed utensils needed, the radiant heaters, with all the heat at the top, are very efficient with ordinary cooking vessels. Non-corrosive material used for the heating elements; water or food spilled over the heater will not damage it. The porcelain brick on which the heating element is assembled will stand rough usage. Deflector plates below the heaters prevent scorching the table, protect the connection, and increase the heaters' efficiency.

Heat Control—The 8-inch heater has a three-heat switch. In the 10-inch heater three separate switches are used. These light up an area 6 inches, 8 inches, or 10 inches in diameter. Each 10-inch heater is therefore really three plates in one.

Style number and price include hot plate with switches as illustrated.

Style No.	Wiring	Volts	Maximum Watts	Approx. Shipping Weight	Net Retail Price
266968	3	100 to 120	3000	30	$37 00
266970	2	210 to 250	3000	30	37 00



SHOWING ACCESSIBILITY OF CONNECTIONS

Order by Style Number and Specify Voltage

HELPFUL COOKING UTENSILS

CLOVER-LEAF SET AND COOKER POT IN SMALL OVEN OF 3-19B ELECTRIC RANGE

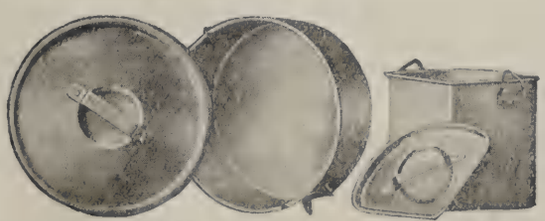
Great economy can be effected in the straight electric range by doing all boiling in the ovens. The clover leaf set and the cooker pot are built specially for these ranges. They are so designed that all four vessels can be put into the small oven together, permitting four different dishes to be cooked at once. In the combination gas and electric ranges these vessels also prove useful.

The vessels are of specially heavy gauge aluminum well made and very substantial.

Clover-Leaf Set—The clover leaf set consists of three triangular vessels, each holding two quarts. All three vessels can be placed in the small oven of the type 3-19-B range so that three vegetables can be boiled separately at the same time.

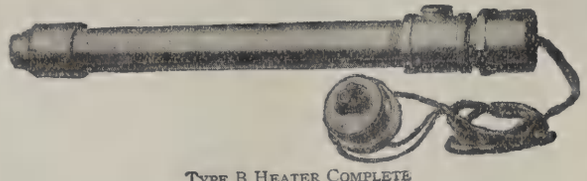
Cooker Pot—The cooker pot is a round 2½-quart vessel which fits over the clover-leaf set or can be used separately. It is useful in preparing boiled meats, stews, etc.

Style No.	Description	List Price
278401	Clover-Leaf Set (three vessels)	4 00
278402	Cooker Pot	1 50

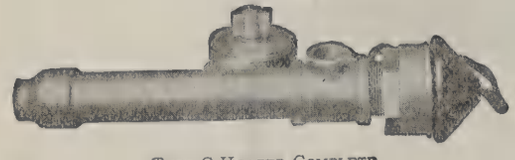


COOKER POT CLOVER-LEAF VESSEL

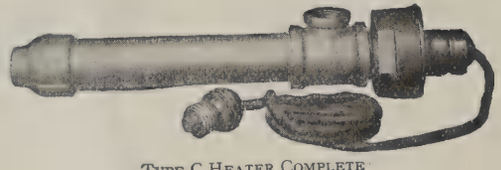
BAYONET IMMERSION HEATERS
FOR DOMESTIC USE



TYPE B HEATER COMPLETE



TYPE C HEATER COMPLETE
1000 AND 2000 WATT



TYPE C HEATER COMPLETE
400 AND 600 WATT

For data on size of heater required see Section 9-A.

Circulation water heaters or immersion heaters are used with an insulated storage tank to supply hot water for household use; in coffee urns; for indirect melting of glue, paraffine, tar and other viscous substances; for generating low pressure steam (maximum gauge pressure of 15 pounds per square inch); for sterilizing; and for multiplicity of applications where heating may be accomplished directly or indirectly by the heating of a liquid, the temperature of which should not exceed 250 degrees Fahrenheit, or the liquid pressure 150 pounds per square inch.

The heater may be removed from the casing and inserted directly in the vessel containing the liquid. The blades of these heaters should **always** be **completely** immersed in the liquid.

Lagging—For most efficient operation of bayonet immersion heaters, the storage tanks, heater casings, and all connection pipes should be well lagged to prevent heat loss by radiation.

Features—On account of their simple construction these heaters are easily removable and hence easily cleaned. Being completely immersed in the liquid, they are extremely efficient—all heat goes into the liquid. They are strong and rugged and will withstand a reasonable amount of abuse.

Construction—The types B and C heaters are of similar construction and differ only in size and number of blades and the construction of the terminals. They consist essentially of a flat ribbon resistor assembled in a mica sheath and encased under pressure in a flattened copper tube, which is brazed into a brass head. The brass head is threaded to screw into the casing. The casing consists of a piece of standard iron pipe with proper fittings to attach to the water system.

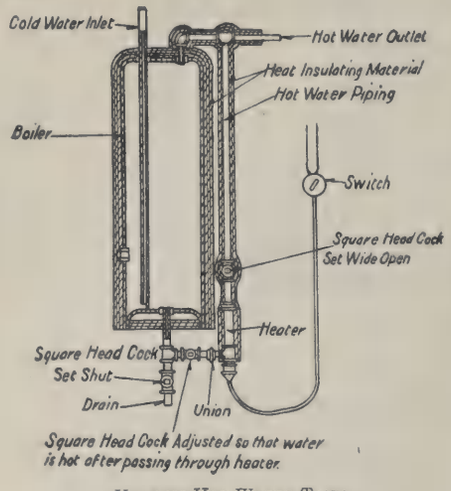
Type C Heaters—In the type C heaters of 1000 and 2000-watt capacity heavy screw terminals are mounted in a molded terminal block located within the brass head. A flexible cord is permanently attached to the terminals which are protected by a molded terminal cover and a three-heat indicating snap switch is supplied with each heater. The heater casing consists of a suitable length of standard 1¼-inch malleable iron pipe with tee fitting, in which the heater head screws, and a reducing coupling on the other end.

Watts Input Max.	Watts Input Med.	Watts Input Low	Approx. Shipping Wt., Lbs.	Style No. 100–120 V	Style No. 200–240 Volts	Style No. 240–260 Volts	Net Retail Price
				TYPE C			
				With Switch and Casing			
* 400	....	...	14	251200	251202	.....	$24 00
* 600	....	...	16	251208	251210	.....	24 00
1000	500	250	20	274441	274443	.....	28 00
2000	1000	500	22	274449	274451	.....	34 00
				With Switch but Without Casing			
* 400	....	...	14	251140	251142	.....	23 00
* 600	....	...	14	251148	251150	.....	23 00
1000	500	250	16	274425	274427	.....	27 00
2000	1000	500	20	274433	274435	.....	33 00
				TYPE B			
				With Switch and Casing			
2500	1250	625	30	280944	280945	285352	36 00
3500	1750	875	32	280946	280947	285353	38 00
				With Switch but Without Casing			
2500	1250	625	28	285268	285269	285356	34 00
3500	1750	875	30	285270	285271	285357	36 00
				Without Switch or Casing			
2500	1250	625	28	280952	280953	285360	33 00
3500	1750	875	30	280954	280955	285361	35 00

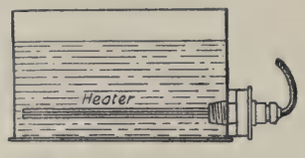
*These heaters are not furnished with switch but are equipped with standard parallel blade separable attachment plug.
Heaters can be supplied with nickel finish casing on special order.
For heaters of capacity higher than 3500 Watts, see catalogue section on Industrial Heating Apparatus.

Order by Style Number

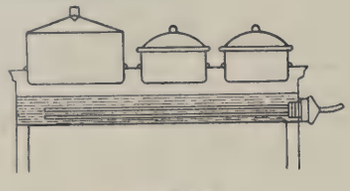
BAYONET IMMERSION HEATERS—Conitnued



HEATING HOT WATER TANK



TANK HEATING BY DIRECT IMMERSION



STEAM TABLE

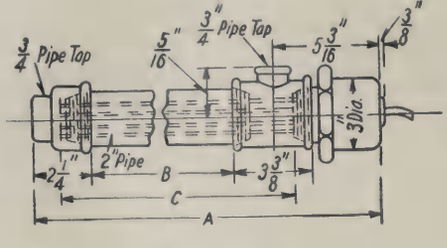


FIG. 1. TYPE B

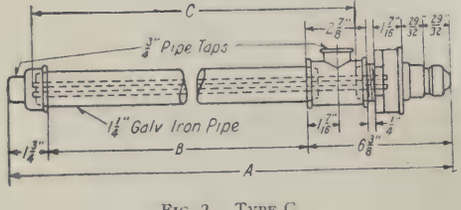


FIG. 2. TYPE C
1000 AND 2000 WATT

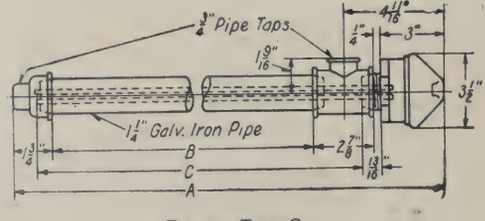
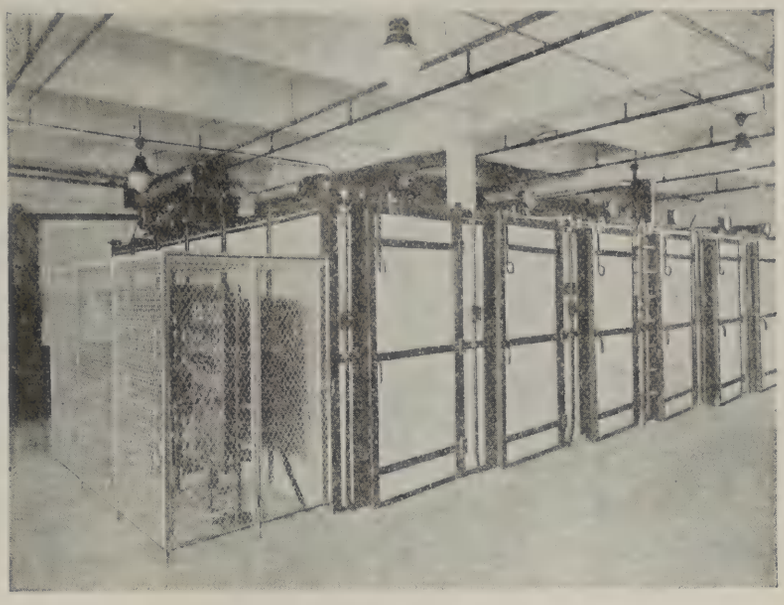


FIG. 3. TYPE C
400 AND 600 WATT

Max. Input Watts	Volts	Fig.	Dimension Inches A Min.	A Max.	B Min.	B Max.	C
TYPE C HEATERS							
400	100–120	2	15 7/16	16 3/16	7 1/16	8 1/16	10 1/16
	200–240	2	22 7/16	23 3/16	14 5/16	15 1/16	17 1/16
600	100–120	2	15 7/16	16 3/16	7 5/16	8 1/16	10 1/16
	200–240	2	18 7/16	19 3/16	10 5/16	11 1/16	13 1/16
1000	100–120	3	22 3/16	22 13/16	14 5/16	15 1/16	17 1/16
	200–240	3	39 1/16	40 3/16	31 1/16	32 1/16	34 1/16
2000	100–120						
	200–240	3	39 1/16	40 7/16	31 1/16	32 1/16	34 1/16
TYPE B HEATERS							
2500	100–120	1	17 9/16	18 5/16	8 1/16	9 1/16	12
	200–240	1					
3500	100–120	1	21 9/16	22 5/16	12 1/16	13 1/16	16
	200–240	1					

These dimensions are for reference only. For official dimensions apply to the nearest district office.

ELECTRIC HEATING EQUIPMENT FOR OVENS



TYPICAL TRUCK-OPERATED KILN-TYPE ENAMELING OVEN INSTALLATION.
BANK OF SIX SIGN METAL OVENS HAVING A TOTAL CAPACITY OF 500 KILOWATTS.

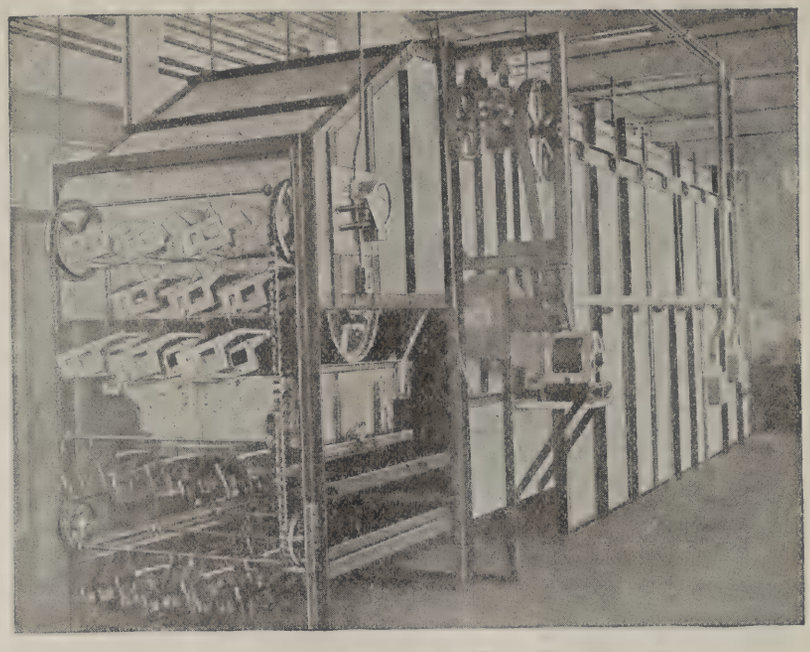
For the electrically-heated oven may be claimed all of the advantages now recognized as having been obtained in the application of electricity to industrial plants in the various forms of power; i. e. economy of operation; reliability of service; increased production; ease of operation and safety.

OVEN CONSTRUCTION

An enameling oven is essentially a heat insulated room. The inner wall consists of thin sheet metal and the insulation may consist of powder, blocks, or bricks. Where powder or blocks are used, the insulation must be placed between inner metal lining and an outer lining, thus practically constructing one sheet metal box within another with insulation placed in the space between the two. When insulating brick is used the wall is built up around the inner metal lining in the same manner that masonry brick is laid.

Before electricity came into use for enameling, almost no attention was paid to the kind or thickness of **insulation,** or oven construction in general, so far as retaining the heat in the oven is concerned. The reason for this was that gas being a very cheap fuel, it was not considered necessary to go to any particular expense to obtain an oven having good heat-insulating qualities. It was very seldom that one would see an oven with two inches of insulation, one or one and one-half inches being the rule. Moreover, this insulation was of a very poor quality.

There was another feature pertaining to oven design which had been absolutely neglected, and that is with reference to the amount of metal connecting the interior of the oven to the exterior surface, or as it is now termed, the amount of **through metal.** One is very apt to under-estimate the effect of through metal, in conducting heat from the interior to the exterior of an oven. The sectional area of the metal extending through the oven, even in the earliest types of ovens where no attention was paid to through metal, would appear to be relatively small in proportion to the insulating surface. This is true, but there is another property which offsets this difference in relative area exposed to the interior and exterior oven surfaces, i. e. the thermal conductivity of the material. The coefficient of thermal conductivity of any material is the B. T. U. conducted through the material per hour, per square foot of surface, per inch of thickness, per degree F. difference in temperature of the two exposed walls. With a conductivity of 500. for iron and .5 for a high grade insulation, the relative conductivity would be 1000



A Continuous Conveyor-Type Oven in Which Typewriter Parts are Dipped and Baked in an Automatic Process

to 1 or, with equal sections and length exposed to the same temperature, iron would conduct 1000 times as much heat through the wall as a high-grade insulating material. The effect of through metal is apparent and the necessity for eliminating it is readily understood because one square inch of metal extending from the interior to the exterior surface of the oven will conduct as much heat away to the atmosphere as 7 square feet of the highest grade insulation obtainable at this time.

In a number of the ovens now in use, no attention has been paid to **insulating the floor,** which is a very serious mistake, especially in view of the desirability of obtaining uniform temperature through-out the oven. Thought is being given to this matter as to the most practical and desirable way of accomplishing this result since the majority of the ovens have floors of concrete, which is not to be classified as a heat insulator. The thermal conductivity of concrete will vary in accordance with the proportion and kind of material used in mixing but for the average floor it will be approximately five, or a conductivity of ten times that of an insulated wall of the same thickness. The greater thickness of a concrete floor off-sets in a measure the increase thermal resistance of the oven walls, but not sufficiently. In the latest type of ovens, this loss is being taken into consideration and the floor insulated to a thickness equivalent to half of that of the oven walls

Types of Ovens

Ovens may be classified under four general divisions as follows:

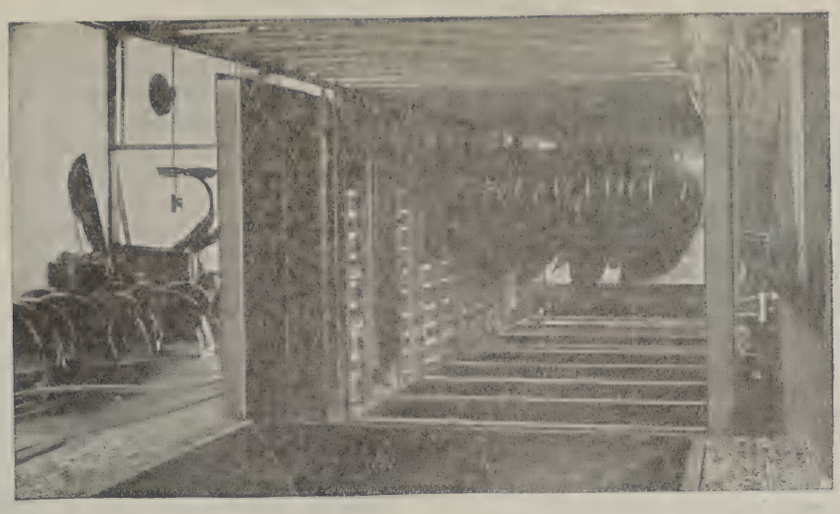
Kiln-type oven hand-operated.
Kiln-type oven truck-operated.
Semi-continuous conveyor-type oven.
Continuous conveyor-type oven.

The **hand-operated kiln** or box-type oven, consists of an insulated room into which the work or parts to be baked are carried by hand and hung up in place on suitable racks or hooks.

The **truck-operated kiln** or box-type oven consists of an oven similar to the hand-operated. However the work is loaded on trucks which are wheeled into the oven and which remain in the oven with the work.

The **semi-continuous conveyor-type** oven consists of an oven having doors at both ends, with an overhead conveyor running directly through the oven. This conveyor usually consists of a continuous chain which passes through the oven and returns over the top of the oven. With an oven 20 feet long, the conveyor would extend in a horizontal plane at least 20 feet on either end of the oven. A batch of work is dipped in the enamel and hung on the conveyor to drip for approximately 15 or 20 minutes. After this period the conveyor is started and the work moved into the oven. While the first batch is being baked the second is being dipped and being hung on the conveyor. As soon as the first batch has baked the conveyor is started up, the first being carried out, and the second batch into the oven. A third batch is then dipped and hung on the conveyor, while the second batch is being baked, and the first batch removed from the conveyor. This operation is repeated indefinitely.

A continuous conveyor-type oven consists of an



BAKING THE ENAMEL ON AUTOMOBILE FENDERS IN A SEMI-CONTINUOUS CONVEYOR-TYPE OVEN

oven having a conveyor running through, which operates continuously and not intermittently as in the case of the semi-continuous conveyor type oven. The work is hung onto a moving conveyor or chain and carried directly into the oven. The speed of the chain, the length of travel and the temperature of the oven must be such, that by the time the work reaches the exit, the enamel has been thoroughly baked. Ovens of this character require the doors to be open continuously. In order to prevent heat losses through these openings and the smoke and vapors from filling the enameling room, the oven must be constructed so as to obtain an air seal around the opening, or an exhaust fan used at the proper point of the oven to secure an air balance, and at the same time provide ample ventilation.

Efficiency of Operation

The **hand-operated kiln-type** oven is the most in-efficient type of oven used. Due to the fact that the work must be carried in by hand, the oven cannot be at a very high temperature during the loading period. Also, after the baking has been completed the oven doors must be opened and the oven allowed to cool down to about 150 degrees F. before the workmen can enter the oven for removing the work. Before the oven can then be loaded, ready to be put into operation again, the temperature is down to that of the room. This means that in almost every case this type of oven must be heated from approximately room temperature up to maximum baking temperature for every bake that is obtained.

With the **truck-operated kiln-type** oven, the doors may be open a much shorter period than where ovens are hand-operated, from 5 to 10 minutes being ample time after the doors have been open for removing the trucks and running other trucks into the oven.

The **semi-continuous-conveyor** oven is about on a par with the truck-operated oven insofar as the efficiency of the oven itself is concerned. Since the work progresses through the oven, both ends of the oven must be laid wide open when loading, with the consequent result of a large cooling effect. Ovens of this type will drop from 450 degrees to 250 degrees while this change is being made. The total weight of the conveyor in proportion to the amount of work entering the oven per bake is probably not as great with this type of oven as in the case of the truck-operated oven, hence the efficiency of operation is improved in this particular. The overall efficiency, however, is approximately the same as the truck-operated oven.

The **continuous conveyer-type** oven is the most efficient type of oven and is coming largely into use in the automobile industry. The oven operates continuously at one temperature, requires a minimum of ventilation and a conveyor of minimum weight. The net result of this is that the latest designs of continuous conveyor-type ovens have an efficiency in excess of double the amount obtained by the best semi-continuous conveyor-type oven.

The efficiency of the above types of ovens, expressed in pounds of work or finished product, per KW hour consumption for ovens of the latest of each of the respective types, having the highest grade insulation, proper ventilation and intelligent operation of the oven is, herewith given.

Kiln-Type Oven, Hand-Operated; 6 to 8 pounds of work per kilowatt hour.

Kiln-Type Oven, Truck-Operated; 10 to 12 pounds of work per kilowatt hour.

Semi-Continuous Conveyor-Type Oven; 10 to 12 pounds of work per kilowatt hour.

Continuous Conveyor-Type Oven; 25 to 30 pounds of work per kilowatt hour.

ELECTRIC HEATERS

The number of heaters for any given installation depends upon the weight of material baked, maximum temperature required, time required in which to reach maximum temperature, ventilation or changes of air per hour, location of heaters and oven construction.

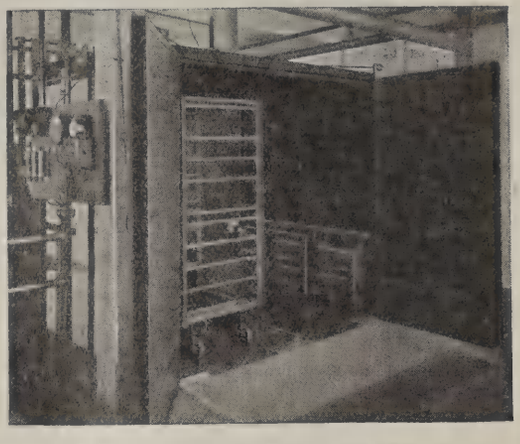
In the majority of enameling-oven installations the **maximum temperature** will be from 400 to 450 degrees Fahr., which will be reached in from one half to one hour's time. The ventilation or changes of air per hour will depend upon a number of variables, such as kind of enamel used, speed of baking, maximum temperatures, and oven construction. This will vary through a range of from 10 to 20 complete changes of air per hour.

The **method of applying heat** to ovens depends upon local conditions. In some cases it may be necessary or sufficient to install the heaters along the side walls, while in other cases it may be necessary to supplement the heaters on the side wall with one or more rows down the center of the oven.

In a well constructed oven, and with a long baking period, heaters arranged two high along both sides of the oven may be sufficient. Where a short baking period is required, it may be necessary to install heaters three or four high. A row of bus-bars is not required over each row of heaters, that is, with heaters installed four high, on a three-phase system, there will be but one bus-bar on the top row and two bus-bars between the second and third rows.

In many cases, due to interference of trucks, conveyors, or the work, the heaters may extend only a definite distance above the floor line, in which case it is necessary to place part of the heaters elsewhere in order to get sufficient heat in the oven to meet the required operating conditions. Under these conditions, as many heaters are mounted on the side walls as possible, and the rest placed in a row, one or more heaters high, down the center of the oven. With exceptionally wide ovens, in order to obtain uniform temperature throughout, it is necessary to supplement the heaters along the side walls by heaters mounted on the floor, in one or more rows, distributed so as to produce the best baking results.

Where workmen are apt to come in contact with the heaters or bus-bars, or where same may be injured accidently by trucks or work falling off the conveyors, it is necessary to provide against such



TRUCK-OPERATED KILN-TYPE OVEN SHOWING CONTROL PANEL AND METHOD OF INSTALLING HEATERS

accidents by the use of a **protecting wire screen.** This screen should be made in sections, and may be attached directly to the flanged end plates of the heater, and extended up and over the bus-bars, thus completely enclosing all electrical equipment in the oven.

Standard Sizes of Heaters—Heaters are built in units of 2.3 kilowatts at 110 volts each. A sufficient number are installed in an oven to obtain the required amount of heat. For 220-volt circuits, two heaters are connected in series, and for 440-volt circuits, four heaters are connected in series.

CONTROL APPARATUS

The control equipment consists of the Westinghouse standard type F magnet switch with protecting fuses. When automatic temperature control is desired, a thermostat with suitable relay is used, in conjunction with the magnet switch, by means of which the temperature within the oven may be held constant within narrow limits, continuously and entirely automatically.

In many installations it is necessary to group the heaters into two or more circuits, in order to limit the capacity of each circuit to 300 amperes or less. Also with large ovens, particularly in case of long narrow ovens, two or more control circuits are required in order to maintain uniform temperature throughout the entire length. In some installations it has been deemed advisable to have what may be termed Constant Heat Circuits and Temperature Control Circuits. A sufficient number of heaters are placed on the constant heat circuit to just maintain the operating temperature with a minimum amount of work in the oven. The rest of the heaters are placed on the temperature control circuit, and are operated by the temperature control instrument by cutting them on when the temperature drops to the minimum limit and cutting them off when it reaches the maximum predetermined limit.

TYPE C OVEN HEATERS

The type C oven heater is designed especially for use in enameling or japanning ovens, but may be used in a large variety of applications where ovens are employed for a baking or drying process.

The **heating element** consists of a ribbon wound on a number of fire clay bushings assembled on two steel tie rods between two pressed steel end plates. The ends of the ribbon are secured to forged steel terminals which are clamped to the steel tie rods, the rods therefore becoming the **terminals** for the heaters. These rods are insulated from the end frames where they pass through same, and the ends are threaded for bolting on the connectors.

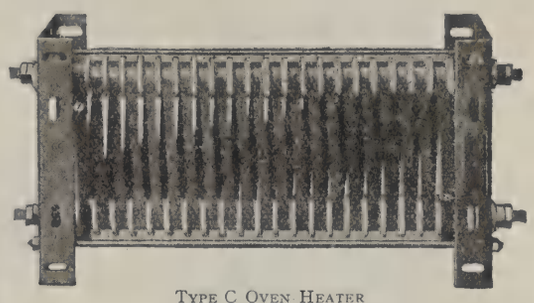
Connectors are made of ⅛" x 1" cold rolled steel. A large number are made standard and may be supplied directly from stock along with the heater. Special connectors are furnished to meet any requirements. Cold rolled steel **busbars** are recommended, and may be mounted directly above the heater on insulators bolted directly to the end frames. Connectors are secured to bus bars by steel clamps.

Hooks are used for **hanging the heaters** on to the usual supporting steel work, which may be flat, angle or channel iron, or pipe work. The hooks are bolted to the flanged end plates of the heaters.

Heaters may be mounted either on the side walls or on the floor, and in any position.

Protecting screens may be attached directly to the flanged end plates, without any other means of support.

Heaters are normally **rated** at 2.3 kilowatts at 110-volts. Any number of these heaters may be installed in an oven, and connected to any single-phase, polyphase, or direct current 110, 220 or 440-volt power circuit that may be available. On 220-volt service, two heaters are connected in series and on 440-volt service, four heaters are connected in series. Where three-phase power circuits are used, the heaters are connected in three-phase delta, with the phases balanced.



TYPE C OVEN HEATER
STYLE NO. 245730-A

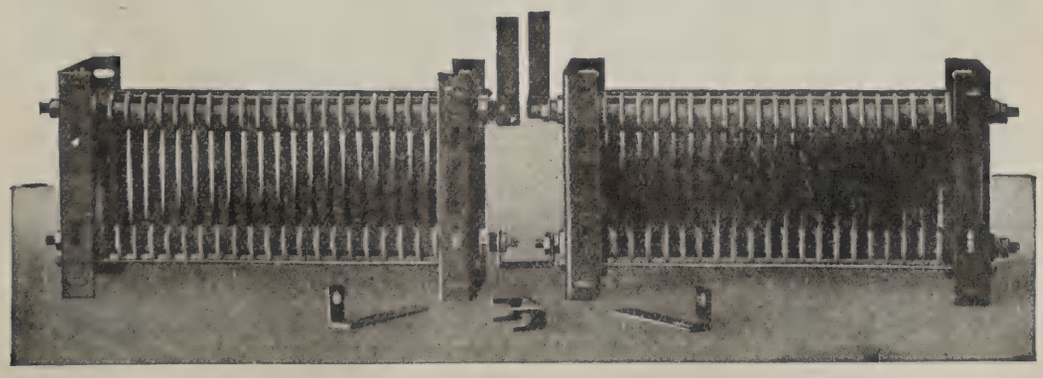
Distinctive Features of the Westinghouse Type C Oven Heaters

1. Entire elimination of all sharp bends in the ribbon. Short bends have been one of the chief sources of trouble in oven heaters. The expansion and contraction of the ribbon, due to alternately heating and cooling, causes the ribbon to crystallize at any short bend, with the result that sooner or later the ribbon will break at that point.

2. Heavy forged steel terminal connectors for the ribbon are used.

Short bends in ribbon, together with faulty terminals, have been responsible for most of the troubles in enameling oven heaters. In the Westinghouse heater, the ribbon is clamped by means of a heavy steel clamp to a ½-inch steel rod constituting one of the supports for the insulator spools. This connection is made at the factory, and is permanent, thereby eliminating the probability of getting kinks or short bends in the ribbon, which is apt to occur if the end of the ribbon has to be handled during the installation of the heaters.

3. Heater terminals consist of ½-inch threaded steel rods with lock nuts. The new type of terminal, as used on the type C heater, has been pronounced of superior design and construction. With a ½-inch bolt connector, positive contact is assured.



THE C OVEN HEATERS, SHOWING METHOD OF CONNECTING TWO HEATERS IN SERIES FOR 220-VOLT SERVICE.

TYPE C OVEN HEATERS—Continued

4. Connections from heater to heater, and from heater to bus-bars, are made of flat cold rolled steel. Where wire connectors are used, the expansion and contraction cause continual working of the connections, which, in time, cause poor contact, followed by an over-heated connection, and consequently a burn-out.

5. Heaters are designed for hanging up on angle or channel iron, strap iron, or pipe without any drilling or bolting. This feature has the following advantages:

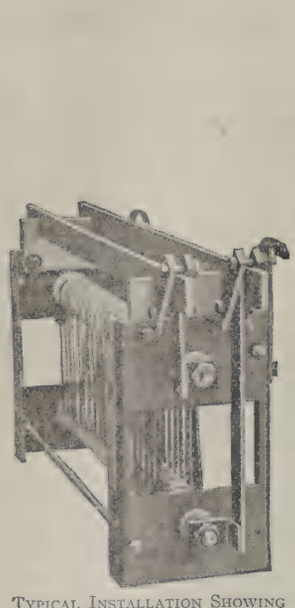
(a) Eliminates all drilling of iron work in the oven.

(b) Permits quick installation and replacement.

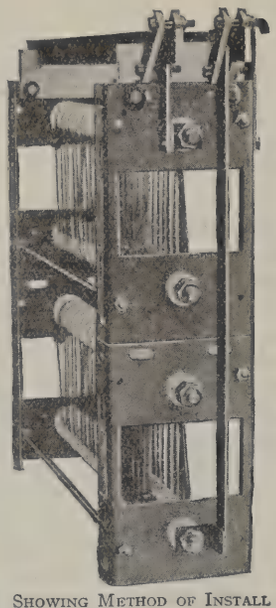
(c) Permits a re-arrangement of the heaters. The heaters can be lifted off the hangers and moved along on channel so as to distribute the heat to points found necessary to increase or decrease the heat in order to produce a uniform bake at all points of the oven.

(d) Permits heater to expand or contract, without restriction.

6. Bus-bars mounted on the heater frame are a part of the heater, and require no other support. Bus-bars are made of cold rolled steel, and rest in recessed special moulded insulators, bolted to the end frames of the heaters. Steel connectors from the heaters are bolted to the bus-bars by steel clamps, which entirely eliminate all drilling of bus-bars for connecting bolts.



TYPICAL INSTALLATION SHOWING HEATER CONNECTED TO SECTION OF BUS-BARS



SHOWING METHOD OF INSTALLING AND CONNECTING TYPE C HEATERS TWO-HIGH (One on Top of the Other)

7. Flanged end plates of the heater provide ample facilities for attaching guard wires or protecting screens.

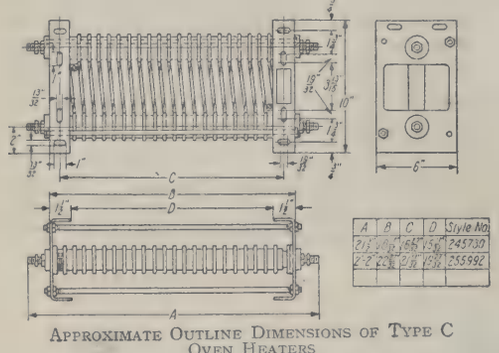
8. Heater and protecting screen may be mounted in a space as small as 8 inches from the oven wall.

9. Heaters may be mounted in a row in the middle of an oven with equal ease, and without any special arrangement. One heater may be mounted on top of another, the two bolted together with an iron strap, the top heater only carrying the bus-bars.

Other qualifications possessed by the Westinghouse type C heater are:—

1. A non-oxidizing ribbon is used.

2. Short span or turn of ribbon. In the type C heater this has been reduced to 6 inches, thus entirely eliminating all possibility of ribbon sagging and making contact with adjacent turns.



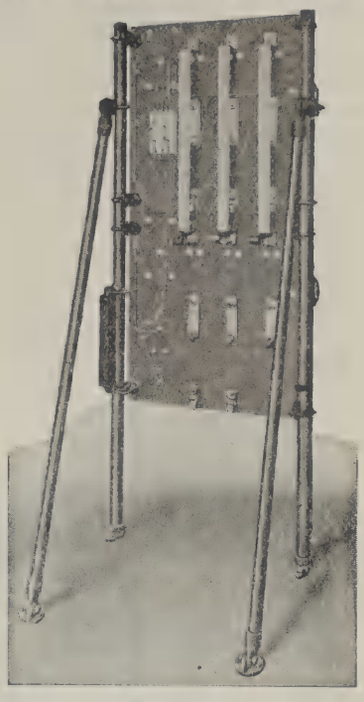
APPROXIMATE OUTLINE DIMENSIONS OF TYPE C OVEN HEATERS

Style No.	Description	Length of Tubing Feet	Scale Range Degrees F	Kind	List Price
277641	Thermostat	25	40–600	Control & Index	$80 00
277640	Thermostat	25	90–280	Control & Index	75 00
293008	Thermostat	6	100–500	Control	87 00
293009	Thermostat	15	100–500	Control	95 00
282632	Thermostat	15	200–300	Control	91 00
253704	Thermostat	25	250–500	Control & Index	75 00
282633	Thermostat	15	300–525	Control	91 00

		Kilowatts	Volts	Net Wt. Lb.	
245730	Type "C" Oven Heater and Connectors, etc.	2.30	110	15	13 50
245730	Type "C" Oven Heater Only	2.30	110	13	13 00
255992	Type "C" Oven Heater and Connectors, etc.	1.65	110	20	15 00
255992	Type "C" Oven Heater Only	1.65	110	18	14 50
217987	Push Button Station	....	...	..	6 00
273150	Door Switch	....	...	..	6 00
152526	Time Clock and Relay	....	...	..	10 00

CONTROL EQUIPMENT FOR ENAMELING OVENS

Front View



Rear View

FIG. 1—TYPE F MAGNET-SWITCH CONTROL PANEL WITH TWO FUSED CIRCUITS AND RELAY FOR THERMOSTATIC CONTROL

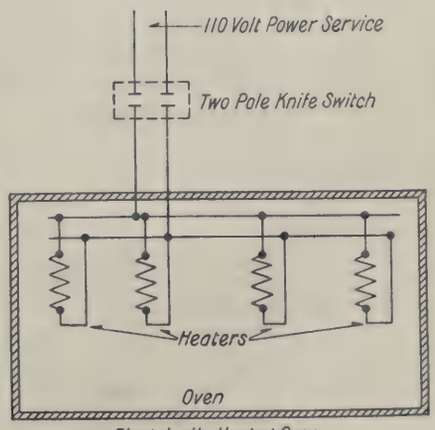
The simplest form of enameling oven equipment consists of one or more heaters installed in an oven, connected to a two-wire circuit and controlled with a **knife switch** (Fig. 3).

A three-wire or three-phase circuit would scarcely be said to complicate matters, as it can be readily seen by referring to Fig. 4. With this arrangement, as well as in the previous case, in order to turn the current on the heaters, the knife switch must be manually operated.

Where it is desirable to control the oven from a distant point, **magnet switches** are used. This method of operation is employed in large installations where one man is placed in charge of the operation of all the ovens, and is held responsible for the maintenance of the proper temperature at all times. Thermo-couples are used to indicate the temperatures in such cases, the wires from all the ovens being brought to a control desk at which the man who has charge of the operation of the ovens is located. Small control switches operate the magnet switches of the different oven circuits from this point. (Fig. 5).

FIG. 2
STYLE 217987
TYPE "C"
PUSH BUTTON
STATION

In most installations it is desirable, and in fact, essential, that the temperature of the oven be held constant, continuously and entirely **automatically** throughout the working day. The accomplishment of this feature necessitates the use of the **thermostat,** with suitable relays, to be used in connection with the magnet switches (see Fig. 6). The thermostat consists of a contact making instrument, the movable element being actuated by pressure generated in a capillary tube that extends into the oven. The tube is filled with gas, vapor, or mercury. The pressure generated in the tube and exerted on



Electrically Heated Oven.
Hand Controlled.

FIG. 3—DIAGRAM OF CONNECTIONS OF HAND-CONTROLLED ELECTRICALLY HEATED OVEN ON SINGLE-PHASE 110-VOLT CIRCUIT

CONTROL EQUIPMENT FOR ENAMELING OVENS—Continued

the movable hand is a function of the temperature; hence the instrument may indicate temperature by being so calibrated and the scale marked accordingly. Adjustable contacts or indicators are provided, by means of which the temperature may be held constant between the operating limits desired. A relay is required in connection with the thermostat for operating the main magnet switches. This relay consists of a single-pole magnet switch with an additional interlock or secondary switch.

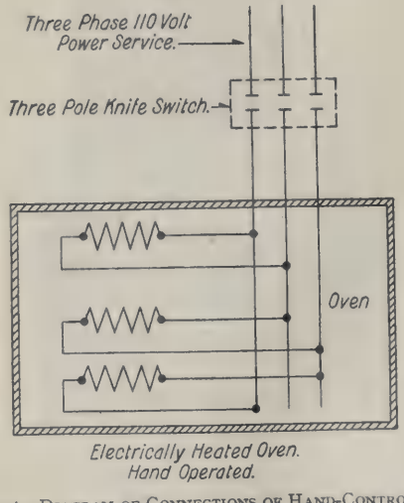


FIG. 4—DIAGRAM OF CONNECTIONS OF HAND-CONTROLLED ELECTRICALLY OPERATED OVEN ON THREE-PHASE 110-VOLT CIRCUIT

Assume that the oven is cold, and it is desired to heat it and keep it in continuous operation. The adjustable contacts are set for the maximum and minimum allowable temperatures and the push button closed. Instantly the current flows through the "low" contact, the movable pointer and through the relay coil. Energizing the relay coil causes the relay switch and interlock to close simultaneously. The closing of the relay switch causes the main magnet switch coil to be energized, closing the main circuit. Closing the interlock,

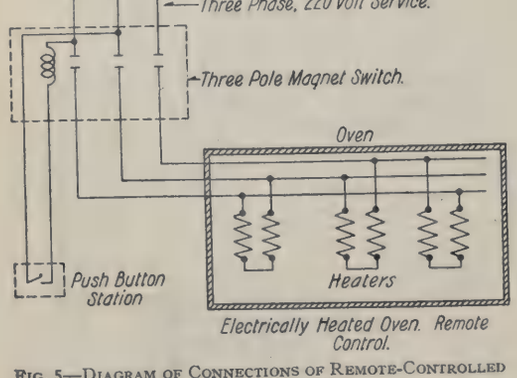


FIG. 5—DIAGRAM OF CONNECTIONS OF REMOTE-CONTROLLED ELECTRICALLY HEATED OVEN ON THREE-PHASE 220-VOLT CIRCUIT

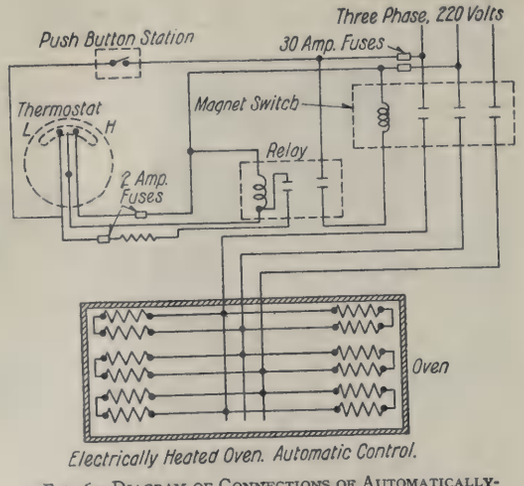


FIG. 6—DIAGRAM OF CONNECTIONS OF AUTOMATICALLY-CONTROLLED ELECTRICALLY HEATED OVEN ON THREE-PHASE 220-VOLT CIRCUIT

gives a new path for the current to the relay coil, so that when the movable hand breaks contact with the "low" contact it does not break the circuit. The temperature of the oven increases until the movable hand reaches the "high" contact, at which instant the relay coil is shunted, causing it to be demagnetized, and opening the relay switch and consequently the main switch. As soon as the

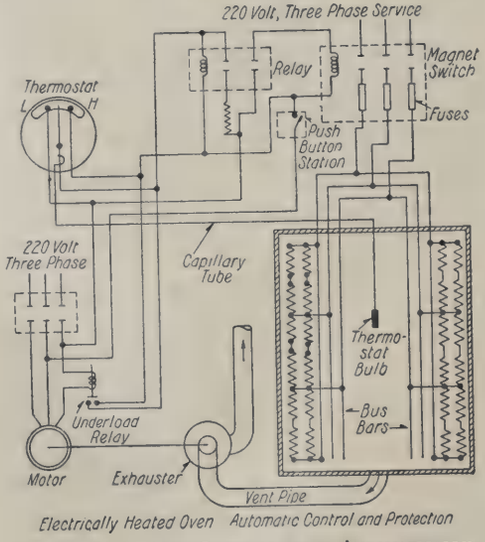


FIG. 7—DIAGRAM OF CONNECTIONS OF AUTOMATICALLY-CONTROLLED AND VENTILATED ELECTRICALLY HEATED OVEN ON THREE-PHASE 220-VOLT CIRCUIT

heat is cut off the movable hand begins to travel from the "high" to the "low" temperature contact, and, upon reaching the lowest temperature setting or limit, contact is again made, energizing the relay, and again closing the main switch. This operation will go on indefinitely.

It is rapidly becoming the practice to install individual exhaust fans in connection with each oven, for the purpose of **insuring proper ventilating** conditions. When natural ventilation afforded by the use of a high stack is depended upon, the ventilation is not a constant quantity, but varies from day to day depending upon humidity, air temperature, and wind. Even with an exhauster, the ventilation will become impaired in course of time due to the heavy oily vapors condensing in the vent pipes, forming a tarry substance which finally solidifies and cakes. Thus the vent pipes gradually become restricted as to cross sectional area, with the possibility that in course of time the ventilation will become sufficiently impaired to prevent the escape of the volatile naphtha vapors and an explosive mixture is formed. The arrangement outlined in Fig. 7 is designed to overcome this condition by using a motor operated exhauster. In the first place the power for operating the main magnet switch is taken from the exhauster motor circuit, and connected back of the starting switch, thereby eliminating the possibility of the oven being operated without the exhauster. In the second place, it is known that the power required to operate an exhauster or blower varies with the amount of air passing through it. While in this case the power would not vary directly with the amount of air handled, the variation is sufficient to enable an instrument to be calibrated in such a manner as to give a close indication, by the decrease in current input to the motor, the amount by which the vent pipe has become stopped up. Further if a relay be inserted in the motor circuit as shown with a suitable coil and short circuiting plunger, the stopping up of the vent pipe, whether caused by the vapor condensing in the pipe, accidental closing of the damper, or a piece of work falling off the conveyor, across the vent opening, will be followed by a decreased input to the motor. This decreases the current flowing in the current coil to such an extent that the magnet no longer has sufficient power to hold up the plunger and weight, and allows it to drop, short-circuiting the two auxiliary contacts which in turn short circuit the thermostat relay coil, and cause the main magnet switch to open. Thus with a properly equipped electric oven, the danger from explosions of volatile gases may be entirely removed.

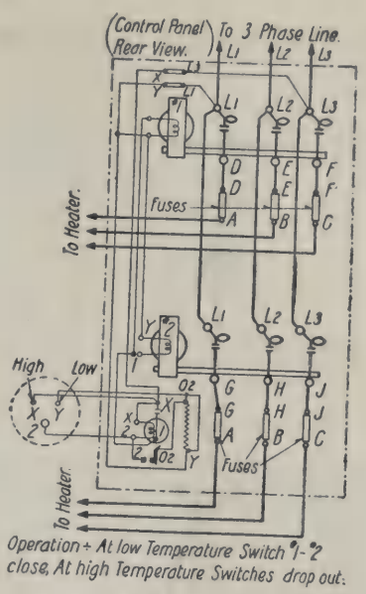


FIG. 9—DIAGRAM OF CONNECTIONS OF THERMOSTAT CONTROL FOR ENAMELING OVENS (SEVERAL CIRCUITS)

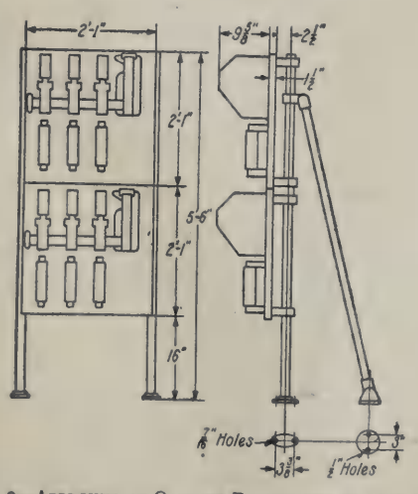


FIG. 8—APPROXIMATE OUTLINE DIMENSIONS OF TYPE F SWITCH PANEL FOR HEATING SERVICE, 250 AMPERES 220 AND 440-VOLT, THREE-PHASE

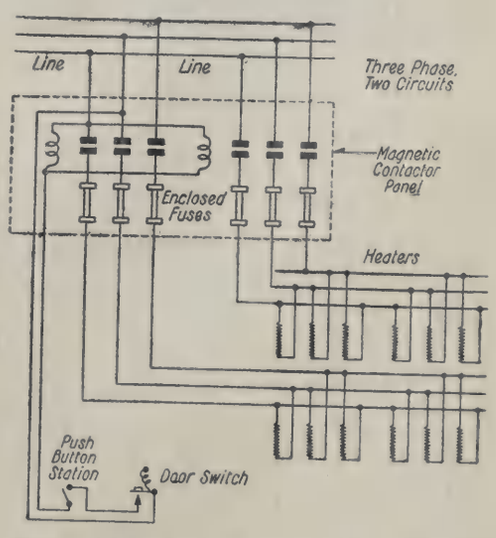
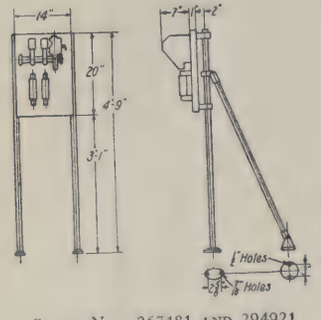
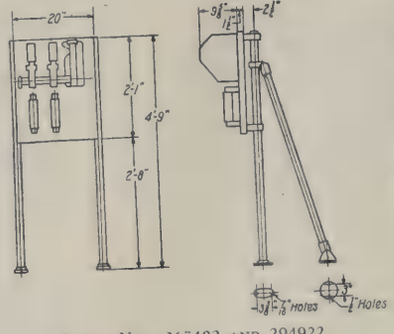


FIG. 10—DIAGRAM OF CONNECTIONS OF CONTROL PANEL FOR ENAMELING OVENS, TWO-CIRCUITS THREE-PHASE, SINGLE-HEAT

APPROXIMATE OUTLINE DIMENSIONS FOR TYPE F CONTROL PANELS



STYLE NOS. 267481 AND 294921



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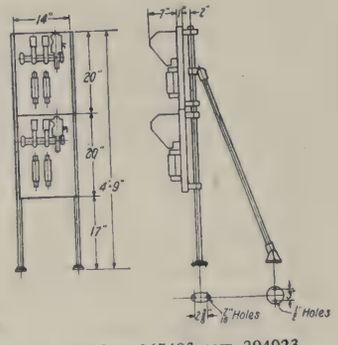
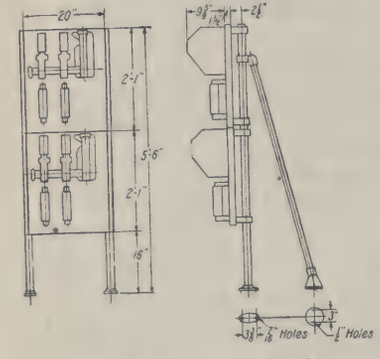
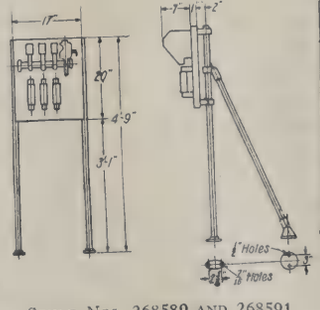


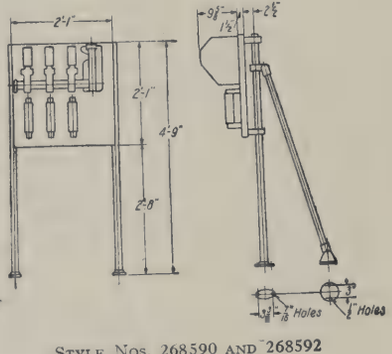
STYLE NOS. 267483 AND 294923



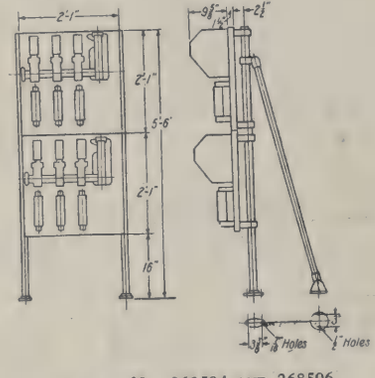
STYLE NOS. 267434 AND 294924



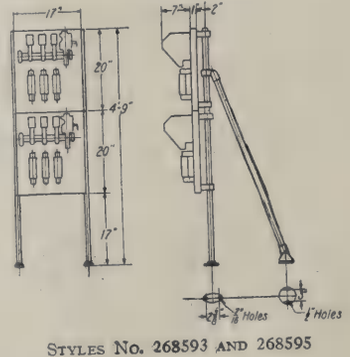
STYLE NOS. 268589 AND 268591



STYLE NOS. 268590 AND 268592



STYLES NO. 268594 AND 268596



STYLES NO. 268593 AND 268595

Standard Type F Oven Control Panels

Style Number	Sections	Poles	Voltage	Amperes	Cycles	List Price
294921	1	2	220	125	60	$120 00
294922	1	2	220	250	60	178 00
294923	2	2	220	125	60	192 00
294924	2	2	220	250	60	306 00
268589	1	3	220	125	60	139 00
268590	1	3	220	250	60	214 00
268593	2	3	220	125	60	228 00
268594	2	3	220	250	60	378 00
267481	1	2	440	125	60	122 00
267482	1	2	440	250	60	184 00
267483	2	2	440	125	60	196 00
267484	2	2	440	250	60	318 00
268591	1	3	440	125	60	142 00
268592	1	3	440	250	60	218 00
268595	2	3	440	125	60	234 00
268596	2	3	440	250	60	395 00

Note: All single section panels are automatic having "KR" relay mounted on the panel. All two section panels are semi-automatic and include one "KR" relay. Besides the panels listed, control panels can be made for 110 volts and for 25 cycle service.

ELECTRIC OVENS FOR BAKING RAILWAY-MOTOR ARMATURES

The proper baking of railway motors involves six essentials:

(1) The use of the right kind of baking varnish.
(2) The thorough impregnation of the coils.
(3) That the baking be done in suitable ovens.
(4) That dependable electric heaters be used.
(5) That automatic temperature control be used in order.
(6) To maintain a proper baking temperature.

The first two conditions are easily met by the railway companies, the great difficulty being to strictly comply with the four remaining conditions. In order that the process of dipping and baking railway motors may be carried on as prescribed by the Westinghouse Electric and Manufacturing Company, and in order to obtain the best results, complete oven equipments have been designed for railway equipments and installations of various sizes.

The equipment recommended consists of the following:

(1) An insulated oven.
(2) A blower and a motor for the ventilation of the oven.
(3) Oven heaters and connectors.
(4) A control panel.
(5) Suitable trucks.

Oven—The ovens are built sectional of two inches of insulation encased between sheet metal walls. Where the railway company does not wish to build its own ovens the Westinghouse Company will supply section ovens, built up of two inches of high grade heat insulating material incased between sheet metal walls. The standard ovens are insulated on all four sides and on the top and the bottom. Rails for the trucks are furnished when specified, and are mounted on the insulated floor.

The ovens are built in single units or in batteries of any number. Where more than one is required, it is preferable to use a battery, on account of the saving in floor space and reduction in price, since one side wall is eliminated in each additional oven installed.

Two systems of handling the armature are applicable:

(1) An Overhead Trolley System which may extend from the dipping tank into the oven. This is not included with the oven, and when used, must be supported independently of the oven.

(2) A Truck System, the armature being loaded on a truck and conveyed into the oven. With this system there are three very good possibilities:

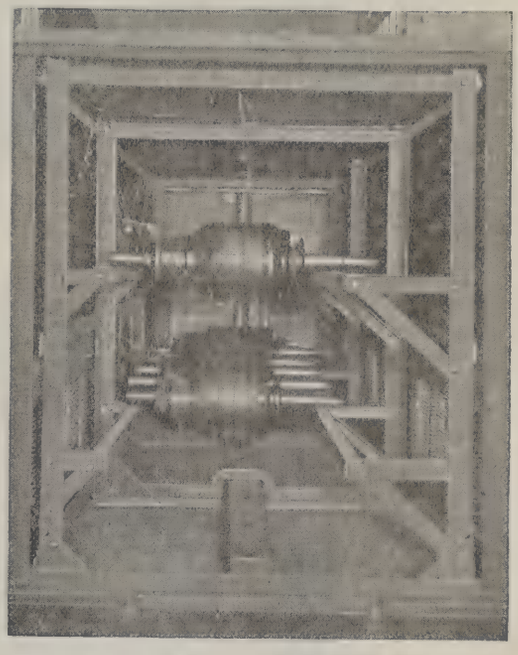
(a) Rails extending out of the oven to the oven door only, a transfer truck being used to carry the armature truck from the dip tank to the oven.

(b) Rails extending out of the oven to a distance equal to the depth of the oven, the loading and unloading being done at that point by a crane.

(c) Rails extending from the oven to the dip tank.

Blower and Motor—Ventilation is one of the most important considerations in the baking of railway motors. Naphtha vapors must be carried away as rapidly as formed and fresh air must be supplied for the oxidation of the varnish. The rapidity with which the baking is accomplished depends largely upon the amount of heated air that passes over the armatures, and the power consumed depends largely upon the manner in which the air is circulated through the oven. Suitable ventilating and re-circulating air ducts are provided both inside and outside the oven for producing the desired results. This includes all piping up to the blower. Each oven equipment includes a motor driven blower.

Oven Heaters and Connectors—Dependable heating units are important. The Westinghouse type C oven heaters are thoroughly dependable, were specially designed for the heating of ovens, and they have many special features that make them indispensable; such as, bus-bar supports, protecting screen support, supporting hooks, cold rolled steel terminal connectors, and a non-oxidizing and non-corroding heating element. With the heaters, are supplied all necessary bus-bars, bus-bar insulators and supports, heater connectors and terminals, bus-bar clamps, and heater hooks. In the Westinghouse outfits, everything essential to the proper installation and connection of the heaters within the oven is supplied, the installation requiring only the use of a monkey wrench—no drilling necessary. Cold rolled steel bus-bars and connectors are used throughout; this having been found to be the best material for oven work. Openings are provided



BAKING RAILWAY ARMATURES IN OVEN
SHOWING METHOD OF INSTALLING HEATERS

in the oven, through which the bus-bars extend for the external connections. Oven insulators are supplied for insulating the bus-bars when they pass through the oven; also, for preventing a loss of heat at that point.

Control Panel—The control panel consists of the well-known Westinghouse type C magnet switches, operated by means of a thermostat for temperature control. A door switch cuts off the current immediately upon opening the oven door. An "on" and "off" push button station is also supplied as an independent means for cutting off the current at any time. Each circuit is protected by enclosed fuses.

Trucks—Trucks are not included as standard equipment and are supplied only when specified. These are made with flat tops on which may be mounted suitable supports for holding the armatures in a vertical position. As the design of these supports will depend upon the size of the armatures which they are to accommodate, they are not furnished with the trucks.

ELECTRIC OVENS FOR BAKING RAILWAY-MOTOR ARMATURES—Continued

TYPE R-1 OVEN
Characteristics

Capacity of oven..... Six armatures.
Size of oven, inside dimensions:
Width.....5′– 6″
Depth.....6′–10″
Height.....6′– 0″
Door opening:
Width.....4′–4″
Height.....5′–8″
Type of oven—Kiln-type, truck operated.
Capacity in heaters installed—25 kilowatts.
Control equipment—full-automatic, temperature control.
Number of trucks per oven—one.
Size of truck—4′ by 6′.

Electrical Equipment

Heaters—F fteen type C oven heaters, Style No. 255992, with a total consumption of 25 kilowatts at 550 volts.

Connectors Insulators—The necessary connectors, bus-bars, bus-bar insulators, connector clamps, and heater hooks for the insulation of 15 oven heaters, are furnished.

Control Equipment—Power Service—550 volts. D. C.

Temperature Control Circuit—One circuit consisting of:

One 125-ampere two-pole type C magnet switch with two 150-ampere enclosed fuses.

One type C relay with interlock and resistance, all mounted.

One electric contact-control thermostat.

One graphic recording thermometer.

One push button station, with "on" and "off" push buttons, and suitable cover for conduit work.

One door switch.

Drawings—The necessary layout drawings showing the method of the heater installation and the electrical connection are furnished.

TYPE R-2 OVENS
Characteristics

Capacity of oven.....Eight armatures.
Size of oven, inside dimensions:
Width.....5′–6″
Depth.....8′–6″
Height.....6′–0″
Door opening:
Width.....4′–4″
Height.....5′–8″
Type of oven—Kiln-type truck operated..
Capacity of heaters installed—33 kilowatts.
Control equipment—Full-automatic, temperature control.
Number of trucks per oven—two
Size of trucks—4′ by 4′.

Electrical Equipment

Heaters—Twenty type C oven heaters, Style No. 255992, w th a total consumption of 35 kilowatts at 550 volts.

Connectors, Insulators—The necessary connectors, bus-bars, bus-bar insulators, connector clamps, and heater hooks for the installation of 20 oven heaters, are furnished.

Control Equipment—Power Service—550 volts, D. C.

Temperature Control Circuit—One circuit consisting of:

One 125-ampere two-pole type C magnet switch with two 150-ampere enclosed fuses.

One type C relay with interlock and resistance, all mounted.

One electric contact control thermostat.

One graphic recording thermometer.

One push button station, with "on" and "off" push buttons and suitable cover for conduit work.

One door switch.

Drawings—The necessary layout drawings showing method of the heater installation and the electrical connection are furnished.

TYPE R-3 OVENS
Characteristics

Capacity of oven.....Twelve armatures
Size of oven, inside dimensions:
Width..... 5′–6″
Depth.....12′–8″
Height..... 6′–0″
Door opening—
Width..... 4′–4″
Height..... 5′–8″
Type o oven—Kiln-type, truck operated.
Capacity in heaters installed—50 kilowatts.
Control equipment—Full-automatic, temperature control.
Number of trucks per oven—two
Size of trucks—4′ by 6′.

Electrical Equipment

Heaters—Thirty type C oven heaters, Style No. 255992, with a total consumption of 50 kilowatts at 550 volts.

Connectors, Insulators—The necessary connectors, bus-bars, bus-bar insulators, connector clamps, and heater hooks for the installation of 30 oven heaters are furnished.

Control Equipment—Power Service—550 volts, D. C.

Temperature Control Circuit—One circuit consisting of:

One 125-ampere, two-pole type C magnet switch with two 150-ampere enclosed fuses.

One type C relay with interlock and resistance, all mounted.

One electric contact control thermostat.

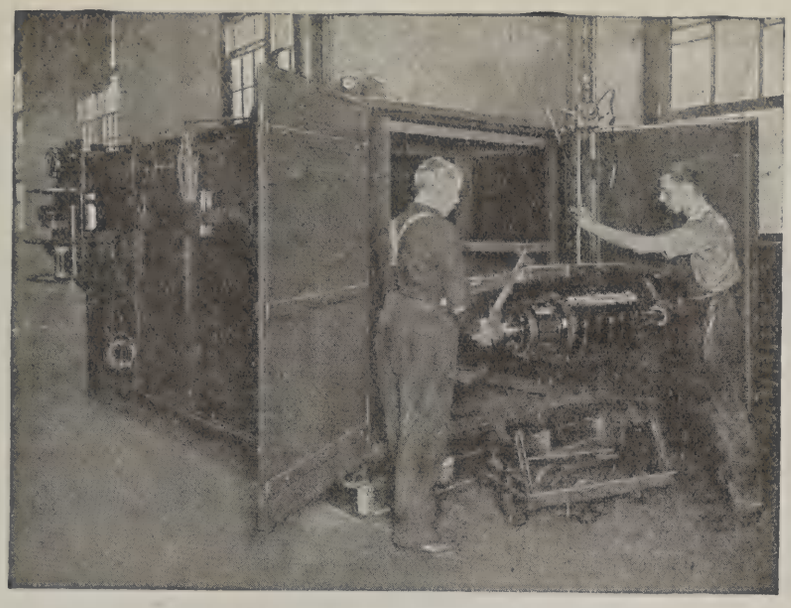
One graphic recording thermometer.

One push button station, with "on" and "off" push buttons, and suitable cover for conduit work.

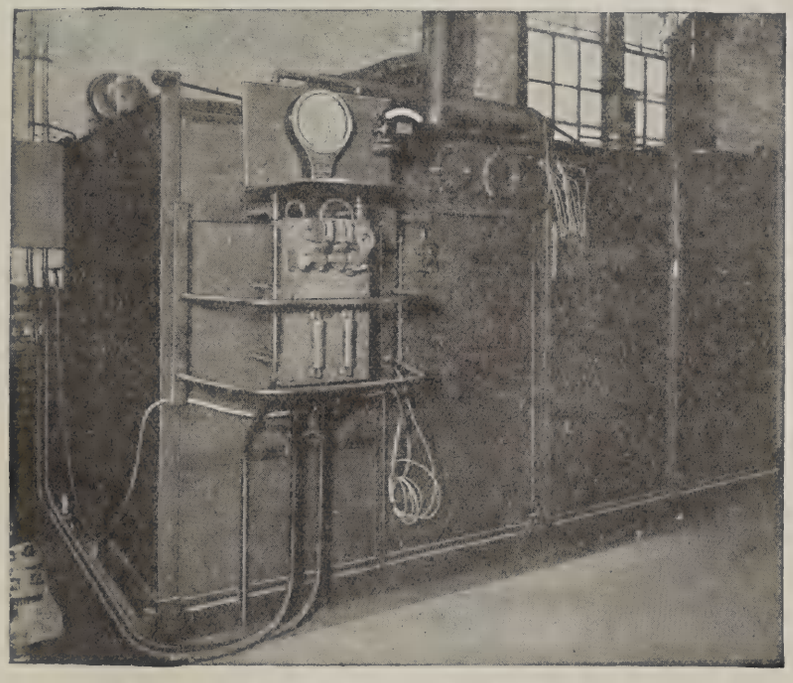
One door switch.

Drawings—The necessary layout drawings showing the method of the heater installation and the electrical connection are furnished.

ELECTRIC OVENS FOR BAKING RAILWAY-MOTOR ARMATURES—Continued



AN OVEN FOR BAKING RAILWAY ARMATURES
SHOWING METHOD OF HANDLING ARMATURES



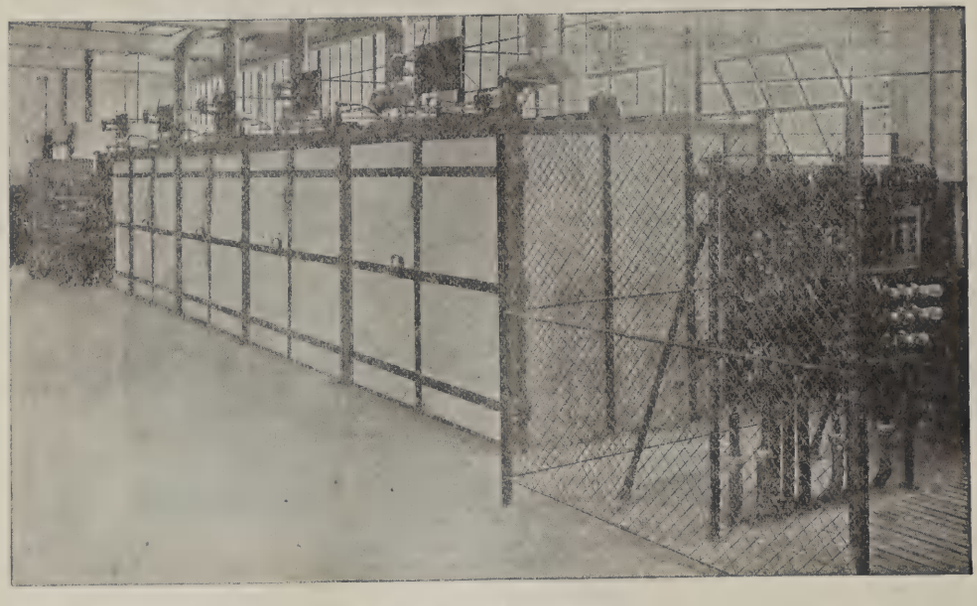
SIDE VIEW OF ARMATURE BAKING OVEN SHOWING
FULL AUTOMATIC TEMPERATURE CONTROL EQUIPMENT

PRICES

Type	Description	LIST PRICES — NUMBER OF COMPARTMENTS 1	2	3	4
R-1	Oven and Electrical Equipment	$1510 00	$2950 00	$4400 00	$5850 00
R-1	Electrical Equipment only	640 00	1280 00	1920 00	2560 00
R-2	Oven and Electrical Equipment	1670 00	3240 00	4800 00	6360 00
R-2	Electrical Equipment only	720 00	1440 00	2160 00	2880 00
R-3	Oven and Electrical Equipment	2025 00	3950 00	5800 00	7800 00
R-3	Electrical Equipment only	870 00	1740 00	2610 00	3480 00

1911-7A

WESTINGHOUSE STANDARDIZED ELECTRIC OVENS



ELECTRICALLY-HEATED OVENS

The several types of ovens listed on the following pages have been selected as standard in consideration of their extensive application and the rapidly increasing demand. The capacity of the heating equipment is given for each size of oven; this capacity may be used as an approximation in figuring for the electrification of ovens already installed.

Heating Capacity—The ovens are constructed in accordance with modern practice in thermal insulation and none but high-grade material is used. Ovens with two-inch wall insulation are supplied with electrical heating equipment sufficient for keeping the temperature under normal conditions as high as 300° Farenheit; ovens with three-inch and five -inch wall insulation, will hold temperatures as high as 450° Farenheit. The **heating units** consist of type "C" oven heaters for all types of ovens, except K-1 and K-2, which have "Steelclad" heaters.

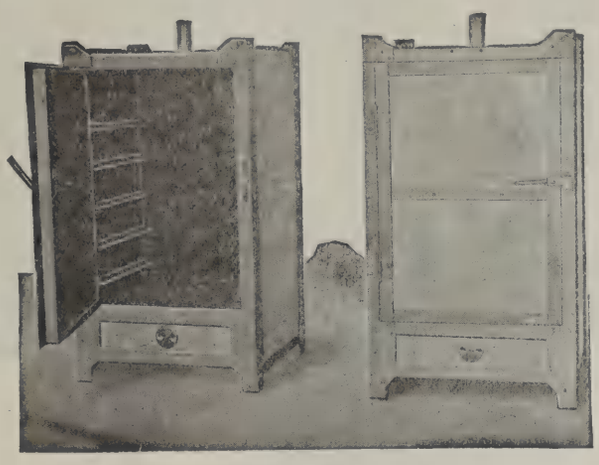
Equipment—The **reliability** of this equipment has been thoroughly demonstrated in various applications. For each oven installation, there is included with the heaters, all necessary connectors, terminals, bus-bar insulators, supports, clamps, and heater hooks for mounting. Bus-bars and connectors are made of cold rolled steel, which has been found to be the most satisfactory material for oven work. Openings are provided in the oven wall through which the bus-bars extend for connection to the power circuit.

Temperature Control—Ovens are listed for manual and for automatic control. The automatic control consists of the Westinghouse standard types F and KR magnetic contactors operated by means of an electric contact control thermostat. By means of this thermostatic control, the temperature is automatically maintained between limits established by the setting of the thermostat. Circuits are protected with enclosed fuses. An "on" and "off" push button station provides a means for opening the circuit at any time.

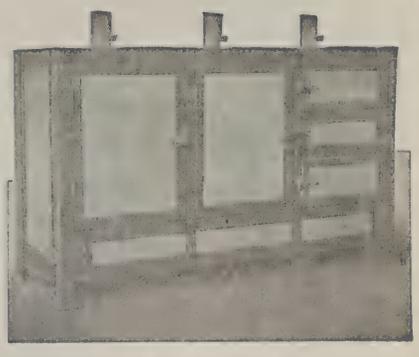
Special Ovens and Equipment—Where the available power service differs from that for standard equipment, prices will be quoted on request. In requesting quotations on special sizes of ovens or on electrical equipment for ovens already installed, the following information should be submitted:

1—Material to be baked, giving dimensions and weight of pieces and total weight to be baked at one time.
2—Type and make of oven.
3—Inside dimensions of oven.
4—Number and size of doors.
5—Thickness and kind of material of which oven walls are constructed.
6—Space available for mounting heaters. Space above or below the working floor.
7—Weight and material of racks and hangers which remain in the oven at all times.
8—Weight and material of racks or trucks which enter and leave the oven with the load.
9—Temperatures of oven at beginning and end of bake.
10—Time allowed for reaching maximum temperature.
11—Length of baking period.
12—Number of bakes made each day.
13—Power Service, voltage, phase, frequency.

STANDARDIZED ELECTRIC OVENS—Continued



TYPE K-1 ELECTRIC OVEN



TYPE K-2 ELECTRIC OVEN

TYPE K-1

A small box type of oven suitable for enameling or japanning, lacquering and evaporation of moisture, with oven temperatures up to 300° F.

Inside dimensions are 36″ high, 24″ wide and 18″ deep. Angle supports are placed on side walls at 6″ intervals.

Heaters—Steel-clad heaters with total input of 1.8 Kw.

Switches—Two series parallel switches. One main line fused knife switch, two pole, single-throw,

This oven is shipped complete with heaters installed.

Shipping Weight

Oven and Electrical Equipment	375 pounds

List Price

Oven and Electrical Equipment	$205.00
Electrical Equipment Only	75.00

TYPE K-2

This oven has four compartments two of which are 24″ high, 18″ wide and 15″ deep, and two 10½″ high, 18″ wide and 15″ deep. It is a convenient type for laboratory work, enameling or japanning, lacquering, armature drying and baking, and evaporation of moisture; with oven temperatures up to 300° F.

Heaters—Steel-clad heaters with total input of 4.0 Kw.

Switches—Suitable switches for operation of each compartment and one main line fused knife switch.

Shipping Weight

Oven and Electrical Equipment	550 pounds

List Price

Oven and Electrical Equipment	$705.00
Electrical Equipment Only	180.00

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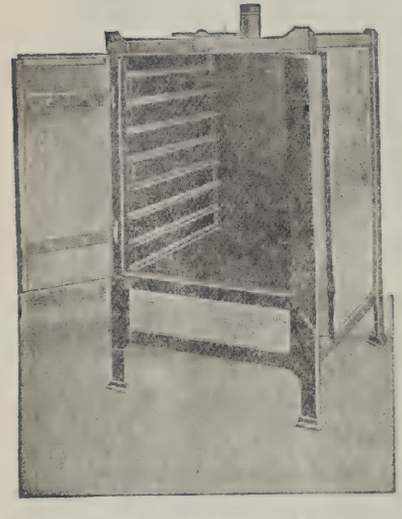
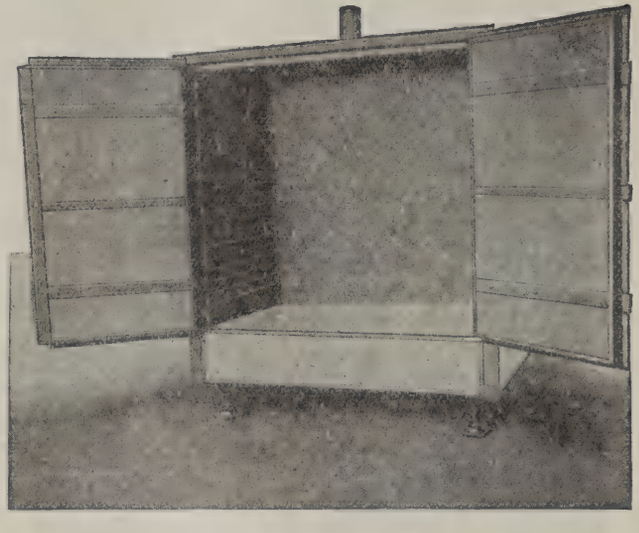


TYPE K 3 ELECTRIC OVEN



TYPE K-4 ELECTRIC OVEN

TYPE K-3

This oven is used for enameling or japanning, and drying paint, varnish and chemicals. It is built with either single or double swing doors. Angle supports are placed at 3″ intervals on side walls and there is a short vent with damper control. The oven space is 38″ high, 32″ wide and 35″ deep.

Heaters—Two type C oven heaters, Style No. 245730-A, with insulators and connectors. 4.6 Kw. at 220 volts.

Control—One 40 ampere, one pole type KR magnetic contactor, one electric contact control thermostat, one push button station, and one main line fused knife switch.

The same oven can be supplied for hand control of temperature, in which case suitable knife switches are substituted for the above automatic temperature control equipment.

Shipping Weight

Oven With 2″ Insulation	730 pounds
Oven With 3″ Insulation	950 pounds

List Price

Oven With 2″ Insulation, Automatic Control	$375.00
Oven With 2″ Insulation, Hand Control	220.00
Oven With 3″ Insulation, Automatic Control	500.00
Oven With 3″ Insulation, Hand Control	340.00
Electrical Equipment Only, Hand Control	45.00
Electrical Equipment Only, Automatic Control	200.00

TYPE K-4

Type K-4 is suitable for enameling, drying paint and varnish, lithographing and for baking cores, shells and armatures. Angle supports are bolted to side walls at 3″ centers. It has a top vent with damper control. The oven space is 54″ high, 60″ wide and 32″ deep.

Heaters—Six type C oven heaters, Style No. 245730-A, with connectors and sulators.

Control—One is 125 ampere, 3 pole, type F magnetic contactor with fuses, KR relay, electric contact thermostat, push button and door switch.

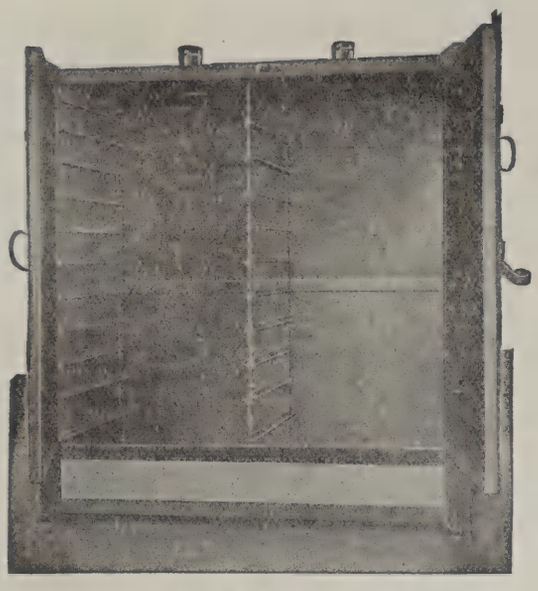
Power Service—3 phase, 60 cycles 220 volts, 14 Kw.

Shipping Weight

Oven With 2″ Insulation and Electrical Equipment	1600 pounds
Oven With 3″ Insulation and Electrical Equipment	2100 pounds

List Price

Oven With 2″ Insulation and Electrical Equipment	$ 645.00
Oven With 3″ Insulation and Electrical Equipment	870.00
Electrical Equipment Only	370.00



TYPE K-5 ELECTRIC OVEN

TYPE K-5

Type K-5 is suitable for enameling, drying paint and varnish, lacquering, evaporation of moisture, and baking cores, shells and armatures. Angle supports are bolted to side walls at 3″ centers and there is a removable skeleton partition in the middle. It has a top vent with damper control.

The oven space is 63″ high, 69″ wide and 35″ deep.

ELECTRICAL EQUIPMENT FOR OVEN WITH 2-INCH INSULATION

Heaters—Six type C oven heaters, Style No. 245730-A, with connectors and insulators.

Control—One 125 amp., 3 pole type F magnetic contactor with fuses, KR relay, electric contact thermostat, push button and door switch.

Power Service—3 phase, 60 cycles, 220 volts, 14 Kw.

Shipping Weight

Oven and Electrical Equipment..... 2000 pounds.

List Price

Oven and Electrical Equipment	$720.00
Electrical Equipment Only	370.00

ELECTRICAL EQUIPMENT FOR OVEN WITH 3-INCH INSULATION

Heaters—Ten type C oven heaters, Style No. 245730-A, with connectors and insulators.

Control—One 125 amp., 3 pole type F magnetic contactor with fuses, KR relay, electric contact thermostat, push button and door switch.

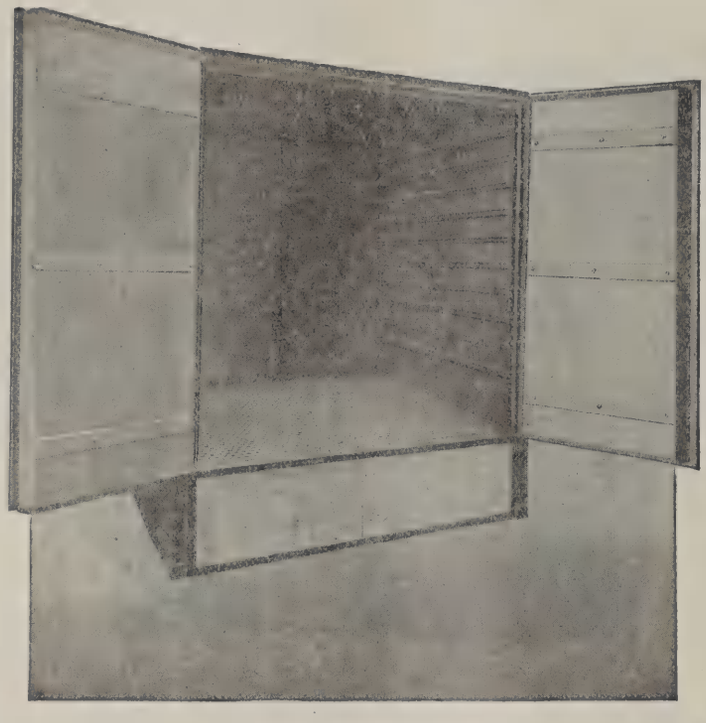
Power Service—3 phase, 60 cycles, 220 volts, 23 Kw.

Shipping Weight

Oven and Electrical Equipment..... 2700 pounds.

List Price

Oven and Electrical Equipment	$1030.00
Electrical Equipment Only	425.00



TYPE L-1 ELECTRIC OVEN

TYPE L-1

Type L-1 oven is used for enameling, drying paint and varnish, lacquering and evaporation of moisture. The oven space is 72″ high, 70″ wide and 68″ deep.

Angle supports on side walls are 6″ centers. If truck is used, these supports are omitted and guide rails for the truck, are supplied.

By letting the oven into the floor 18″, the floor plates of the oven are brought even with the shop floor for convenience when trucks are used.

EQUIPMENT FOR OVEN WITH 2-INCH INSULATION

Heaters—Twelve type C oven heaters, Style No. 245730-A, with connectors and insulators.

Control—One 125 ampere, 3 pole, type F magnetic contactor with fuses, KR relay, electric contact thermostat, push button and door switch.

Power Service—3 phase, 60 cycles, 220 volts, 28 Kw.

Shipping Weight	
Oven and Electrical Equipment	3200 pounds
List Price	
Oven and Electrical Equipment	**$1350.00**
Electrical Equipment Only	460.00

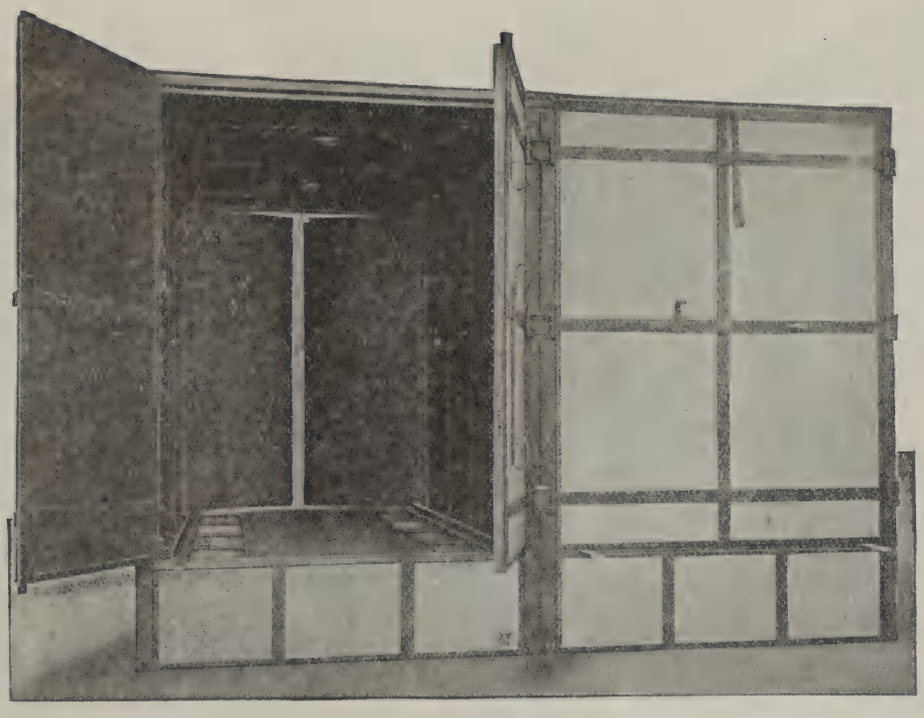
EQUIPMENT FOR OVEN WITH 3-INCH INSULATION

Heaters—Eighteen type C oven heaters, Style No. 245730-A, with connectors and insulators.

Control—One 125 ampere, 3 pole, type F magnetic contactor with fuses, KR relay, electric contact thermostat, push button and door switch.

Power Service—3 phase, 60 cycles, 220 volts, 41 Kw.

Shipping Weight	
Oven and Electrical Equipment	4100 pounds
List Price	
Oven and Electrical Equipment	**$1780.00**
Electrical Equipment Only	540.00



TYPE L-2 ELECTRIC OVEN

TYPE L-2

Type L-2 has two compartments with a solid partition. Double doors are fitted at each end.

This type is used for enameling, japanning, drying paint and varnish, lacquering, lithographing, and evaporation of moisture.

When trucks are to be run into the oven, the oven may be let into the floor or transfer trucks may be used. Guide rails are supplied for flat wheel trucks when ordered.

The oven space of each compartment is 7′ high, 78″ wide and 10′ deep.

OVEN WITH 2″ INSULATION EQUIPMENT FOR EACH COMPARTMENT

Heaters—24 type C oven heaters—Style No. 245730-A, with connectors and insulators.

Control—One 250 ampere, 3 pole type F magnetic contactor with fuses, KR relay, electric contact thermostat, push button and 2 door switches.

Power Service—3 phase, 60 cycles, 220 volts, 55 Kw.

Shipping Weight

Oven and Electrical Equipment..... 9000 pounds

List Price

Oven and Electrical Equipment..... $3025.00
Electrical Equipment Only..... 1370.00

OVEN WITH 3″ INSULATION EQUIPMENT FOR EACH COMPARTMENT

Heaters—30 type C oven heaters, Style No. 245730-A, with connectors and insulators.

Control—One 250 ampere, 3 pole, type F magnetic contactor with fuses, KR relay, electric contact thermostat, push button and 2 door switches.

Power Service—3 phase, 60 cycles, 220 volts, 69 Kw.

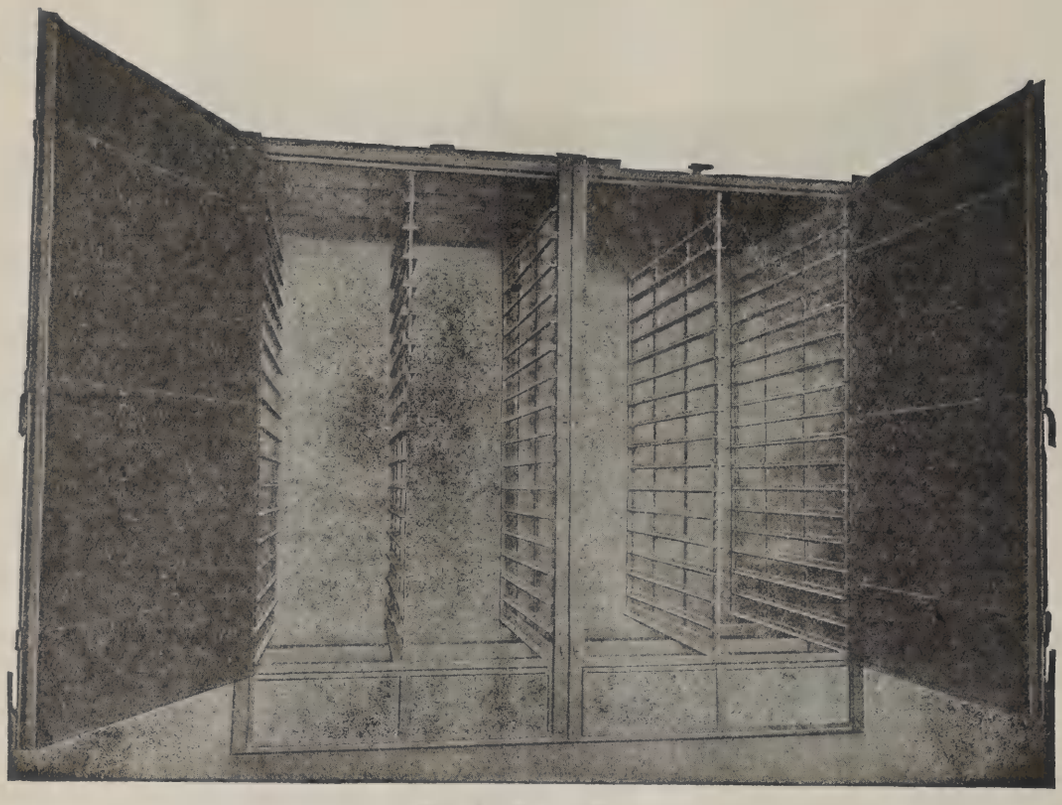
Shipping Weight

Oven and Electrical Equipment..... 12,000 pounds

List Price

Oven and Electrical Equipment..... $4125.00
Electrical Equipment Only..... 1530.00

STANDARDIZED ELECTRIC OVENS—Continued



TYPE L3 ELECTRIC OVEN

TYPE L-3

Type L-3 has two compartments with a solid partition. Each compartment has one swinging door. The center rack support in each compartment is removable. Type L-3 is suitable for oven applications for temperatures up to 300° F. for the 2″ insulation, and 450° F. for the 3″ insualtion.

The oven space of each compartment is 105″ high, 60″ wide and 72″ deep.

OVEN WITH 2-INCH INSULATION EQUIPMENT FOR EACH COMPARTMENT

Heaters—18 type C oven heaters, Style No. 245730-A, with connectors and insulators.

Control—One 125 ampere, 3 pole, type F magnetic contactor with fuses, KR relay, electric contact thermostat, push button and door switch.

Power Service—3 phase, 60 cycles, 220 volts, 41 Kw.

Shipping Weight

Oven and Electrical Equipment.....7500 pounds.

List Price

Oven and Electrical Equipment	$2675.00
Electrical Equipment Only	1075.00

EQUIPMENT FOR OVEN WITH 3-INCH INSULATION

Heaters—24 type C oven heaters, Style No. 245730-A, with connectors and insulators.

Control—One 250 ampere, 3 pole, type F magnetic contactor with fuses, KR relay, electric contact thermostat, push button and door switch.

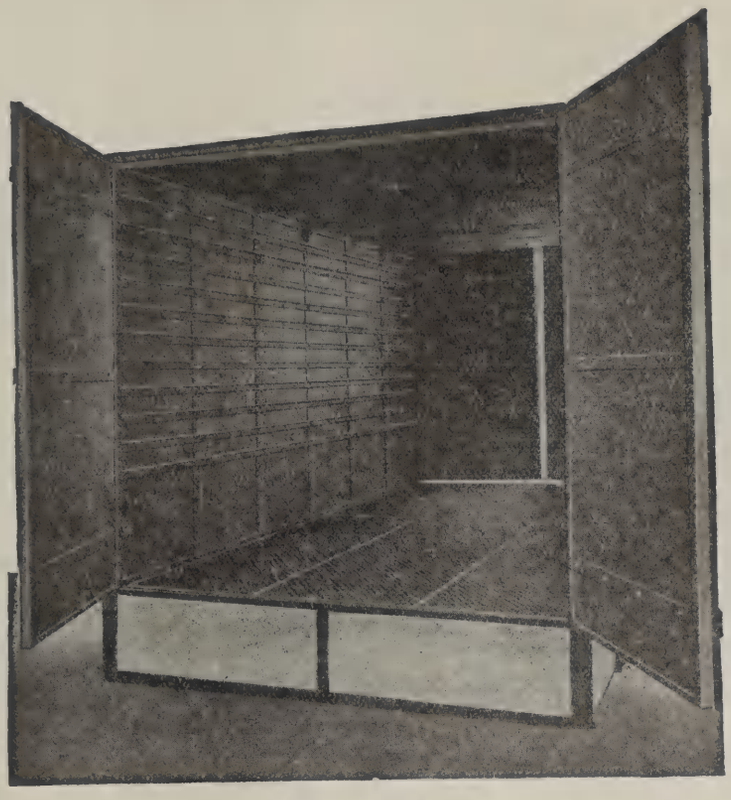
Power Service—3 phase, 60 cycles, 220 volts, 55 Kw.

Shipping Weight

Oven and Electrical Equipment.....10,000 pounds.

List Price

Oven and Electrical Equipment	$3750.00
Electrical Equipment Only	1345.00



TYPE L-4 ELECTRIC OVEN

TYPE L-4

Type L-4 is for use with trucks and has double swing doors at each end. It may be let into the floor so as to bring the oven floor even with shop floor. The usual applications for this type of oven are enameling, japanning, drying paint and varnish, lacquering, lithographing, and evaporation of moisture.

The oven space is 90″ high, 96″ wide and 216″ deep.

EQUIPMENT FOR OVEN WITH 2-INCH INSULATION

Heaters—54 type C oven heaters, Style No. 245730-A, with connectors and insulators.

Control—Constant heat circuit, one 250 amp. 3 pole type F magnetic contactor with fuses.

Temperature control circuit, one 250 amp, 3 pole type F magnetic contactor with fuses, KR relay, electric contact thermostat, 2 push buttons and 2 door switches.

Power Service—3 phase, 60 cycles, 220 volts, 124 Kw.

Shipping Weight

Oven and Electrical Equipment	9300 pounds

List Price

Oven and Electrical Equipment	$3370.00
Electrical Equipment Only	1250.00

ERUIPMENT FOR OVEN WITH 3-INCH INSULATION

Heaters—72 type C oven heaters, Style No. 245730-A, with connectors and insulators.

Control—Constant heat circuit, one 250 amp. 3 pole type F magnetic contactor with fuses.

Temperature control circuit—One 250 amp. 3 pole type F magnetic contactor with fuses, KR relay, electric contact thermostat, 2 push buttons and 2 door switches.

Power Service—3 phase, 60 cycles, 220 volts, 165 Kw.

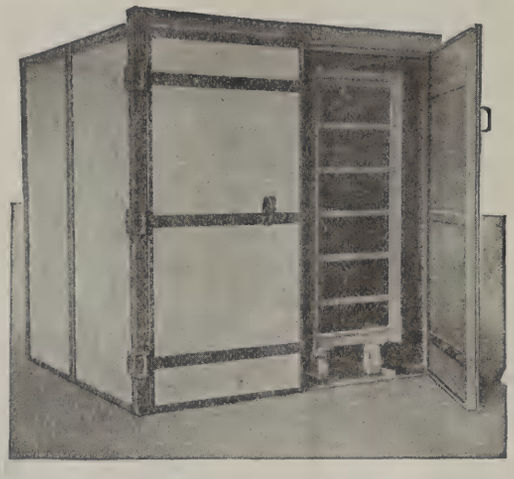
Shipping Weight

Oven and Electrical Equipment	12,500 pounds

List Price

Oven and Electrical Equipment	$4660.00
Electrical Equipment Only	1500.00

Motors and Contro



TYPE M-1 ELECTRIC OVEN

TYPE M-1

This oven is for use with trucks and has double swing doors at one end. It is used for enameling or japanning, drying paint and varnish, baking armatures, drying and baking metal furniture, and baking abrasive wheels.

The oven space is 78″ high, 90″ wide and 74″ deep. The heaters are installed in the oven space along the side walls and in the center between the trucks.

EQUIPMENT OF OVEN WITH 2-INCH INSULATION

Heaters—Twelve type C oven heaters, Style No. 245730-A, with connectors and insulators.

Control—One 125 ampere, 3 pole type F magnetic contactor with fuses, KR relay, electric contact thermostat, push button and door switch.

Power Service—3 phase, 60 cycles, 220 volts, 28 Kw.

Shipping Weight

Oven and Electrical Equipment.....3000 pounds.

List Price

Oven and Electrical Equipment	$1200.00
Electrical Equipment Only	460.00

EQUIPMENT OF OVEN WITH 3-INCH INSULATION

Heaters—Eighteen type C oven heaters, Style No. 245730-A, with connectors and insulators.

Control—One 125 amp. 3 pole type F magnetic contactor with fuses, type KR relay, electric contact thermostat, push button and door switch.

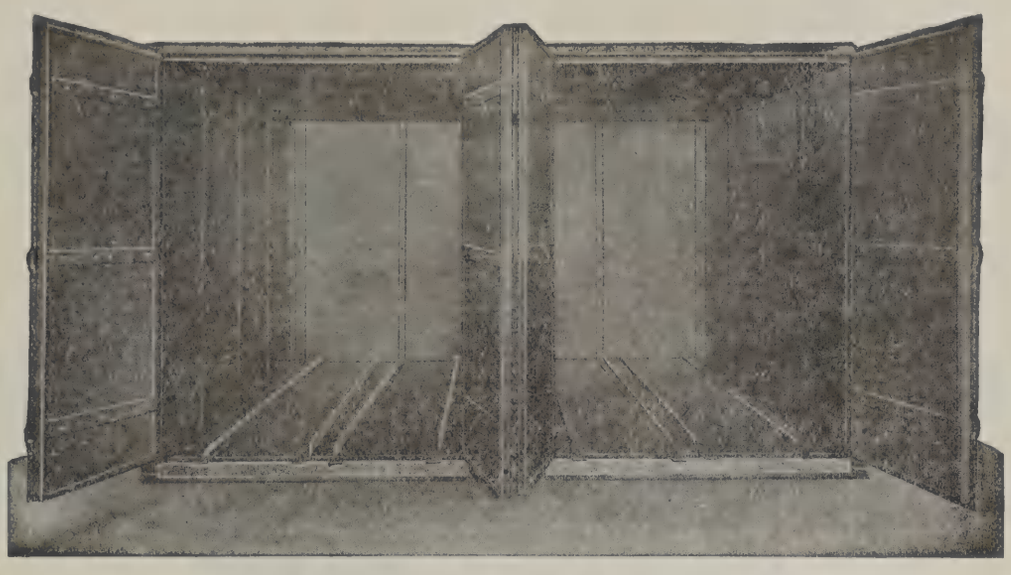
Power Service—3 phase, 60 cycles, 220 volts, 41 Kw.

Shipping Weight

Oven and Electrical Equipment.....3900 pounds.

List Price

Oven and Electrical Equipment	$1550.00
Electrical Equipment Only	540.00



TYPE M-2 ELECTRIC OVEN

TYPE M-2

Type M-2 is a single compartment oven having two sets of double swinging doors at one end of the oven. It is used for enameling, drying paint and varnish, lacquering, lithographing, baking armature and drying and baking metal furniture. Guide rails are supplied for flat wheeled trucks when ordered.

The oven space is 78″ high, 144″ wide, and 138″ deep. The heaters are installed along the side walls and one row in the middle of the oven space.

EQUIPMENT OF OVEN WITH 2-INCH INSULATION

Heaters—Forty-two type C oven heaters, Style No. 245730-A, with connectors and insulators.

Control—One 250 ampere, 3 pole type F magnetic contactor with fuses, KR relay, electric contact thermostat, push buttons and two door switches.

Power Service—3 phase, 60 cycles, 220 volts, 96 Kw.

Shipping Weight

Oven and Electrical Equipment..... 7500 pounds

List Price

Oven and Electrical Equipment	$2465.00
Electrical Equipment Only	925.00

EQUIPMENT OF OVEN WITH 3-INCH INSULATION

Heaters—Sixty type C oven heaters, Style No. 245730-A, with connectors and insulators.

Control—Constant heat circuit—one 250 ampere, 3 pole type F magnetic contactor with fuses.

Temperature control circuit—one 250 ampere, 3 pole type F magnetic contactor with fuses, type KR relay, electric contact thermostat, two push buttons and two door switches.

Power Service—3 phase, 60 cycles, 220 volts, 138 Kw.

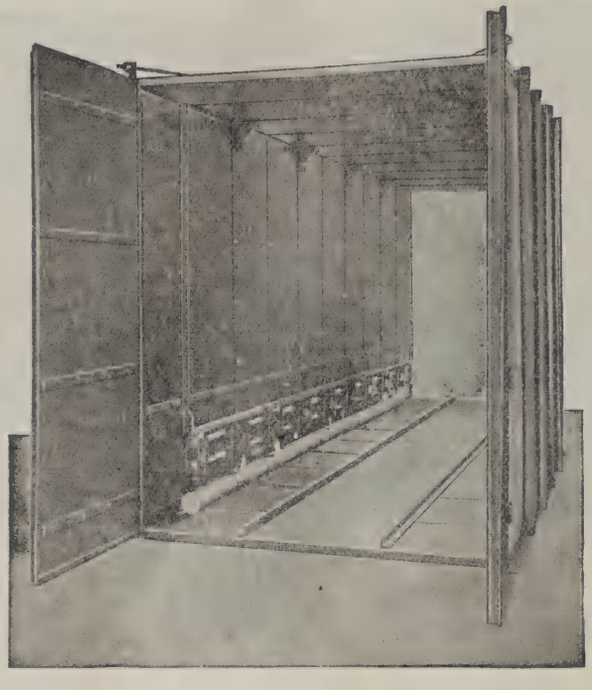
Shipping Weight

Oven and Electrical Equipment..... 10100 pounds

List Price

Oven and Electrical Equipment	$3460.00
Electrical Equipment Only	1330.00

1009-14



TYPE M-3 ELECTRIC OVEN

TYPE M-3

Type M-3 is a single-compartment oven having double swinging doors at both ends. It is used for japanning and enameling, drying paints and varnish, lacquering, lithographing and baking metal furniture.

The oven space is 114 inches high, 90 inches wide and 25 feet long. The heaters are installed along the side walls.

EQUIPMENT OF OVEN WITH 2-INCH INSULATION

Heaters—Eighteen type C oven heaters, Style No. 245730-A with all connectors and insulators.

Control—One 125-Amp., 3-pole type F magnet switch with fuses, type KR relay, electric contact control thermostat, push button and door switch.

Power Service—Three-phase, 60-cycle, 220 volts, 41 kw.

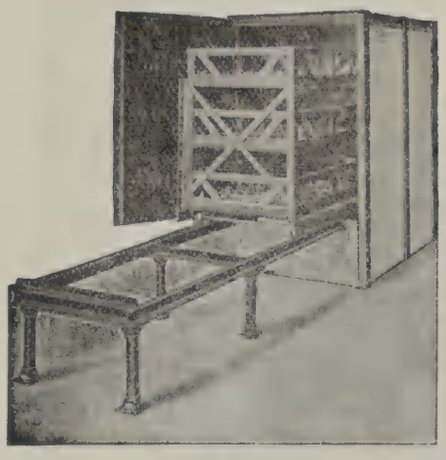
Shipping Weight

Oven and Electrical Equipment	25000 pounds

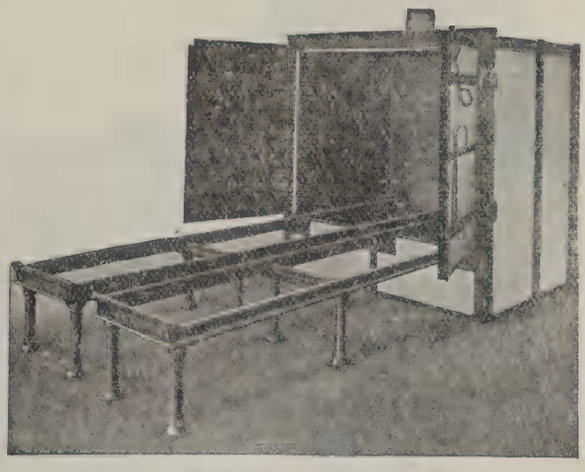
List Price

Oven and Electrical Equipment	$2850.00
Electrical Equipment only	550.00

STANDARDIZED ELECTRIC OVENS—Continued



TYPE N-1 ELECTRIC OVEN



TYPE N-2 ELECTRIC OVEN

TYPE N-1

Type N-1 is a convenient type of small truck oven with elevated tracks and single swing door. Length of track is sufficient to permit closing the door after truck is drawn out. It is used for core baking, drying and baking chemicals, shell baking and evaporation of moisture.

The oven space is 42″ high, 36″ wide and 60″ deep.

Heaters—Six type C oven heaters, Style No. 245730-A, with insulators and connectors.

Control—One 125 amp. 3 pole type F magnetic contactor with fuses, KR relay, electric contact thermostat, push button and door switch.

Power service—3 phase, 60 cycles, 220 volts, 14 Kw.

Shipping Weight

Oven With 3″ Insulation and Electrical Equipment.. ..... 2000 pounds

List Price

Oven With 3″ Insulation and Electrical Equipment.. ..... $1400.00

Electrical Equipment Only 370.00

Prices for trucks furnished on application.

TYPE N-2

This oven has elevated tracks to take two trucks side by side. It is used for core baking, drying and baking chemicals, shell baking and evaporation of moisture.

The oven space is 51″ high, 65″ wide and 50″ deep.

Tracks are provided for flat or flanged wheels, as ordered.

Heaters—Twelve type C oven heaters, Style No. 245730-A, with insulators and connectors.

Control—One 125 amp. 3 pole type F magnetic contactor with fuses, KR relay, electric contact thermostat, push button and two door switches.

Power Service—3 phase, 60 cycles, 220 volts, 28 Kw.

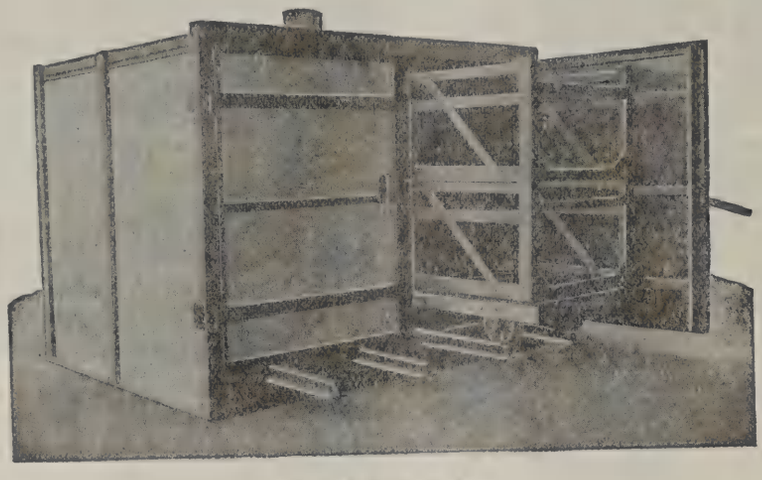
Shipping Weight

Oven With 3″ Insulation and Electrical Equipment ..... 2900 pounds.

List Price

Oven With 3″ Insulation and Electrical Equipment.. ..... $1775.00

Electrical Equipment Only 460.00



TYPE N-3 ELECTRIC OVEN

TYPE N-3

Type N-3 is a two truck oven for heavy duty.

Oven space is 55″ high, 78″ wide and 68″ deep.

Rails are provided for flanged wheeled truck when ordered.

Heaters are mounted along side walls with a row along the center.

Heaters—Eighteen type C oven heaters, Style No. 245730-A, with insulation and connectors.

Control—One 125 ampere, 3 pole type F magnetic contactor with fuses, KR relay, electric contact thermostat, push button and two door switches.

Power Service—3 phase, 60 cycles, 220 volts, 41 Kw.

Shipping Weight

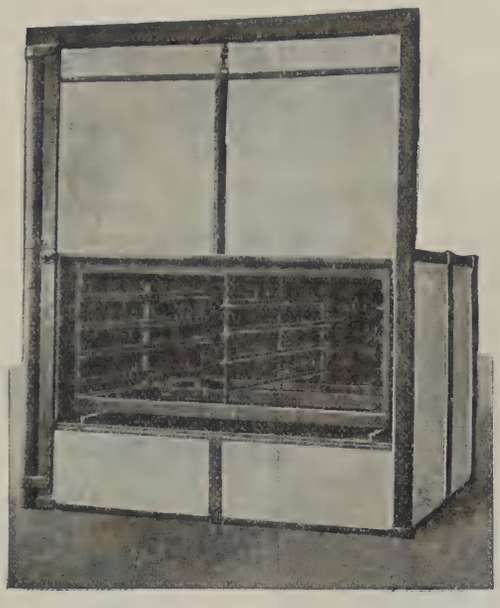
Oven With 3″ Insulation and Electrical Equipment	3500 pounds

List Price

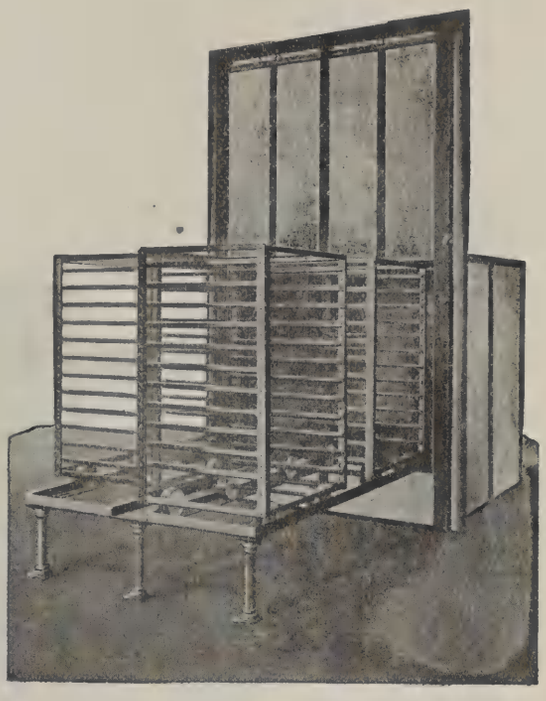
Oven With 3″ Insulation and Electrical Equipment	$1510.00
Electrical Equipment Only	550.00

1909–17

STANDARDIZED ELECTRIC OVENS—Continued



TYPE O-1 ELECTRIC OVEN



TYPE O-2 ELECTRIC OVEN

TYPE O-1

Type O-1 has a balanced weighted vertically sliding door. It has a special truck which is rolled out onto a transfer truck for transportation.

This oven is used for baking cores, shells and abrasive wheels and for drying and baking chemicals.

Oven space is 36″ high, 72″ wide and 72″ deep.

Heaters—Eighteen type C oven heaters, Style No. 245730-A, with insulators and connectors.

Control—One 125 ampere, 3 pole type F magnetic contactor with fuses, KR relay, electric contact thermostat, push button and door switch.

Power Service—3 phase, 60 cycles, 220 volts, 41 Kw.

Shipping Weight

Oven With 2″ Insulation, Including Truck and Electrical Equipment,	2500 pounds.
Oven With 3″ Insulation Including Truck and Electrical Equipment	3200 pounds.

List Price

Oven With 2″ Insulation Including Truck and Electrical Equipment	$1370.00
Oven With 3″ Insulation Including Truck and Electrical Equipment	1650.00
Electrical Equipment Only	530.00

TYPE O-2

Type O-2 has a balanced weighted vertically sliding door. It has double tracks and either two long trucks or four short ones may be used.

Trucks are not included as part of the equipment for this oven, but can be furnished on application.

This oven is used extensively for various baking and drying processes.

Oven space is 48″ high, 70″ wide and 68″ deep.

Heaters—Eighteen type C oven heaters, Style No. 245730-A, with connectors and insulators.

Control—One 125 ampere, 3 pole type F magnetic contactor with fuses, KR relay, electric contact thermostat, push button and door switch,

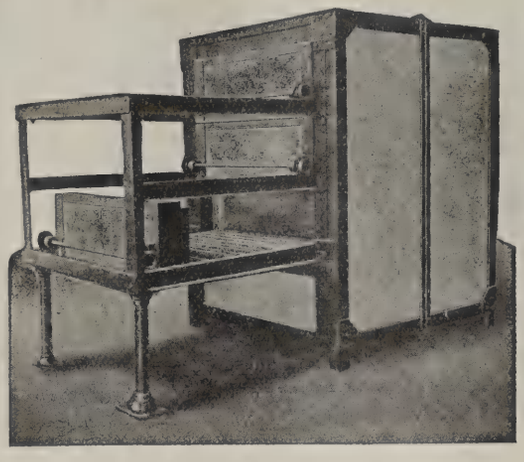
Power Service—3 phase, 60 cycles, 220 volts, 41 Kw.

Shipping Weight

Oven With 2″ Insulation and Electrical Equipment	2700 pounds.
Oven With 3″ Insulation and Electrical Equipment	3400 pounds.

List Price

Oven With 2″ Insulation and Electrical Equipment	$1370.00
Oven With 3″ Insulation and Electrical Equipment	1650.00
Electrical Equipment Only	530.00



TYPE P-1 ELECTRIC OVEN

TYPE P-1

Type P-1 is a convenient construction of drawer plate oven used for baking cores, shells and abrasive wheels, and for drying and baking chemicals. The drawers have a door at the back so that the oven is closed up when the drawer is pulled out. The three drawers are each 10″ high, 36″ wide and 36″ deep.

Six type C oven heaters, Style No. 245730-A, with connectors and insulators.

Control—One 125 ampere, 3 pole type F magnetic contactor with fuses, KR relay, electric contact thermostat, and push button.

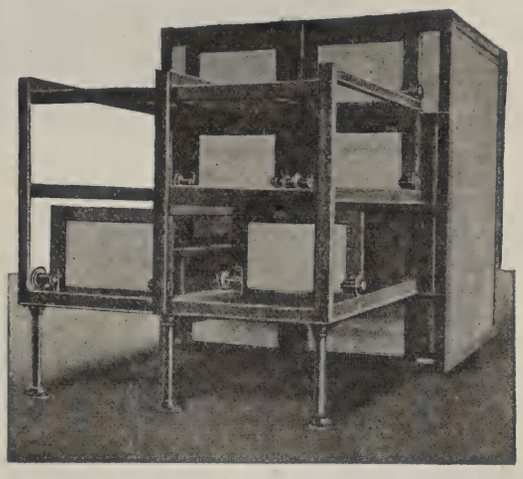
Power Service—3 phase, 60 cycles, 220 volts, 14 Kw.

Shipping Weight	
Oven With 5″ Insulation and Electrical Equipment	3400 pounds
List Price	
Oven With 5″ Insulation and Electrical Equipment	$1140.00
Electrical Equipment Only	358.00

1909–19

STANDARDIZED ELECTRIC OVENS—Continued

TYPE P-2 ELECTRIC OVEN



TYPE P-3 ELECTRIC OVEN

TYPE P-2

Type P-2 is a draw plate oven having four large drawers for baking cores, shells and abrasive wheels and drying and baking chemicals.

The two lower drawers are 16″ high, and the two upper drawers are 14″ high. The inside of the oven is 64″ wide and 64″ deep.

Heaters—Twenty-four type C oven heaters, style No. 245730-A, with connectors and insulators.

Control—One 250 ampere, 3 pole, Type F magnetic contactor with fuses, KR relay, electric contact thermostat and push button.

Power Service—3 phase, 60 cycles, 220 volts, 55 Kw.

Shipping Weight

Oven With 5″ Insulation and Electrical Equipment	8500 pounds

List Price

Oven With 5″ Insulation and Electrical Equipment	$2060.00
Electrical Equipment Only	660.00

TYPE P-3

Type P-3 is a six drawer oven used for baking cores, shells and abrasive wheels and baking.

The drawers are 18″ high, 30″ wide and 60″ deep.

Heaters—Twenty-four type C oven heaters, style No. 245730-A, with connectors and insulators.

Control—One 250 ampere, 3 pole type F magnetic contactor with fuses, KR relay electric contact thermostat, and push button.

Power Service—3 phase, 60 cycles, 220 volts, 55 Kw.

Shipping Weight

Oven With 3″ Insulation and Electrical Equipment,	4200 pounds

List Price

Oven With 3″ Insulation and Electrical Equipment	$3630.00
Electrical Equipment Only	660.00

OUTDOOR SERVICE FOOT WARMER

The success of any new development in the industrial field depends almost entirely upon one thing—increased efficiency. However, increasing the efficiency of a machine or a man as the case may be, must be done at an expense comparable with the results secured,—a reasonably low first cost and maintenance, and a reasonably lower power consumption. There are several ways of increasing the efficiency of a plant—by the use of labor saving machines, more highly efficient machines, changes in process of manufacture, by proper routing of materials in course of production, and by increasing the ability of the men to do better work.

The necessity for good lighting and proper heat in buildings is apparent to all. If the illumination is not sufficient the workmen cannot do good work, and consume too much time in doing it. If the building is not properly heated, the physical discomfort of the workmen will soon assert itself by the inability of the men to accomplish the usual amount of work, due to the impossibility of concentrating their attention to a given task when the body is suffering physical discomfort or pain.

The truth of these statements has been universally recognized and while elaborate means at great expense have been used to increase the efficiency of labor employed in buildings by adding to the bodily comfort, almost nothing had been done to increase the efficiency of labor employed outside. In many cases, labor employed outdoors is performing very active physical work which even in extreme cold weather will keep them fairly comfortable. But there are a great number of men employed outdoors, in more or less exposed positions, who, from the nature of their work, cannot secure sufficient exercise to maintain bodily comfort. Everyone has experienced, to a more or less degree, the disagreeable feeling due to cold feet. In many cases it results very seriously, and in others it is only temporarily a serious matter but a torture to be endured probably for hours at a time, until an opportunity can be secured for supplying the necessary warmth to again produce comfort.

The result as to how these conditions could be met by the use of an electric heater was the development of an electric foot warmer different from anything previously on the market. The application of such a piece of apparatus is enormous, as will be shown by a partial list as follows:

Watchmen at Industrial Plants
Traffic Policemen
Gatemen at Railway Stations
Doormen at Hotels and Clubs
Motormen on street railway cars
Sentrymen on Guard Duty at
Industrial Plants, wharves, piers,
bridges, cantonments, etc.

To properly meet these requirements a heater first of all, should be waterproof and should be designed to supply the necessary heat during moderately cold, cold and extreme cold weather. This necessitates a 3 heat control. A low temperature heater is essential since the surface must not at any time become too warm, as there is a possibility of chilblain resulting from the feet becoming overheated. The surface of the heater must be treaded to prevent a person from slipping when standing on it.

There are two sizes of foot warmers now manufactured. One size, 14 inches wide, 20 inches long and 3½ inches high, is made either of cast iron or brass, in one piece. The cast iron foot-warmer weighs approximately 60 pounds. This size is constructed to give three-heat operation and with a three-heat

OUTDOOR SERVICE FOOT WARMER, Continued

snap switch, wattages of 200, 100 and 50 watts at 125 volts can be obtained. This size can also be operated on 250 volt service and rated at 200 watts single heat. The smaller size, 12 inches wide, 16 inches long and 3½ inches high, is rated at 200 watts on 125 volts single heat. Six feet of cord with a snap switch is supplied with the foot warmer.

The top surface is diamond treaded and feet are provided at the corners to raise the warmer 1 inch above the floor. The heater unit is clamped against the under side of the main casting by a sheet-steel clamping plate ⅛ inch thick and a bottom sheet-steel plate sealed with waterproof gum covers the heating element. The rubber insulated cable enters the foot warmer through a bell-mouth waterproof fitting mounted in the middle of one side.

The resistance is of the slotted ribbon type distributed uniformly over the entire surface. The ribbons are assembled between two plates of built-up mica 0.025 inch thick cemented together to form a unit.

By means of the 3-heat control snap switch 200 watts on 125 volts is obtained on high, for the large size, by connecting the two equal circuits of 100 watts each in parallel; 100 watts is obtained on medium by using one circuit only, and 50 watts on low by connecting the two circuits in series.

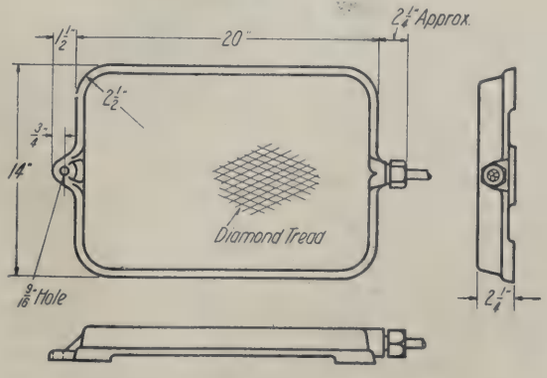
PRICES

Style No.	Size in Inches	Watts	Volts	Heat	Material	Net Price
272608	14 x 20 x 3½	200	120	3	Cast Iron	$ 24 75
275930	14 x 20 x 3½	200	120	3	Brass	43 25
287016	14 x 20 x 3½	200	120	1	Cast Iron	21 00
287017	14 x 20 x 3½	200	240	1	Cast Iron	24 75
287018	14 x 20 x 3½	200	120	1	Brass	40 00
287019	14 x 20 x 3½	200	240	1	Brass	43 75
287020	12 x 16 x 3½	200	240	1	Cast Iron	18 50
287021	12 x 16 x 3½	200	120	1	Brass	37 00
287022	12 x 16 x 3½	200	240	1	Brass	40 00

Style number includes foot warmer complete with six (6) feet of cord and snap switch.

OUTLINE DIMENSIONS

(Large Size)



WATER HEATING

The **capacity of heaters** for any application is determined by (1) weight of water, (2) rate of heating, (3) radiation and other losses.

Absorption of Heat by Water—The specific heat of water is 1.00. One B. T. U. or .293 Watthours will heat 1 lb. of water 1° F. 1 B. T. U. = .293 Watthours.

Rate of Heating—The input for heating of water only must be sufficient to deliver the total quantity of heat required in the time desired. This equals the total watthours required divided by the number of fraction of hours allowable for doing the heating.

Losses—

Character of Surface of Tank	Watts Lost per Degree F. per Sq. Ft.	Watts Lost per 30 Gallon Tank per Degree F.
Rough Iron	.80	13.8
Polished Copper or Nickel	.58	10.0
Rough Iron Poorly Lagged	.50 Approx.	8.6
Rough Iron well Lagged 2 Inches Thick	.20 Approx.	3.5

(A thirty-gallon tank has approximately 17.2 square feet of exterior surface.)

The maximum input of the heater must, therefore, be sufficient to heat up the water in the time required and supply the radiation losses.

General information is often required as to the temperatures of water for various purposes. The following data pertaining to this must necessarily vary somewhat with different individuals, but will serve as a guide in determining the amount of heat to allow for heating the water for such purposes:

	Temperature, Degrees F.
Bath	95
Hands, average	104
Hands, maximum	113
Face	99
Luke Warm	86
Temperature of water in boiler	160

A temperature drop of 5 or 10 degrees may be obtained in a relatively short length of pipe. In order to reduce the loss to a minimum, hot water pipes should be lagged to retain the heat. This makes it unnecessary to drain off a large quantity of water before water of sufficient warmth reaches the user. To the amount of hot water at boiler temperature used, there will be added at least an equal amount of cold water. Consequently, in determining the quantity of water required for a given purpose, it must be borne in mind that the quantity of water actually heated may be considerably less than the total amount required for use, since it is heated initially to a much higher temperature than that actually required in order to get a great quantity of heat stored in a relatively small space.

For the determination of the amount of power required for heating a given quantity of water, the following information is required:

1. Capacity of tank or pounds of water to be heated.
2. Time required for heating water from the temperature of water entering tank to maximum temperature desired.
3. Temperature of water entering tank.
4. Temperature of water leaving tank.
5. If tank is insulated, what is the thickness and kind of insulation?
6. Power service available.

Power (Watts) Required For Heating Water in Tanks

The power requirements as listed below are based upon the following assumptions:

Initial Temperature of Water	60° F.
Final Temperature of Water	160° F.
Time for Heating	2½ Hours
Insulated Tank	2 Inches Insulation
Uninsulated Tank	Rough iron surface

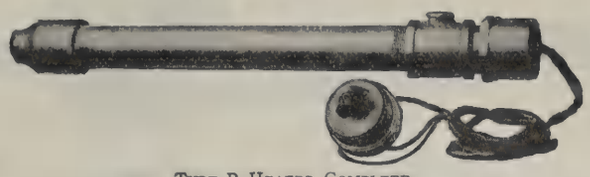
Boiler Capacity Gallons	Boiler Capacity, Pounds Water	Watts Required With Insulated Tank	Watts Required With Uninsulated Tank
18	150	2070	2940
21	175	2420	3430
24	200	2760	3920
27	225	3100	4400
30	250	3450	4900
35	292	4030	5730
40	334	4600	6550
48	400	5500	7850
63	525	7250	10300
82	685	9450	13400
100	833	11500	16300
120	1000	13800	19600
144	1200	16600	23600
168	1400	19400	27500
192	1600	22100	31400

The following table suggests the size of heater that is required for various sizes of boilers, when uninsulated and when completely insulated, including the piping; assuming that ten gallons of water are used per day, and that the heater is on the circuit continually. The water is assumed to enter the boiler at 60° Fahrenheit and to be drawn off at 160° Fahrenheit. The size of heater for any other rate of consumption can be determined by allowing 10 watts additional for each additional gallon used per day. It should be understood that these figures will have to be increased when comparatively large quantities of water are drawn off at short intervals. The next larger standard heater should be used in each case.

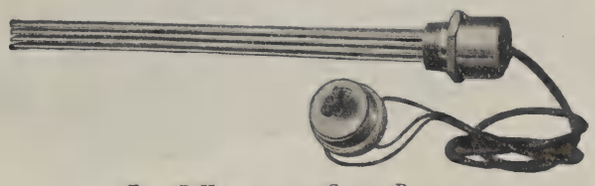
Capacity of Boiler	Uninsulated Galvanized Boiler and Piping	Boiler Insulated with 2" Covering and Piping with 1" Cover
12 gallon	550	220
18 "	600	240
21 "	650	260
24 "	700	280
27 "	775	300
30 "	850	320
35 "	900	340
40 "	950	360
63 "	1450	500

BAYONET IMMERSION HEATERS

For Industrial Use



TYPE B HEATER COMPLETE



TYPE B HEATER WITH CASING REMOVED

The type B bayonet immersion heaters are used for heating large quantities of water and other liquids other than acids. They are also used for indirect melting of glue, paraffine, tar and other viscous substances. The indirect method of heating consists of heating a vessel of water containing a separate vessel into which the substance to be heated, is placed. These heaters are used for generating steam at a maximum pressure of 15 pounds gage in hospital sterilizers. There are many applications where heating can be accomplished directly or indirectly by bayonet immersion heaters, the limiting condition being that the temperature must not exceed 250 degrees Fahrenheit. These heaters can be removed from their casings and inserted directly into a vessel containing the liquid. The blades or heating elements **must** always be **completely immersed** in the liquid.

Lagging

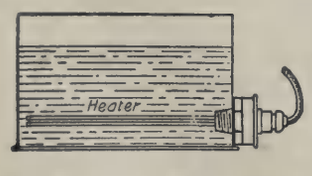
For the most efficient and satisfactory operation of bayonet heaters, the tank or vessel and all piping should be well lagged to prevent heat loss by radiation.

Construction

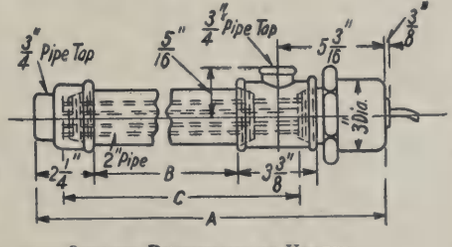
Type B heaters consist of a flat ribbon resistor assembled in a mica sheath and encased under pressure in a flattened copper tube. These tubes, which are four in number, are brazed into a brass head which is threaded to screw into the casing. The casing consists of a piece of standard iron pipe with proper fittings to attach to the water system.

The leads are attached to heavy screw contacts in a block supported on the brass head and protected by a removable metal cover. A flexible cord with three-heat indicating snap switch is supplied with each heater. The casings are made of two inch malleable iron pipe with tee fitting into which the heater head screws, and a reducing coupling on the other end.

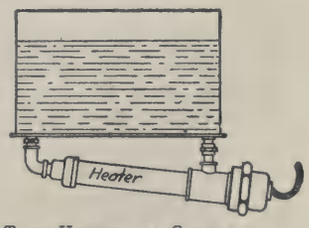
Unit package, 1 bayonet type immersion heater.
Bulk package, any 4 bayonet type immersion heaters.



TANK HEATING BY DIRECT IMMERSION



OUTLINE DIMENSIONS OF HEATER



TANK HEATING BY CONNECTION

PRICES

Description	Style Number 100-120 V.	200-240 V.	240-260 V.	Watts	Length Inches	Finish	List Price
With Switch and Casing	280948	280949	285354	4500-1125	20	Black	$40 00
With Switch, without Casing	285272	285273	285358	4500-1125	20	Black	38 00
Without Switch, without Casing	280956	280957	285362	4500-1125	20	Black	37 00
With Switch and Casing	280950	280951	285355	6000-1500	25	Black	60 00
With Switch, without Casing	285274	285275	285359	6000-1500	25	Black	58 00
Without Switch, Without Casing	280958	280959	285363	6000-1500	25	Black	57 00

Order by Style Number and Specify Exact Voltage

"STEELCLAD" HEATERS

FIG. 1—NARROW HEATER

FIG. 2—WIDE HEATER

Steelclad heaters are suitable for a wider variety of industrial applications than any other type of heater on the market. They are used in almost any application except where an immersion type of heater is required. Heaters have three distinct classes of service to meet the requirements of the various applications.

CLASS A—For heating of small ovens and drying rooms where the temperature of the air surrounding the heaters is not more than 400 degrees F (200 degrees C.) and where there is good circulation of air.

CLASS B—For air heating at ordinary temperatures where there is reasonably good circulation.

CLASS C—For heating of press heads, rolls and plates, where the heaters are clamped between heavy plates.

Construction of Heater

Steelclad heaters are constructed to operate satisfactorily under the most severe conditions of industrial service. A flat ribbon resistor is assembled in a mica sheath and encased in a heavy steel casing under pressure. Suitable terminals and terminal covers are provided. This construction reduces to a minimum the possibility of injury and also provides rapid transfer of heat from the resistance element, thus insuring long life under severe operating conditions.

Types—There are two general types, the **narrow** and the **wide,** the selection of the proper type being governed by the requirements of the application.

Heat Control—The wide type heater may be furnished for one or three heats. The narrow type is furnished for single heat. Where two heaters, or multiple of two, are used three heats can be obtained by interconnection of single-heat heaters using a three-heat snap switch for control.

Steelclad Heaters for Press Heads

In the manufacture of certain molded articles the press heads had been heated with gas. This gas was burned in holes through the platens and an effort made to maintain constant combustion conditions so that the temperature variations would be reduced to a minimum. There were always a number of rejections of the finished goods because of over- or under-baking. When this occurred there was a total loss of the material. High pressure steam was tried for heating the platens, but there was so much trouble with the piping and the condensation was so difficult to dispose of that it did not give results any better than gas. Electric heating was tried out and it was discovered that although the speed of operation could be increased the loss from defectives was reduced enormously. In fact, the money saving in the reduction of defective product was several times the cost of the current to heat the press. Under these conditions there was no question of the comparative unit cost of gas and electricity.

In another case a photographer had a 12x12-inch hand press for mounting and embossing photographs. Live steam was not available and a gas flame was being used to heat the platen. There was a considerable fire risk and dirt and soot which at times caused trouble. An electric heater was installed and proved entirely satisfactory to the owner. It was always ready, clean and maintained uniform temperature. The cost of the current was a minor consideration.

For the application of steelclad heaters to presses the following information is required: Size of press, number of openings, maximum temperature desired, minimum temperature desired, number of operating points desired, temperature desired at each point, weight of mold, length of time mold is in press, length of time mold is out of press, maximum time allowable for initial heating of press at beginning of working day, power available for heaters, and, if possible, a drawing of press.

"STEELCLAD" HEATERS—Continued

Application of Steelclad Heaters

The enormous field of usefulness of the steelclad heater to heating press platens may be ascertained from the following partial list of users:—

a. Bookbinding—embossing book covers.

b. Hatmaking—stamping hat bands and embossing hat markers.

c. Photography—mounting photographs.

d. Hard rubber goods—heating moulds under pressure.

e. Rubber stamps.

f. Buttons.

g. Insulators.

h. Fountain pens.

i. Bakelite molding mixtures.

j. Hard rubber compounds.

k. Fibre soles and heels for shoes.

l. Hot presses for vulcanizing rubber goods.

m. Small drying Ovens.

n. Paper tubing manufacture—to heat mandrels and rolls.

o. Hard fibre manufacture.

p. Dies, irons, tools required to be heated and to which a flat heater may be clamped or bolted.

q. Heating liquids in tanks by clamping steelclad heaters on outside of tank.

r. Heating vessels, containers, special drying, baking or roasting ovens of small capacities.

s. Drying sand molds in foundries.

This list is necessarily incomplete but will give an idea of the possibilities of the various applications of steelclad heaters.

Steelclad heaters are designed for general use in applications requiring a temperature of not more than 750 degrees F (400 degrees C) on the surface of the heater. The units are manufactured in standard lengths having definite wattage and voltage specifications. The standard heaters are shown in table I. Special applications requiring steelclad heaters of special lengths, where standard heaters will not apply, should be figured from table II.

TABLE I—STANDARD STEELCLAD HEATERS

Style Number	Length in Inches	Wattage of Heater	Type	Voltage	Figure Numbers: Class A-B-C	Class B-C	Class C	List Price
285241	12	175	Narrow	110	..	3	..	$ 7 00
				220	..	4	..	
285242	24	350	Narrow	110	..	3	..	8 50
				220	..	4	..	
285235	12	550	Wide	110	10	9	7–8	8 25
				220	*	*	10	
285236	15	650	Wide	110	10	9	7–8	8 50
				220	*	*	10	
285237	24	1000	Wide	110	7	6	5	9 00
				220	10	9	8	
285238	24 (overall)	600	Wide	110	6–7	5	..	6 00
				220	9–10	8	..	
285239	30	1300	Wide	110	7	6	5	10 50
				220	10	9	8	
285240	36	1500	Wide	110	7	6	5	12 25
				220	10	9	8	

*Drawing of connections furnished on request.

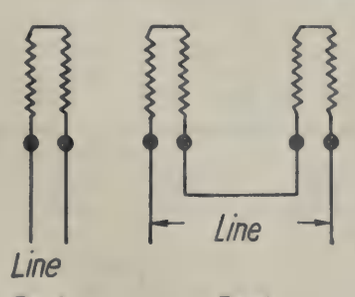


FIG. 3

FIG. 4

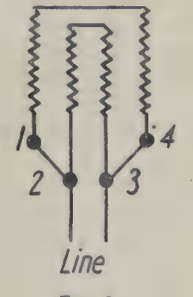


FIG. 5

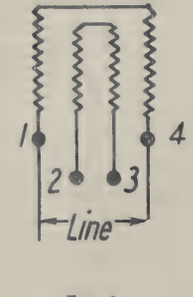


FIG. 6

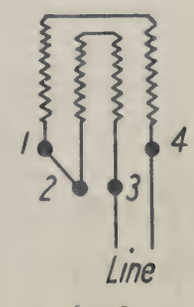


FIG. 7

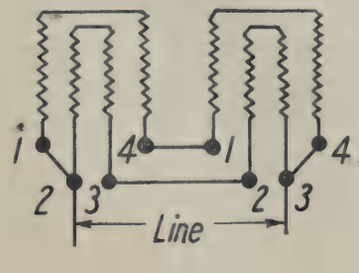


FIG. 8

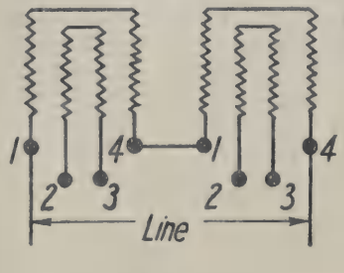


FIG. 9

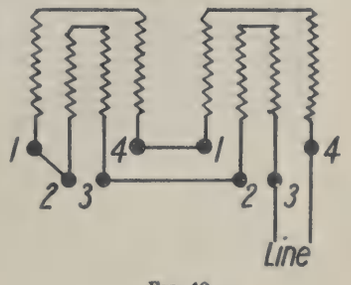


FIG. 10

"STEELCLAD" HEATERS—Continued

TABLE II—"STEELCLAD" HEATERS FOR SPECIAL APPLICATIONS

Volts	Type	Heat	Minimum Length of Heater Inches	Watts Input of Minimum Length of Heater	Maximum Input in Watts for Lengths (A Inches) of Heater 10	15	20	25	30	35
Class A "Steelclad" Heaters for Small Ovens										
110	Narrow	Single	16	125	...	...	150	190	225	260
220	Narrow	Single	29	225	...	...	...	...	225	260
110	Wide	Single	11	165	...	225	295	375	440	515
110	Wide	Three	15	250	...	250	300	350	450	500
220	Wide	Single	22	300	...	...	...	350	450	500
220	Wide	Three	30	450	...	...	...	...	450	500
Class B "Steelclad" Heaters for Special Air Heaters										
110	Narrow	Single	11	175	...	225	300	375	450	525
220	Narrow	Single	21½	325	...	...	...	375	450	525
110	Wide	Single	8	225	290	435	585	730	875	1025
110	Wide	Three	11	375	...	450	575	725	875	1025
220	Wide	Single	15	450	...	450	575	725	875	1025
220	Wide	Three	22	625	...	...	...	725	875	1025
Class C "Steelclad" Heaters for Press Heads, Rolls, Hot Plates										
110	Narrow	Single	8½	225	250	375	500	625	750	875
220	Narrow	Single	17	425	...	...	500	625	750	875
110	Wide	Single	6	275	485	730	975	1100	1100	1100
110	Wide	Three	9	450	500	725	975	1220	1450	1700
220	Wide	Single	12	600	...	725	975	1220	1450	1700
220	Wide	Three	17	800	...	...	975	1220	1450	1700

SWITCH ACCESSORIES

Style No.	Switch	Kind	Amperes	List Price
159907	Knife	Series-Parallel	25	$4 25
159908	Knife	Series-Parallel	50	5 75
186208-A	Knife	Series-Parallel	100	8 25
146865-D	Snap	3-Heat	10	1 85
160451-B	Snap	3-Heat	20	3 00
160452-D	Snap	3-Heat	30	3 50
216225	Snap	1-Heat	10	1 85
223863	Snap	1-Heat	20	3 25

OUTLINE DIMENSIONS

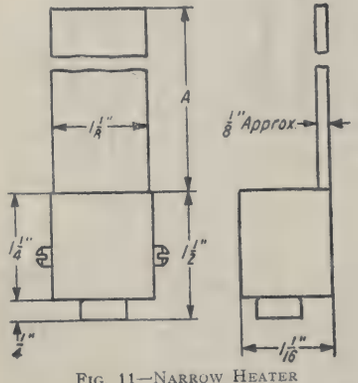


FIG. 11—NARROW HEATER

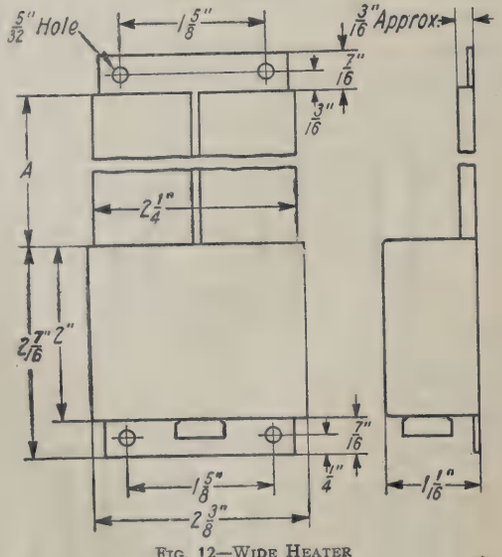


FIG. 12—WIDE HEATER

WESTINGHOUSE ELECTRICALLY-HEATED HOT TABLES

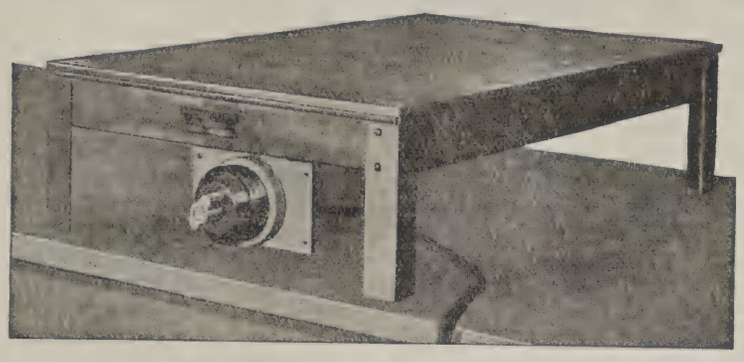


FIG. 1—ELECTRICALLY-HEATED HOT TABLE

Medium temperature heating to industrial processes has an enormous field of application. Many industries have trade practices which have standardized on certain cycles of operation and have largely been developed about the use of some particular form of heat. The quality of product, speed of operation or working conditions incident to that particular form of heating have been accepted as necessary and often there is no realization that any improvement may be possible. In most cases the cost of fuel, or source of heat, constitutes an almost negligible portion of the total production cost of the products so that it is often possible to use more expensive heating methods and bring about a large reduction in total production cost. A very good example of this is cited in the manufacture of celluloid articles.

The manufacture of celluloid articles requires the application of considerable heat to soften the celluloid stock during certain of the manufacturing processes, as the stock can be worked properly only at temperatures varying from 165 to 190 degrees F. according to the nature of the operation. When so heated the celluloid is pliable and may readily be chiseled, molded or stamped as occasion requires.

For the heating of this material many manufacturers have used flat steam tables, supplied with steam at 50 lb. pressure. The steam tables are liable to cause considerable trouble, however, due to lack of suitable temperature control and there is also frequent trouble with steam condensation, which causes flooding, making it difficult to obtain uniform temperatures. These operating difficulties, together with the scarcity and poor quality of fuel during the winter of 1917-1918 caused a certain comb company in Massachusetts to experiment with electric tables. They obtained a 16 by 24 inch electric table having three-heat control with current consumptions of 1800, 900 and 450 watts respectively. The successful operation of this table soon led to the installation of eleven similar tables. As it is necessary to heat the celluloid for every operation, the tables were distributed in the embossing, chiseling and finishing departments. These electric tables can be heated to working temperatures in ten minutes and can be maintained at any one of the three operating temperatures with practically no temperature fluctuations.

Motors and Control

FIG. 2—HEATING FINISHED COMBS ON HOT TABLE BEFORE PROCESS OF BENDING

FIG. 3—ROW OF HOT TABLES INSTALLED IN STAMPING ROOM FOR HEATING CELLULOID IN THE VARIOUS STAGES OF COMB MANUFACTURE

This factory manufactures combs, barrettes and imitation tortoise shell eye glass rims from flat celluloid stock. In the manufacture of straight combs, large sheets of flat celluloid stock about 0.125 inch thick are sheared into flat pieces of eight or nine inches long and about 2.25 inches wide. A piece of this size is sufficient for two combs. The next operation is embossing, in preparation for which a number of pieces are heated on the electric tables. When these pieces have reached the proper temperature they are placed in the die of the power press, which embosses a design on either or both sides. These embossed pieces are now ready for the chiseling machines. They are heated again to a pliable state on electric tables and are run through the chiseling machine. This machine has a vertical knife which cuts the celluloid to form two combs dovetailed together, which are readily stripped apart, while the material is still warm. By this method only two small pieces of stock at the ends are wasted.

The next operation is called burring for which no heat is necessary. The burr used for this operation is a circular cutter having five circular cutting blades which smooth five comb teeth at a time. With this tool the teeth are tapered down to a blunt point. The combs are then polished, which on certain classes of work is done with rag wheels and on others with a chemical bath, whose chief component is acetic acid. When combs are polished chemically they are dipped in the solution and dried in a large wooden compartment which has steel clad electric heaters at the bottom, furnishing a very mild heat. After this drying process the combs are ready to be packed for shipment. Curved combs are subjected to another heating process, preliminary to the bending operation.

The principal saving produced by the use of the electric tables is time. In the embossing operation an operator who formerly turned out 12 gross per day on the steam table, increased his production to 14 gross per day, also reducing the spoilage by more than half.

Owing to the better temperature control of the electric tables, the manufacturers also found that they could use lighter weight stock and secure equally good results. For example, 0.14 inch thick flat was formerly used to manufacture large combs; now they are using stock of 0.125 inch thickness, which produces a considerable saving in raw material.

FIG. 4—HEATING CELLULOID COMB BLANKS ON HOT TABLE

FIG. 5—HEATING VARIOUS ARTICLES ON ELECTRIC TABLE

FIG. 6—HEATING CELLULOID COMB BLANKS BETWEEN THE EMBOSSING AND CHISELING OPERATIONS

FIG. 7—EMBOSSING AND CHISELING PROCESSES GREATLY IMPROVED WHEN MATERIAL IS HEATED ON AN ELECTRIC HOT TABLE

To determine the **cost of operating** an electric table, they connected a single phase watthour meter with the trial table. This table was operated continuously on medium heat for certain work and on low heat for lighter work. As a result of several days test it was found that the cost of operating on medium heat all day was 17 cents and on low heat 9 cents. The rate for electric heating was the same as their power rate which averaged 2.25 cents per kw.-hr. The total cost of current used in making combs by electric heat did not exceed three cents per gross. Tests to determine the uniformity of heat secured with a table which had been in operation several months showed that the widest variations in temperature in a three hour test did not exceed 1.5 per cent.

With respect to **economy of operation** the Company stated that by installing electric tables, they reduced the operating expenses by more than one-half. In addition, the production has increased 25 per cent and spoilage is now reduced to a minimum solely through the adopting of electric tables.

There are two **sizes manufactured** at the present time. The 16 inch by 24 inch by 6 inch high, table is normally rated at 1800 watts and made for 110 or 220 volt power service. It is equipped with a three-heat snap switch to obtain wattages of 1800, 900 and 450 respectively. The larger size has dimensions 18 inches by 34 inches by 6 inches and is rated at 5200, 2600 and 1300 watts. The large table is supplied with a three-heat snap switch separate from the table, which can be mounted on the wall or any convenient place near the table. The heating units of the table consist of our standard steel-clad heaters clamped tight against the under side of the steel top plate. The electric hot table can be used for a great number of processes. The maximum limiting temperature of the heating elements is approximately 600 degrees Fahrenheit. They are listed as follows:

Style No.	Size in Inches	Watts	Voltage	Heats	Net Retail Price
270732	16 x 24 x 6	1800	110	3	$60 00
277827	16 x 24 x 6	1800	220	3	60 00
283536	18 x 34 x 6	5200	110	3	100 00
283537	18 x 34 x 6	5200	220	3	100 00

Prices given here are for estimating purposes and are subject to change without notice

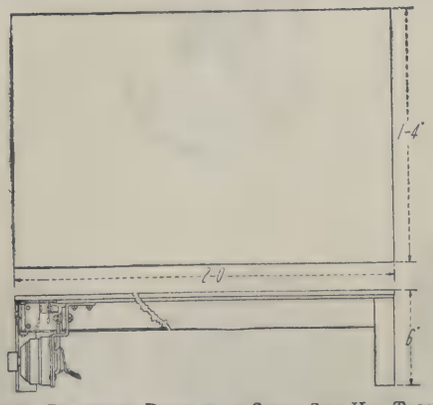
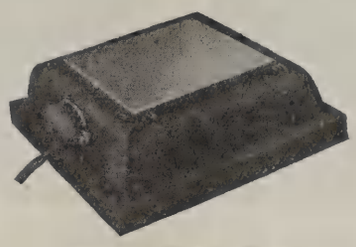


FIG. 8—DIMENSION DIAGRAM OF SMALL SIZE HOT TABLE

INDUSTRIAL HEATING PLATE



INDUSTRIAL HEATING PLATE

The Westinghouse electrically-heated industrial heating plate is useful in almost every industrial plant and repair shop wherever heat is required in small quantities at low temperatures. The absence of flame or glowing elements makes these stoves particularly applicable to heating of inflammable liquids.

The industrial heating plate is designed especially for industrial uses, is very substantially constructed, and will give dependable service. The heating elements are distributed so as to provide a uniform temperature over the entire surface of a metal plate, on which the object to be heated is placed, and will operate satisfactorily for processes requiring a surface temperature of approximately 600 degrees Fahrenheit. The stove sits flat on a bench or table. Each stove is supplied with six feet of flexible cord attached to the heating element by two thoroughly protected terminals. The industrial heating plate is equipped with a slate base.

Style number and price include stove as described, but no switches or attachment plugs.

Unit Package, 1 industrial heating plate.
Bulk Package, any 4 industrial heating plates.

Volts	Size, Inches	Watts	Style No.	Net Retail Price
100-120	5 x6	350	140606	$15 00
100-120	5¼x7	450	140609	18 00
200-240	5 x6	350	Special	25 00

DRY-TYPE GLUE POTS

Electrically-heated glue pots without a water jacket have been demonstrated by test and by practical experience to be far superior in every respect to the old wet-type pots. It has been shown that as long as the input to the electric heater element is such that the glue is kept at the proper working temperature, the best results are obtained. The heating element is so designed that it takes just the proper temperature when the pot, which must be at least one-third full of glue, is operated continuously. As a consequence the glue is always at the right temperature, whether the glue is being used or not, and there is positively no danger of overheating. With the dry-type glue pot it takes approximately 15 minutes to heat a sufficient quantity of glue to working temperature so that the workman can begin his work.

Distinctive Features—There are many points of advantage and improvement of the new dry-type glue pot over all other forms of heating glue. Among the most important are:—

(a) The water bath is eliminated. With the old wet-type there was always danger of the water evaporating and burning the glue and the heater burning out. With the dry-type glue pot the current can be applied continuously without any danger of the heater burning out or the glue becoming overheated.

(b) The single-heat constant input heater gives the correct working temperature to the glue for continuous operation of the dry-type glue pot.

(c) The necessity of continuous addition of water and the inconvenience and sloppiness of the water bath are entirely eliminated.

(d) The new dry-type glue pot is more efficient because the glue is heated directly and none of the energy is required to heat a water bath.

(e) There is a great saving in time because the glue is heated directly and held at the proper temperature without attention.

Construction—In the new dry-type pot the copper glue vessel fits snugly into the sheet-steel outer jacket and makes good thermal contact with the heating element, which is clamped between the sheet-steel bottom plates. An extra sheet-steel plate is placed underneath the heating element in such a way as to form a dead air space between. This keeps the heat, which is generated in the heating element from being radiated downward from the pot.

Style number and price include glue pot complete with glue vessel, heater and flexible cord with separable attachment plugs.

COMPLETE GLUE POT

Capacity	Watts	Approx. Overall Dimensions, Inches: Diam.	Max. Wdt.	Hght.	Approx. Wt. Lb.: Net	Shipping	Style No.: 100-120 Vts.	200-240 Vts.	List Price
1-Pt.	60	4 5/16	5 7/16	4 3/8	2 1/2	3 1/2	256814	289829	$ 8 00
1-Qt.	80	5 5/16	6 1/4	5	3 1/2	4 1/2	252668	289828	12 00
2-Qt.	100	6 1/2	7 1/4	6 1/4	4 1/2	5 1/2	289831	289832	14 00
4-Qt.	140	7 7/8	9	8 1/8	7 1/2	10	256817	289830	18 00

Order by Style Number

Flexible Cord With Separable Attachment Plug

Heating Element Between Sheet-Steel Plates

Spun Copper Glue Vessel

Sheet-Steel Outer Jacket

SOLDER POTS

Electric solder pots for individual use form the most satisfactory, economical, and safest means of melting solder, lead, tin, babbitt, and similar metals, and keeping them in a liquid condition. Where the metal must be carried to the work in ladles, a good deal of the workman's time is lost, and the metal cools rapidly, thus making bad joints. There is also a considerable loss of metal, as the residues are not always returned to the melting pot. Furthermore, with individual pots the danger of serious burns to workmen is practically eliminated.

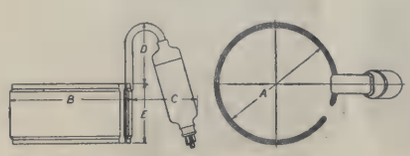
Special Features—Immersion heaters. Pots made of cold-rolled steel, light but strong. Two-heat switch furnished.

Style number and price include pot complete with immersion heater, ladle, and 6-foot flexible cord with two-heat snap switch. Separable attachment plug is also included with 8-pound pot.

Unit package, 1 solder pot.

Bulk package, any 4 solder pots.

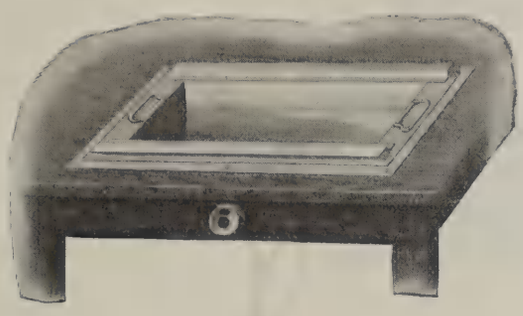
Capacity Pounds	Watts High Heat	Watts Low Heat	Approx. Shipping Wt., Lb.	Style No. 100–120 Volts	List Price
8	500	250	5½	133629	$25 00
15	800	400	6½	133632	35 00

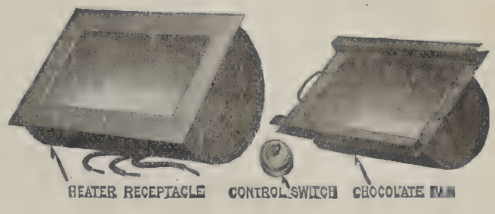


Solder Pot Heater Dimensions

Pot Capacity	Dimensions in Inches A	B	C	D	E	Approx. Net Weight Pounds
8 lbs.	3⅜	3 11/32	2 9/16	1⅞	2 7/16	1½
15 lbs.	4 9/16	4 15/16	2 17/32	2⅜	2 7/16	2

CHOCOLATE WARMERS





Electric chocolate warmers are used by candy manufacturers for maintaining chocolate continuously in a fluid state at exactly the proper consistency for dipping. The gentle diffused heat of the warmer keeps the chocolate at an absolutely uniform temperature, and enables each dipper to produce high-grade work.

The electric warmer consists essentially of a chocolate pan of sheet metal; a hermetically-sealed sheet metal receptacle, containing the heating element; and a control switch. The receptacle is arranged for mounting in the top of a table as shown in the figure. The chocolate pan sets inside of the receptacle. Longitudinal lips formed from sheet metal are provided to extend over marble slabs which are used in connection with the chocolate dipping pan. The heater and conducting wires are shielded so as to prevent accidental contact with them.

Special Features—Compact. Easy to install. Heat can be controlled.

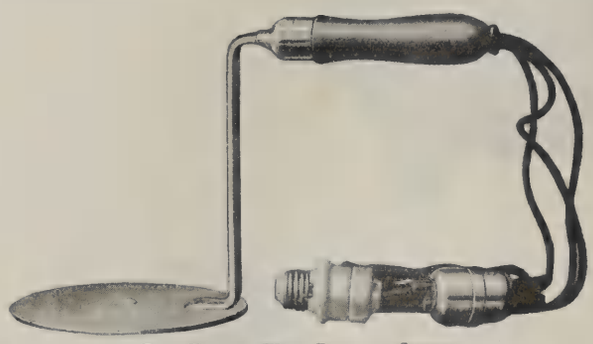
Style number and price include chocolate warmer complete with leads and three-heat switch. Marble slab and table not included.

Unit package, 1 chocolate warmer.
Bulk package, any 4 chocolate warmers.

Dimensions Inside Pan	Opening in Table	Watts	Approx. Shipping Wt., Lb.	Style No. 100-120 Volts	Style No. 200-240 Volts	Price List
14¼" long 7⅝" wide 6" deep	17⅝" x 10⅞"	264 132 66	35	140577	140581	$42 00

Order by Style Number and Specify Exact Voltage

DISC IMMERSION HEATERS



DISC HEATER WITH PENDANT SWITCH

These heaters may be used to heat liquids in almost any vessel the capacity of which is within the range of the heater and the temperature does not exceed 250 degrees Fahrenheit. The flat disc rests on the bottom where it is most effective and the stem comes out at the side where it is out of the way.

In the home one of these heaters is invaluable where a quantity of water is to be heated, as for shaving, warming infants' food, making tea, and many other purposes. The two smaller sizes can be attached to a standard lamp socket.

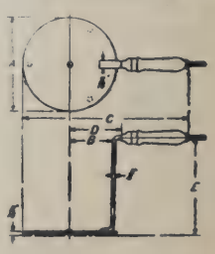
In almost all industrial plants there is some operation which requires the heating of water or other liquids. For many such uses a disc immersion heater is particularly applicable as it requires no special wiring, and is portable, convenient to use, and efficient. It should always be completely immersed

The heating element is sealed in the disc and cannot oxidize, insuring long life. The disc being flat and thin, offers a large exposed heating surface with a short distance for the heat to travel in reaching the surface. All metal parts are copper, heavily tinned, and the handles are of wood with a durable ebony finish.

Style number and price include heater complete with a flexible cord and two-heat control switch. The 5 and 6-inch heaters have the control switch connected in the cord and are supplied with a separable attachment plug. The 8-inch heater is supplied with a snap switch for wall mounting but no attachment plug.

Unit package. 1 disc immersion heater.
Bulk Package. any 4 disc immersion heaters.

Diameter Inches	—Watts Input— Max.	Min.	Approx. Wt. Lb. Net	Shipping	Style No. 100-120 Volts	List Price
5	500	125	3	4	151102	$10 00
6	650	162	5½	6½	151104	11 00
8	1100	275	9	10	151106	12 50

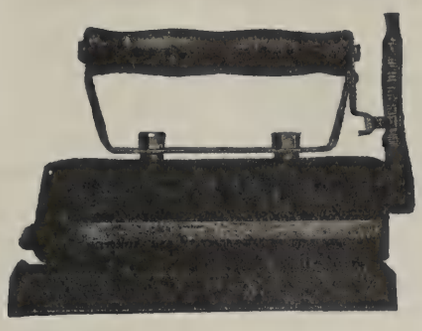


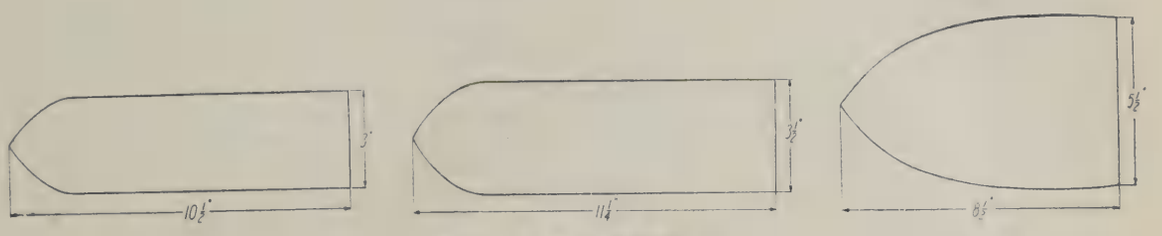
Approximate Dimensions of Disc Heaters

Style No.	Dimensions in Inches A	B	C	D	E
151102	5 3/16	2 11/32	10 1/8	3 21/32	6
151104	6 1/8	2 11/16	11 1/16	3 5/16	7 1/4
151106	8 1/8	3 11/16	13 1/16	4 5/16	8 1/2

Order by Style Number

TAILORS' IRONS





OUTLINES OF IRONING FACES

Cleanliness, absence of fumes, reduction of fire hazard, saving of time, and quicker and better work are features that make electric irons specially desirable in tailoring and pressing establishments.

These irons are similar to standard flat irons but of heavier construction. The stand is a cast-iron plate mounted on a slate base.

Finish—Working face, polished; lower edges, blued; casing, dull black; handle standards, bright steel; handle, natural color.

Unit package, 1 tailors' iron.
Bulk package, any 4 tailors' irons.

Connections—Cord is permanently attached. These irons should not be connected to lamp sockets because of their heavy current. A 10-ampere plug switch makes a simple and reliable method of connecting to circuit.

Style number and price include iron complete with cord and fire-proof stand, but no attachment plug.

Watts	Wt., Lbs. Net	Wt., Lbs. Boxed	Style No. 100-120 Volts	Style No. 200-240 Volts	List Price
3 Inches Wide, 10½ Inches Long					
700	12	22	122502	122505	$14 50
700	15	25	122508	122511	16 00
750	18	28	122514	122517	17 50
3½ Inches Wide, 11¼ Inches Long					
800	16	26	121355	121358	17 50
800	20	30	121361	121364	19 00
*850	24	34	121367	121370	22 00
5½ Inches Wide, 8½ Inches Long					
750	12	22	122478	122481	14 50
*750	15	25	122484	122487	16 00
*800	18	28	122490	122493	17 50
*800	22	32	122496	122499	21 00

Net weight includes iron only. Boxed weight includes stand and is only approximate.
*Not carried in stock and must be ordered special.

Order by Style Number and Specify Exact Voltage

ENERGY REQUIRED FOR HEATING BUILDINGS

To determine the electrical energy necessary to heat a room or building, many factors must be taken into consideration. Heat is lost by (a) transmissio through walls, floor, and ceiling (see table I), and (b) through air necessary for ventilation (see table II). The exposure of the building must also be considered.

Table I—Watts Lost by Radiation Per Square Foot of Surface Per Degree F. Difference in Temperature

Radiating Surface	Watts
24-inch brick wall	0.0575
12-inch brick wall	0.0925
8-inch brick wall	0.1350
4-inch brick wall	0.1930
Wooden flooring	0.0245
Wooden ceiling	0.0305
Fireproof flooring	0.0360
Fireproof ceiling	0.0425
Single window	0.355
Single skylight	0.300
Double window	0.170
Double skylight	0.185
Door (65 per cent wood—35 per cent glass)	0.170
Door—plain	0.120
Wood partition—1-inch thick	0.120

These co-efficients, for latitudes approximately that of Pittsburgh, will be increased as follows.

10 per cent for northern and windy exposure.

10 per cent where building is heated during day time only, and building is not exposed.

30 per cent where building is heated during day time only, and location is an exposed one.

50 per cent where the building is heated intermittently during the winter months.

(From "Ventilation and Heating"—B. F. Sturtevant Co.)

Table II—Air Required for Ventilation of Rooms

Service	Cu. Ft. of Air per Hr.
Hospitals	3,600 per single bed
Legislature assembly halls	3,600 per seat
Barracks, bedrooms and workshops	3,000 per person
Schools and churches	2,400 per person
Theatres and ordinary halls	2,000 per seat
Office rooms	1,800 per person
Dining rooms	1,800 per person
Homes	Once per hour

These figures are for uncontaminated air. Where smoke, gas, gas illumination, etc, are present additional provision must be made. A single gas burner consumes about 45 cubic feet of air per minute. To heat one cubic foot of air one degree F. requires 0.0054 watt-hours, or one kilowatt-hour will heat 2650 cubic feet of air 70 degrees F. From this the energy necessary to heat the air required for ventilation may readily be determined.

A quicker method of determining approximately the amount of heat necessary to maintain the temperature of a room is given in the following formula:

$$\left(\frac{W}{4}+G+\frac{C}{55}\right)\frac{T}{3.4}=\text{heat losses in watts.}$$

Where W = exposed wall surface in sq. ft.

G = exposed glass surface sq. ft.

C = contents in cubic ft.

T = difference between inside and outside temperature in degrees F.

This formula assumes that the building is of good construction, with fairly thick walls, tight-fitting doors and windows and no unusual conditions, such as exposure to high winds, etc. It is an approximation only for preliminary estimates and not to be considered accurate for all cases.

In all calculations of the heat necessary to obtain a certain result, the character of the installation must be considered. For instance in a small store where the doors are open often, an additional allowance should be made. In the home the loss from this may be neglected. The lowest outside temperature on record should always be used in these calculations.

Example—Office 15 by 15 by 10 feet—located at the northwest corner on the third floor of a four-story warehouse. The building has 12-inch brick walls, floors of fireproof construction, two windows, each 18 square feet, one door 3 by 7 feet, a one-inch wood partition. Temperature of office to be 70 degrees F., balance of building 40 degrees F., outside zero degrees F. Air supply 4000 cubic feet per hour

Then according to the above conditions:

		Watts
Exposed wall	264 sq. ft. by 0.0925 by 70 = 1710 + 10 per cent =	1880
Exposed glass	36 sq. ft. by 0.355 by 70 = 900 + 10 per cent =	990
Interior partition	300 sq. ft. by 0.12 by 30 =	1080
Ceiling	225 sq. ft. by 0.0425 by 30 =	290
Floor	225 sq. ft. by 0.036 by 30 =	240
Air	4000 cu. ft. by 0.0054 by 70 =	1510
TOTAL WATTS		5990

There should be used two 3-kilowatt air heaters, one under each window, each having three-heat control.

Owing to the extreme variations in local conditions encountered in this class of service it must be evident that a definite guarantee of accomplishing certain results cannot be given, and that the engineer's estimate can be based only on his best judgment and the best information available concerning the installation at hand. If installation is of importance and size, a local responsible heating engineer should be consulted for a statement of total heat required.

BABBITTS AND SOLDERS

The babbitt consumer today is confronted with a great variety of babbits now on the market. In many cases absurd claims are made as to the merits of their product by certain manufacturers. Sometimes such claims are set forth through lack of knowledge on the part of the babbitt manufacturer, and occasionally with the express purpose of inducing the customer to purchase an inferior product at what would appear to be a very attractive price.

The Westinghouse Electric & Manufacturing Company has been a manufacturer and one of the largest users of babbitt metals for over thirty years and, in view of the fact that we are both manufacturer and user, we are particularly well qualified to recommend the proper babbitt for any application.

All our alloys are made from STRICTLY VIRGIN METALS purchased in conformity with the specifications of the American Society of Testing Materials and in accordance with our own formula.

The mixing and alloying of the ingredients is in the hands of experts trained in this line of work, and a very strict laboratory control is exercised over the entire operation. No heat of metal is permitted to enter the manufacturing sections of our shop or our shipping department that does not meet the specifications as to Brinell hardness, toughness, etc.

We appreciate the important part which babbitt plays in the proper performance of our equipment of every description, and therefore give the making of this material special attention and have perfected the method of manufacture and method of application to a high degree of proficiency during a long period of years of experience.

In addition to this manufacturing experience, our scientific control of our babbitt process guarantees that the best results possible of any specified formula will be obtained.

PRICES

On account of fluctuations of the metal market, prices on babbitts and solders vary from time to time and will, therefore, be quoted on request.

BABBITTS

WESTINGHOUSE ALLOY No. 25
Lead Base Babbitt

This is a high grade dependable lead base babbitt of great uniformity which we have used in our own shops for many years in the manufacture of motors, generators, turbines and other electrical equipment of great variety and description. On account of the frequent requests from our customers for a high grade lead base babbitt applicable to a large range of operations, we offer this alloy and are prepared to furnish it in any quantity on short notice.

WESTINGHOUSE ALLOY No. 14
Genuine Babbitt

This is an extremely high grade tin base babbitt made according to our own formula which we have used successfully for a large number of years in a great variety of work where excessive pressures, high speed and heavy duty demand the very best material available. In conformity with the specifications of the American Society of Testing Materials, we guarantee the lead content of this alloy to be not over .35 of one per cent.

This alloy lends itself to a great variety of work, is less sluggish than most genuine babbitt mixtures and can therefore be poured successfully into thin sections requiring a minimum of subsequent machining, remelting of cuttings, etc.

MISCELLANEOUS BABBITTS

We particularly recommend our lead base babbitt Westinghouse alloy No. 25 and our tin base babbitt Westinghouse alloy No. 14 and can ship these babbitts promptly from stock in reasonable quantities. However, where customer requires a babbitt made according to their own formula, we can furnish such material when purchased in quantities.

All negotiations on special babbitt alloys should be referred to the Repair Parts Section, Supply Department.

SOLDERS

In the manufacture of solders the same high grade materials are used. No antimony is used in any of our solders. While the use of antimony improves the appearance of the solder, we do not consider it good practice, and the performance of the solder is no better when antimony is used in the alloy.

WESTINGHOUSE ALLOY No. 15

This is what is known to the trade as a strictly half and half solder from which excellent results in a great variety of work have been obtained. The highest grade materials only are used, and this solder is furnished both in the ingot, weighing approximately 8 pounds, and the bar, weighing approximate y 1½ pounds.

WESTINGHOUSE ALLOY No. 19

This is a wiping solder which has given splendid results and which is particularly applicable to work where a wiping solder is required. It is furnished in ingots weighing approximately 7½ pounds

MISCELLANEOUS SOLDERS

While we particularly recommend our Westinghouse alloy No. 15 for all ordinary soldering purposes and our Westinghouse alloy No. 19 for all purposes where wiping solder will answer, and use these two alloys almost exclusively ourselves, we are prepared to make up special mixtures as per customer's specifications if ordered in sufficient quantities to warrant.

Such special alloys will be cast in ingots as per cut shown above and the mixing and alloying will receive careful attention.

REPAIR PARTS

Westinghouse apparatus is built to afford the most dependable service.

When a point in extended service has been reached which makes replacement necessary — specify Westinghouse parts. These are manufactured by the same organization that made the original. They are made with just as great **care** and **uniformity,** and are given as rigid inspection as the original parts for complete Westinghouse apparatus.

That is why you cannot afford to use other than Westinghouse parts for your Westinghouse apparatus.

"Westinghouse Supply Parts Mean Maximum Service."

POINTS OF IMPORTANCE IN SELECTING AND APPLYING SMALL MOTORS

When selecting small motors for application to a large number of individual machines of a class, precautions should be taken to select a motor with suitable characteristics. Each class of machines has its own peculiarities, and a Westinghouse motor is built or can be built to suit them.

Before deciding on the specifications of a motor for a class of machines, samples of the machines should be thoroughly tested under actual working conditions to determine the required effort or torque, both for starting and running. Some allowance must be made for unavoidable manufacturing variations, differences in materials, etc., which may cause some machines to require more power than others built as duplicates. The same unavoidable causes may result in slight differences in the characteristics of motors supposed to be duplicates, although customers can rest assured that all Westinghouse small motors will be as good, or better, than guarantees. Likewise, allowance must be made for variations in the characteristics of commercial electric circuits. The motor selection should be made with the worst probable conditions in view.

Alternating-Current Motors—Single-phase motors should be selected with a starting torque that will bring the machine promptly up to speed. Allowance must be made for reduced voltage of commercial power and light circuits, since the starting torque developed by the motor varies as the square of the voltage of the circuit to which it is connected. On account of light wiring or insufficient transformer capacity, the voltage of many such circuits drops considerably at times. While the motor is starting, it is possible that the voltage at the motor terminals may be as low as 80 per cent of its rated value, and under this condition the starting torque of the motor is only approximately 64 per cent of its full voltage value. For these reasons, motors to drive machines from indiscriminate lighting circuits should be selected for the worst probable starting conditions.

Clutchless motors are successfully used on all applications where a starting torque greater than full load torque is not required, and where, owing to the size of motor or the liberal rules of the central station, the amount of starting current is not important. Such motors are generally used for washing machines, ironing machines, small fans and blowers, advertising novelties, duplicating machines, folding machines, peanut roasters, etc.

Clutch motors are successfully used on all ordinary applications where a liberal starting torque is necessary. The starting current required is less and falls off more rapidly than with the clutchless type and the clutch also provides overload protection for the windings of the motors under excessive overloads for short periods of time. Such motors are generally used for small house pumps, meat choppers, coffee grinders, air compressors, etc.

Repulsion-Induction motors are successfully used on applications where the starting torque required is very high, and the lowest possible starting current is necessary.

Uniform rules, adopted by the National Electric Light Association, to govern the installation and use of motors on central station distribution systems, permit motors requiring not more than 30 amperes starting current to be connected to 110-volt alternating-current circuits. This current value is that indicated by a suitable well-damped ammeter in the motor circuit on the line side of the starting device, and is 75 per cent of the permissible locked rotor value, which would be 40 amperes.

Polyphase motors, possessing few wearing parts and having high starting torque and high overload capacity, are adapted to industrial service where polyphase power circuits are available. Squirrel-cage motors are suitable for constant speed service; wound-rotor motors for varying speed service.

The maximum turning effort while the motor is running, which is usually called break-down or maximum torque, must also be ample for the worst load conditions which the machine will probably meet, with voltage at least 10 per cent below rated voltage.

Direct-Current Motors—The operating characteristics of direct-current motors depend very largely on the type of field windings employed. The following comparison applies to shunt, compound and series-wound motors of the same rating and hence with substantially the same rated full-load current.

(a) Shunt-wound motors when used without a starting rheostat take several times full-load current at start and develop a starting torque of two to three times full-load torque. When a starting rheostat is used the current is limited to approximately two times full-load current on the first point of the rheostat, in which case the torque developed is directly proportional to the starting current. Starting rheostats are supplied with motors of ½ h.p. and larger and should be used on somewhat smaller motors when the starts are frequent. The operating speed of the shunt motor is practically constant at all loads. Such motors are generally applicable unless the starting or overload conditions are too severe.

(b) Compound-wound motors will develop higher starting and maximum torques with the same current input than shunt-wound motors but the speed while operating varies more widely with the load. They should be applied where high starting torque is desired and where some change of speed with load is not objectionable. When it is necessary for a motor to make frequent starts, even though the torque

POINTS OF IMPORTANCE IN SELECTING AND APPLYING SMALL MOTORS—Continued

required is not excessive, a compound winding should be used. When it is desired to start motors larger than ½ h.p. without the use of a starting rheostat a field winding containing a larger number of series turns than that used on standard compound-wound motors can be furnished. Compound-wound motors should be applied under practically the same conditions as single-phase clutch motors.

(c) Series-wound motors develop higher starting and maximum torques with a given current input than either shunt or compound-wound motors, but while operating the speed varies with the load, increasing to a dangerously high speed at light loads. Series motors are applicable where very high torque must be developed either while starting or operating and where varying speed with varying load is not objectionable. Series-wound motors are particularly adapted to fans of the propeller type, to operating valves and similar applications where the motor is directly connected to the load. Series-wound motors other than the smallest sizes should not be belted or applied where the load may become very light, since if the load is removed a dangerous speed may result.

Mounting—The motor should be so mounted on the driven machine that it will receive a free circulation of air and be protected from heavy dust, dirt, oil and water. Opportunity must be left for inspection, replenishing the lubricant and renewing the brushes. The motor must be held firmly in place to prevent injurious vibration.

Method of Drive—In belting small motors, the arc of contact between the belt and the motor pulley must be sufficient to prevent the belt from slipping, even if it becomes somewhat loose. If the distance between the centers of the motor pulley and the driven pulley is short, or if there is a great difference in size between the two pulleys, some device such as an idler pulley must be used to increase the arc of contact between the belt and the smaller pulley.

If the motor drives through gears or chains, the gears or sprockets must be lined up properly and run freely. Binding will waste power, decrease the life of the gears, chains and sprockets, and increase the noise.

If the motor and driven machine are direct-connected by a rigid coupling, the shafts must be aligned with the greatest accuracy; with a flexible coupling less care is necessary, but good alignment insures minimum loss of power and wear of bearings.

Lubrication—It is essential in order to obtain successful operation to properly lubricate both the motor and the driven machine. Directions for replenishing the lubricant and cautions against putting oil on the motor windings, commutator or brushes accompany each motor. A manufacturer reselling a motor in connection with his machine should send with each outfit full instructions covering the lubrication of the complete apparatus.

Wiring—The machine manufacturer should also keep in close touch with installations of his machines. He should cooperate with wiring contractors with a view to insuring correct wiring. The conductors to the motors must be large enough to carry the current without undue heating or voltage drop. For motors of ⅙ horsepower and larger, separate wires from the main switch are advisable.

Heating—If machines are intended for continuous service, hours at a time, one of them should be operated four or five hours under the worst possible working conditions and the motor temperature observed. If the temperature rise of the hottest part of the motor does not exceed 50 degrees Centigrade (90 degrees Fahrenheit) above the surrounding air, the application will be satisfactory. Care should be taken that the temperature measured is that of the hottest part as the external frame will run several degrees cooler than the internal part where the heat is generated, because a strong current of air is being forced through the motor while it is running. The hottest part will in general be found to be the stator winding on an alternating-current motor, and the rotor winding on a direct-current motor. As long as the hand can be held on the windings of a motor without great discomfort, measurement of temperature is not essential. Beyond this point a thermometer should be used.

Many machines operate for short periods only, with intervals of rest, during which the motor can cool. Motors with ratings for intermittent service can be used in such cases, thus effecting some saving in cost; care must be taken, however, to guard against applying a motor that would overheat, if it is possible for it to be accidentally left in service continuously.

Conservative Rating—The service and reliability of a motor-driven device will be greatly enhanced by the use of a motor rated on a conservative basis. The cost of a motor slightly larger than required under favorable conditions may be a little greater than that of one just sufficient to drive a device, but the reputation that will be established by the device using a conservatively rated motor will more than outweigh the increase in cost.

TYPE CA ALTERNATING-CURRENT MOTORS

SINGLE-PHASE OPEN

1/12 H.P. Frame No. 443

Westinghouse type CA motors are split-phase induction motors which can be operated from a single-phase lighting circuit or from any phase of a polyphase power circuit to drive many small machines such as washing machines, sign flashers, small printing presses, blowers, etc.

The experience of the Westinghouse Electric & Manufacturing Company has enabled it to analyze the requirements of small-motor applications and design the type CA motor so that it is capable of making innumerable starts and giving years of service with little attention except an occasional oiling.

Construction

The **Stator** or stationary element, consists of the frame, primary core, and windings.

The frame is a cylindrical iron casting with the feet forming part of the casting. The feet are slotted for holding-down bolts and for the adjustment of belt tension.

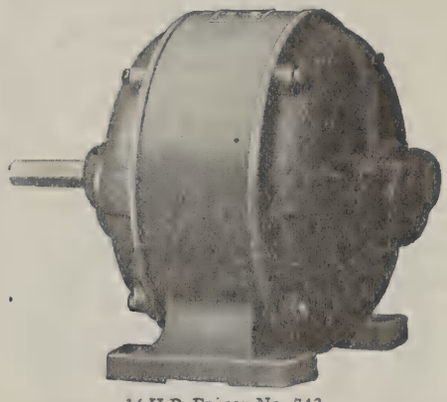
The primary core is built up of steel punchings and rigidly mounted in the frame.

Frame With Brackets and Rotor Removed, Showing Primary Core and Windings

CLUTCH AND CLUTCHLESS

In the slots of the primary core are inserted the two primary windings, the main and the starting windings. The starting winding is in circuit only while the motor is accelerating and is automatically cut out by the starting switch when a predetermined speed has been reached.

The **Rotor** is of the squirrel-cage type and is therefore practically indestructible. The shaft is made of axle steel which is tougher and stronger than the machinery steel usually employed. The shafts for the largest frames have keyways for flat pulleys while the shafts for the smaller frames have "flats"



½ H.P. Frame No. 743

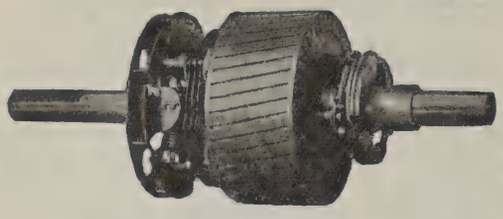
for grooved pulleys since "flats" make it easier for unskilled operators to remove the pulleys.

Mounted on one end of the rotor is the centrifugal operating ring of the starting switch. On the inside of the bearing bracket and insulated from it is the stationary part of the switch. When the rotor is at rest the switch is closed as shown in the cut of the bracket. The upper contacts are mounted on a movable slide which may be moved upward a short

Rotor Showing Centrifugal Operating Ring and Ventilating Plate

distance from the position shown. When the rotor starts the centrifugal operating ring mounted on the rotor does not touch the starting switch until a predetermined speed is reached when the ring expands. For an instant the ring presses against the upper lip on the

TYPE CA ALTERNATING-CURRENT MOTORS—Continued

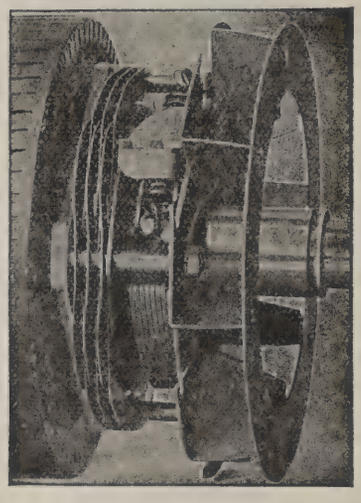


ROTOR OF ½ H.P. MOTOR, SHOWING CLUTCH, CENTRIFUGAL OPERATING RING AND VENTILATING PLATE

slide and causes it to move upwards past the reach of the ring to the limit of its travel where it is held by two steel springs. When the speed drops sufficiently to allow the ring to close, the lower lip on the slide is pressed for an instant by the ring so that the contacts close. The slide travels past the reach of the operating ring due to the action of the springs, which hold the slide up when it is thrown up and hold it down when it is thrown down, thus eliminating wear of both the ring and switch. The ring never carries current nor comes in contact with parts carrying current, therefore there are no sliding contacts but a quick make-and-break action. This reduces arcing to a minimum and insures long life as evidenced by an actual test in which one of the smallest of these switches made more than a million starts. These switches are used in all but the 300 frame. There the current in the starting winding is so small that the centrifugal finger type of switch gives satisfactory service.

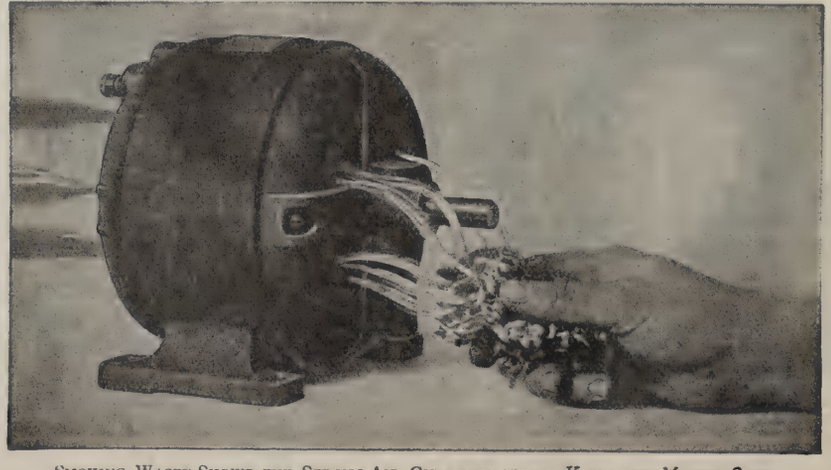
One-sixth horsepower motors and larger may be furnished with multiple-disc clutches for starting extra heavy loads. The motor with a clutch will exert a starting torque or effort approximately equal to the break-down or maximum torque and will positively bring up to full speed any load within its capacity which it can start.

The clutch consists of a group of thin phosphor-bronze plates mounted on the rotor and interleaved between another group of thin steel plates which turn with the shaft. When the rotor is turned by hand, or is running at a very low speed, these plates are free to slide by each other, but when the rotor has attained a predetermined speed, two special centrifugal weights or levers fly out and press the plates together through a toggle, thus preventing sliding and causing the shaft and the rotor to turn together. The clutch is similar in principle to that used in the leading types of automobiles. It will clear itself of all dirt or grease and has an extremely long life under even severe starting conditions. The plates do not rub together sufficiently to cause wear before the weights operate since the end play of the rotor allows them to separate.



MULTIPLE-DISC CLUTCH MOUNTED ON ROTOR FOR ½ H.P MOTOR

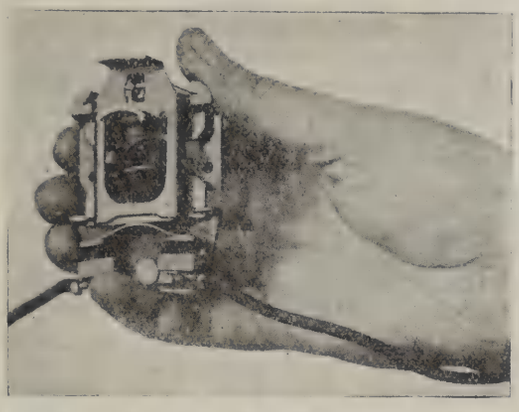
The weights and springs are so adjusted upon the clutch and switch that when the motor is accelerating the switch must open the circuit of the starting winding before the clutch operates. When the motor is retarded by an overload the clutch will slip before the starting-winding circuit can be closed. This absolutely protects the starting winding in



SMOKING WASTE SHOWS THE STRONG AIR CURRENTS WHICH KEEP THE MOTOR COOL

case of an overload and prevents a burnout as long as the clutch is operating.

A ventilating plate mounted on the rotor forces a continuous current of air through the motor. The air is so directed as to cool the cores and windings



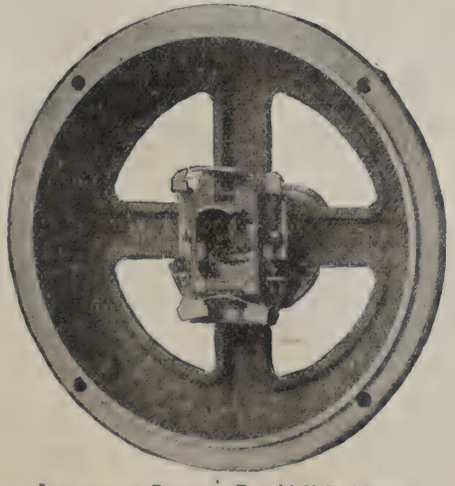
THE SWITCH THAT MADE MORE THAN A MILLION STARTS

thoroughly, thus maintaining practically uniform temperature and avoiding localized heating.

Brackets on frame class 700, are cast separate from the frame to permit the armature to be easily removed from either end. In the smaller sizes with small armatures this feature is not essential and one bracket is cast integral with the frame. This construction also permits a more compact design with less weight.

The bearings are bronze bushings pressed into the housings which form part of the brackets. Metal caps and rings fitting tightly in the bearing housings make the bearings practically dust-proof.

Standard motors are furnished for floor mounting only but those with frame class 700 can be arranged for side wall and inverted or ceiling mounting by turning the assembled bearing brackets 90 or 180 degrees respectively. An additional charge is made for all wall or ceiling mounting motors and all inquiries for them should be referred to the Works.



INTERIOR OF BRACKET FOR ½ H.P. MOTOR SHOWING STARTING SWITCH

Terminal leads are brought out through the lower part of frame 700. The smaller frames, upon which the motors are built that ordinarily operate from lighting circuits, have insulated binding posts to permit ready connection. In all sizes the direction of rotation can be reversed by interchanging leads according to instructions on the following page.

Lubrication of motor bearings on frames 300 and 400 is provided by means of wick-fed grease cups so that these smaller motors can be used on small portable apparatus which may require considerable handling and may be run in a tilted position or momentarily turned upside down without spilling the lubricant. A good grade of unmedicated vaseline is ordinarily used for the lubricant, although, if a motor with grease cups is always to remain in one position where oil will not spill out, a good grade of machine oil may be used. The bearings of all

EXTERIOR OF BRACKET FOR ½ H.P. MOTOR SHOWING OIL RING LUBRICATION

motors on frame 700 are lubricated by oil rings, which type of lubrication is standard for all large motors. In both types, the possibility of the lubricant leaking is reduced to a minimum.

The **finish** is glossy black japan, a finish attractive in appearance and possessing good wearing qualities.

Interchangeability of type CA motors, rating for rating, with type CD direct-current motors with respect to mountings and principal dimensions makes it necessary for the user to provide only one mounting for either direct or alternating-current motors whether the motors are direct connected, geared or belted.

Accessories

Pulleys—Crowned paper pulleys are standard for motors on frame 700. Grooved pulleys are standard for smaller motors. Only standard pulleys are carried in stock but pulleys

smaller than standard may be used. The smallest pulleys listed on the page of ratings are those with minimum allowable diameter and maximum allowable face.

SLIDING BASE FOR FREQUENT ADJUSTMENT OF BELT TENSION

Sliding Bases with belt tightening device can be supplied for 700-frame motors where frequent adjustment of belt tension is necessary.

Performance Guarantees

The temperature rise of all parts, when operating under normal rated conditions as specified on the name plate and at 100 per cent rated load, will not exceed 40 degrees Centigrade.

Clutchless type CA motors have a starting torque of from 1 to 1½ times full load torque and a breakdown or maximum torque of from 1¾ to 2 times full load torque.

Clutch motors have a starting torque and a breakdown or maximum torque of from 1¾ to 2 times full load torque.

Type CA motors will operate successfully with normal rated current and frequency at any voltage not more than 10 per cent above or below normal but not necessarily in accordance with the standards of performance established for operation at normal rating.

Care and Operation

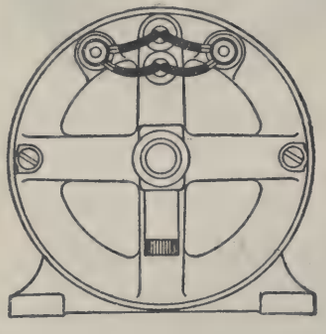
Note the nameplate reading to see that it agrees with the circuit to which the motor is to be connected.

Lubrication—If the motor has bearings of the oil-ring type, fill each reservoir with a good grade of dynamo or machine oil until the oil level rises nearly to the top of the overflow hole. If the motor has bearings of the grease-cup type, unscrew the cup below each bearing and fill with unmedicated vaseline or good machine oil. Replace the cup, making certain that the wick presses against the shaft, then tighten the cup securely to prevent its working loose.

Motors having the grease-cup type of bearings are shipped with the reservoirs filled but the above precautions should always be taken as good lubrication is of prime importance to all electric motors. Although these bearings will run much longer under normal service conditions, replenishing the lubricant in all types of bearings once a month is strongly recommended. About once a year the reservoirs of the oil-ring type bearings should be emptied and cleaned out with gasoline or kerosene to remove any dirt or sediment from the oil.

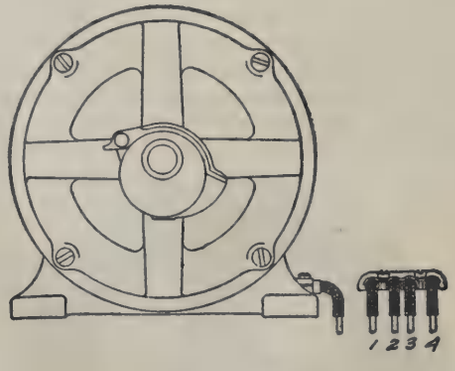
The clutch motors have a hole in the end of the shaft marked "oil." Into this hole a few drops of machine oil should be squirted about once a month.

Connections—Type CA motors can be connected to any phase of a 2-phase or 3-phase circuit of proper voltage and frequency.



FOR FRAMES 300 AND 400

Standard stock motors are shipped connected to run clockwise viewed from this end. To reverse direction of rotation interchange the two upper leads.



FOR FRAME 700

Standard stock motors are shipped connected to run clockwise viewed from this end when leads 1 and 2 are connected to one line wire and leads 3 and 4 are connected to the other line wire. To reverse, interchange leads 2 and 3.

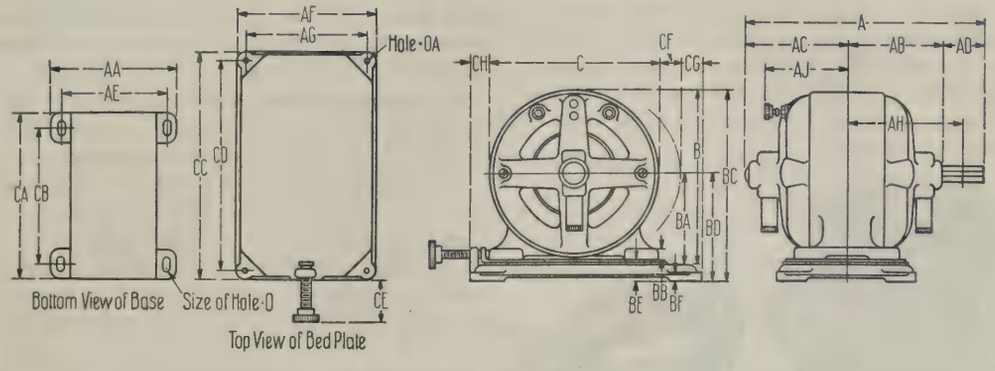
TYPE CA ALTERNATING-CURRENT MOTORS—Continued

RATINGS

Hp. 40°c Cont.	No. Poles	Rpm. At Full Load	Frame No.	Bare Motor 110 Volts *Style No.	Bare Motor 220 Volts *Style No.	Standard Paper Pulleys Style No.	Standard Paper Pulleys Dia. X Face	Special Mim. Dia. X Max Face
STANDARD STARTING DUTY WITHOUT CLUTCHES								
60 Cycle—110-220 Volts								
1/20	4	1750	343	156763	156764	174088	1⅛†	.....
1/12	4	1750	443	156767-A	156768-A	106802	1½‡	.....
40 Cycle—110-220 Volts								
¼	4	1160	645	201782-A	201783-A	174332	3x1¾	2½x2
25 Cycle—110-120 Volts								
⅛	2	1450	525	179347-A	179348-A	168154	2†	.....
¼	2	1450	625	257665	257656	175443	3x1¾	2¼x2
HEAVY STARTING DUTY WITH CLUTCHES								
60 Cycles—110-220 Volts								
½	4	1750	743	198550	198551	100443	3½x2½	2x3
40 Cycle—110-220 Volts								
¼	4	1170	645	.....	.....	174332	3x1¾	1¾x2
25 Cycle—110-220 Volts								
¼	2	1450	625	218725	218726	174332	3x1¾	2¼x2

*Style number does not include sliding base or pulleys.
†Single groove pulley for ¼-inch round belt; diameter applies to pitch circle.
‡Single groove pulley for 1/16-inch round belt; diameter applies to pitch circle.

OUTLINE DIMENSIONS



Frame No.	Shaft Dia.	Keyway Width	Keyway Depth	Keyway Length	Flat for Set Screw	A	†AA	AB	AC	AD	AE	†AF	AG	AH	AJ	*B
343	3/8	..	..	1	½	6 1/16	3½	2 5/8	2 11/16	1	2 13/16	...	...	3 1/16	2 5/8	4 3/4
443	1/16	..	..	1⅛	3/64	7 1/16	3 5/8	2 31/32	3 1/32	1⅛	2⅞	...	...	3 17/32	2⅞	5 3/8
523-543-563	1½	..	..	1¼	3/64	7⅞	3 3/4	3 9/32	3 11/32	1¼	3	5⅛	4 7/16	3 23/32	3⅛	6 3/32
525-545-565	1½	..	..	1¼	3/64	8 3/8	4⅛	3 17/32	3 19/32	1¼	3 3/8	5⅛	4 7/16	4 5/32	3⅜	6 3/32
623-643-663	5/8	3/16	3/16	1½	3/64	9 1/16	4½	3 31/32	4 3/32	1½	3 3/4	5⅞	5 3/16	4 23/32	3½	7 1/16
625-645-665	5/8	3/16	3/16	1½	3/64	10 1/16	5	4 7/32	4 11/32	1½	4¼	5⅞	5 3/16	4 23/32	3 25/32	7 1/16
723-743-763	¾	3/16	3/16	2¼	..	11 27/32	5¼	4 3/4	4 27/32	2¼	4¼	7¼	6	5⅞	....	8 13/16
725-745-765	¾	3/16	3/16	2¼	..	12 29/32	6	5⅛	5 1/16	2¼	5	7¼	6	6¼	....	8 13/16
823-843-863	⅞	3/16	3/16	2¾	..	14 13/32	6 5/8	5 3/4	5 29/32	2¾	5½	8¾	7½	7¼	....	10 13/32
825-845-865	⅞	3/16	3/16	2¾	..	15 13/32	7⅝	6¼	6 13/32	2¾	6½	8¾	7½	7¾	....	10 13/32

Frame No.	*BA	BB	*BC	*BD	BE	BF	C	†CA	CB	†CC	CD	CE	CF	CG	CH	O Width	O Length	OA
343	2 1/16	3/8	....	...	...	..	4 5/8	4 5/8	3 3/4	....	....	...	...	...	...	9/32	11/32	..
443	2 3/4	1/32	....	...	...	..	5 1/4	5 1/4	4 1/4	....	....	...	...	...	...	9/32	11/32	..
523-543-563	3 1/4	1/16	7 3/64	4 3/64	21/64	1/16	6 1/16	6	4 15/16	8½	7 13/16	1¾	1	23/32	23/32	5/16	5/16	3/32
525-545-565	3 1/4	1/16	7 3/64	4 3/64	21/64	1/16	6 1/16	6	4 15/16	8½	7 13/16	1¾	1	23/32	23/32	5/16	5/16	3/32
623-643-663	3 13/16	1/2	8 3/16	4 11/16	7/8	1/16	7	7	5 3/4	9 3/4	9 1/16	1¾	1¼	3/4	3/4	5/16	13/16	3/32
625-645-665	3 13/16	1/2	8 3/16	4 11/16	7/8	1/16	7	7	5 3/4	9 3/4	9 1/16	1¾	1¼	3/4	3/4	5/16	13/16	3/32
723-743-763	4 5/8	5/8	10 3/8	6 1/16	1 1/16	2/16	8 5/8	8½	6 3/4	13 3/4	12½	2 11/16	2	1 1/4	1 7/8	5/8	1 1/8	1/32
725-745-765	4 5/8	5/8	10 3/8	6 1/16	1 1/16	2/16	8 5/8	8½	6 3/4	13 3/4	12½	2 11/16	2	1 1/4	1 7/8	5/8	1 1/8	1/32
823-843-863	5 3/8	3/4	11 43/64	6 7/8	1½	2/16	10 1/16	9 7/8	7 3/8	15	13 3/4	2 11/16	2	1 3/32	1 27/32	7/16	1 5/16	1/32
825-845-865	5 3/8	3/4	11 43/64	6 7/8	1½	2/16	10 1/16	9 7/8	7 3/8	15	13 3/4	2 11/16	2	1 3/32	1 27/32	7/16	1 5/16	1/32

*This dimension will never be exceeded, but may vary 1/16-inch less than shown in table.
†Approximate.
Table correct at date of publication; for latest data apply to the nearest district office of this Company.

TYPE CAH ALTERNATING-CURRENT MOTORS

SINGLE-PHASE SPLASH PROOF CLUTCHLESS AND WITH CLUTCH

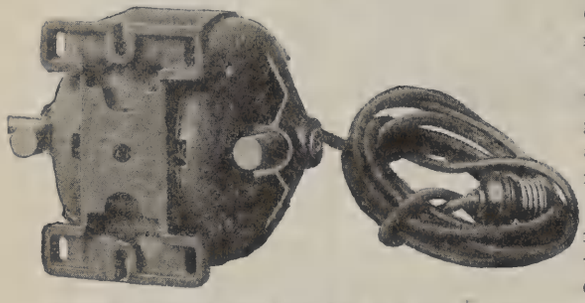
⅛ ⅙, AND ¼ H.P.

Many small-motor applications, such as washing machines, water pumps, dish washers, etc., require compact splash-proof motors with high starting and break-down torques. The type CAH motor possesses not only these desirable characteristics but many others, and can be operated from single-phase commercial lighting circuits. It is ingeniously designed and constructed so as to exclude water and small falling objects, yet it has ample ventilation through the peculiar ducts in the end brackets, making it suitable for a wide range of application.

MOTOR WITH BINDING POSTS

Construction

The frame is of cast iron cylindrical in shape, if furnished without feet, for use where it is desired to build the motor into the driven machine or use a mounting base of special characteristics. If the motors are furnished with feet they are cast solid with the frame. The feet have holes in them, slotted for adjustment of belt tension, for either two or four-point mounting.



BOTTOM OF MOTOR WITH CORD AND PLUG SHOWING THE SLOTTED FEET AND THE VENTILATING DUCTS

Within the frame are mounted the primary core punchings and the two primary windings the same as in the type CA motor.

The **rotor** is very similar in construction to the type CA motor. The type CAH therefore possesses the advantages resulting from the use of the disc clutch and the new starting switch.

The **bearing brackets** are cast separate from the frame, permitting them to be turned 90 or 180 degrees for either wall or ceiling mounting. Motors will be furnished, however, arranged for floor mounting unless otherwise specified on order. When necessary to turn the brackets after shipment, see directions on instruction tag attached to each motor. The bracket construction is one of the specially desirable features of the type CAH motor. Apertures in the lower part of the brackets allow a good circulation of air to keep the motor cool and yet protecting flanges prevent anything from falling into the motor. With such brackets the motor is essentially enclosed thus excluding dripping water and safeguarding the operator or children who may handle the motor.

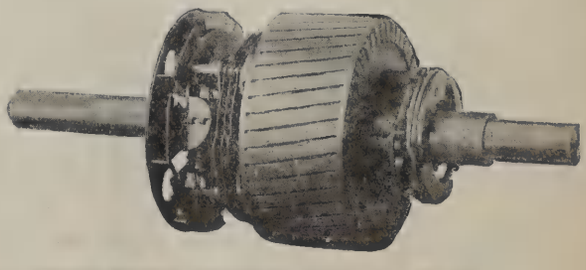
The **bearings** are large bronze bushings pressed into the housings which form part of the brackets. The use of high grade material and the unusual size of the bearings reduces the wear and attention requried to a minimum and insures long life.

Lubrication of type CAH motors is by means of wick-fed grease cups filled with vaseline or a good grade of machine oil. These grease cups are large and require refilling less often than is the case with most small motors.

Interchangeability—When required, direct-current motors, type CD or CDH can be furnished which have the same mounting dimensions as type CAH motors, making it possible for the user to provide one mounting for either direct or alternating-current motors whether the motors are direct connected, geared or belted.

Accessories

The **pulley** furnished with type CAH motors is a single groove iron pulley with a 2-inch diameter of pitch circle for a $\frac{5}{16}$-inch round belt.



ROTOR, SHOWING CLUTCH AND VENTILATING PLATE ON LEFT END

Sliding bases with belt tightening device can be supplied where frequent adjustment of belt tension is necessary.

Performance Guarantees

The temperature rise of all parts, when operating under normal rated conditions as specified on the name plate and at 100 per cent load, will not exceed 50 degrees Centigrade.

ROTOR SHOWING CENTRIFUGAL OPERATING RING AND VENTILATING PLATE

The starting torque of the clutchless motors is 1½ times full load torque and the break-down, or maximum torque, is 2 times full load torque.

The starting torque and break-down torque of the clutch motors are 2 times full load torque.

As these motors are designed for use where heavy torques are required there is a liberal allowance in design above the guaranteed torques.

Type CAH motors will operate successfully with normal rated current and frequency at any voltage not more than 10 per cent above or below normal, but not necessarily in accordance with the standards of performance established for operation at normal rating.

Care and Operation

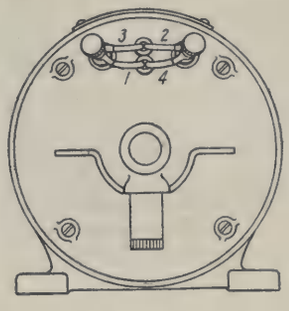
Note the nameplate reading to see that it agrees with the circuit to which the motor is to be connected.

Lubrication—Unscrew the cup below each bearing and fill with unmedicated vaseline or good machine oil. Replace the cup, making certain that the wick presses against the shaft, then tighten the cup securely to prevent its working loose. Although these bearings will run much longer under normal service conditions, replenishing the lubricant once a month is strongly recommended.

Connections—Type CAH motors can be connected to any phase of a 2-phase or 3-phase circuit of proper voltage and frequency. Standard stock motors with binding posts, as shown are shipped connected to run clockwise viewed from this end. The direction of rotation may be reversed by interchanging the two upper leads.

To Arrange for Ceiling Mounting—First, remove both brackets. Second, turn the brackets through 180 degrees so that the oil cups will be directly below the bearings when the motor is mounted on the ceiling. In making this change the leads should be rearranged so that they will not interfere with the starting switch or the rotor. If necessary the part of the starting switch mounted on the bracket may be removed and replaced 180° from its original position. Third, replace both brackets, making sure that the leads to the front brackets are neatly arranged to avoid interference with any of the moving parts, and so that they will not block the ventilating openings behind the stator punchings.

Note Carefully—Make sure the leads do not interfere with the rotating element by turning the rotor by hand before connecting the motor to the supply circuit. When replacing the bracket see that they are firmly seated in their fits in the frame before tightening the screw nuts which hold them



WITH BINDING POSTS

in place, and then tighten the two nuts on opposite ends of each stud uniformly so that the laminations will not be pulled out of place in the frame. After the motor is reassembled and running free the rotor should float between the two bearings.

A SMOKING RAG SHOWS THE COOL AIR CURRENTS THROUGH THE MOTOR

TYPE CAH ALTERNATING-CURRENT MOTORS—Continued

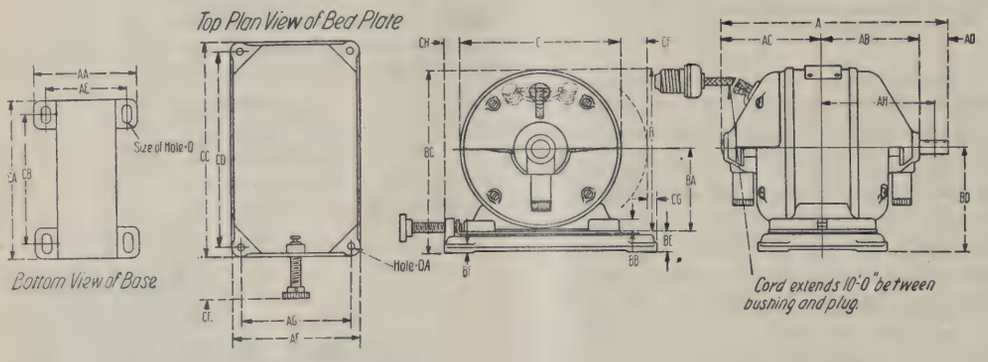
RATINGS

Single Phase

Hp.	Rpm.	Frame No.	Clutch	Rotation‡	STYLE NO. 110 Volts Cord and Plug	110 Volts Binding Post	220 Volts Cord and Plug	220 Volts Binding Post
60 Cycle 110-220 Volts								
1/4	1750	445	No	C	277215	277211	277217	277712
1/6	1750	543	No	C	245225	245209	245227	245210
1/6	1750	543	Yes	C	245233	245213	245235	245214
1/4	1750	545	No	C	245241	245217	245243	245218
1/4	1750	545	Yes	C	245249	245221	245251	245222

‡Viewed from end opposite pulley.

OUTLINE DIMENSIONS



Frame No.	Shaft Dia.	Flat For Set Screw Depth	Flat For Set Screw Length	A	†AA	AB	AC	AD	•AE	†AF	AG	AH	*B	*BA	BB	*BC
425–445	1/2	3/64	1 1/8	8 3/16	3 5/8	3 1/2	3 9/16	1 1/8	2 7/8	5 1/8	4 7/16	4 1/16	5 11/16	2 7/8	15/32	6 31/64
523–543	1/2	3/64	1 1/8	8 3/16	4 1/8	3 11/16	3 3/4	1 1/8	3 7/16	5 1/8	4 7/16	4 1/4	6 15/32	3 11/32	7/16	7 31/64
525–545	1/2	3/64	1 1/8	8 15/16	4 1/8	3 7/8	3 13/16	1 1/8	3 7/16	5 1/8	4 7/16	4 7/16	6 11/32	3 11/32	7/16	7 31/64

Frame No.	*BD	BE	BF	C	†CA	CB	†CC	CD	CE	CF	CG	CH	O Width	O Length	OA
425–445	3 43/64	1 7/32	5/16	5 5/8	5 5/8	4 9/16	8 1/2	7 13/16	1 3/4	7/8	1	1	5/16	5/8	9/32
523–543	4 9/64	1 7/32	5/16	6 3/8	6 1/8	4 13/16	8 1/2	7 13/16	1 3/4	1	9/16	9/16	5/16	5/8	9/32
525–545	4 9/64	1 7/32	5/16	6 3/8	6 1/8	4 13/16	8 1/2	7 13/16	1 3/4	1	9/16	9/16	5/16	5/8	9/32

*This dimension will never be exceeded. When exact dimension is required liners up to 1/16-inch may be necessary.
†Approximate.
Table correct at date of publication; for latest data apply to nearest district office of this Company.

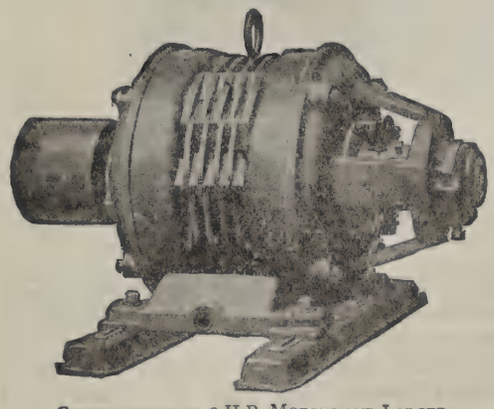
TYPE AR ALTERNATING-CURRENT MOTORS

SINGLE-PHASE

CONSTANT SPEED

REPULSION-INDUCTION

½ TO 10 H.P.



CONSTRUCTION OF 2-H.P. MOTORS AND LARGER

CONSTRUCTION OF MOTORS FROM ½-H.P., 6-POLE, TO 1½-H.P., INCLUSIVE

Westinghouse type AR motors fulfill the demand for simple, reliable single-phase motors having high starting torque or turning effort with low starting current for such applications as rotary blowers, compressors, pumps, etc. They are automatically self-starting and require no starting device except a double-pole switch or circuit-breaker. A starting rheostat can be supplied, however, where especially low starting current is desired, although the starting torque is reduced proportionally.

The efficiency and power factor of these motors are high at full loads and the overload capacity is ample.

Construction

The frames of all type AR motors of 1½ horsepower and smaller are cylindrical iron castings made in one piece with the feet which have slots for holding-down bolts and for adjusting belt tension. Within the frames are the primary core punchings in which the single primary winding is wound.

Type AR motors of 2 horsepower and larger have frames built up of steel laminations similar to the standard type CS motor construction in the same sizes. The punchings are riveted together under pressure between pressed-steel end plates and mounted on pressed-steel feet riveted to the end plates. This construction combines great strength with light weight and compactness. The single primary winding thoroughly insulated is inserted in the slots in the assembled primary core.

STATOR

Secondary—On motors up to and including 1½ horsepower, the secondary laminations are bolted together, and the core thus formed is pressed on a knurled shaft. On motors above 1½ horsepower the secondary laminations with spacers for ventilating ducts are riveted between end plates and the unit thus formed is keyed to the shaft.

SHORT-CIRCUITING SLEEVE AND CENTRIFUGAL SHORT-CIRCUITER

The laminations have partly closed slots. In the larger motors strap copper coils are placed in these slots and secured by means of fibre wedges and band wires. In the smaller motors copper wire coils are threaded into these slots and held in place by fibre wedges.

The commutator of the ½ horsepower, four-pole motor is of the ordinary axial type. All other motors have radial commutators fastened to a cylindrical support which is bolted to the rotor core.

The shaft is made of axle steel and is accurately ground to dimensions.

Short-Circuiter—The mechanism which short-circuits the rotor windings and releases the brushes

TYPE AR ALTERNATING-CURRENT MOTORS—Continued

is located inside the rotor at the commutator end. It consists of a sleeve, centrifugal weights and a spring—the whole being retained in place by a nut on the shaft (see diagram). The sleeve carries a short-circuiting coil which consists of a helical phosphor-bronze spring inside of which is a ring of flexible copper shunts.

The short-circuiter rests against the end of the rotor core and is kept in place by dowels. The short-circuiting sleeve is pressed against the short-circuiter by the spring.

When the motor is at rest, the short-circuiting sleeve is pressed back into the rotor by the spring. When the motor speeds up, centrifugal force causes

INTERIOR OF FRONT BEARING BRACKET

the weights to move outward, and the sleeve is forced forward. At nearly full speed, the short-circuiting coil is forced under the ends of the commutator bars and into very close contact with them, thus completely short-circuiting them. At the same time the end sleeve relieves the spring tension on the brushes, and being free to move away from the commutator they are pushed back by the end-play of the rotor. This action takes place on all except the ½ horsepower, 4-pole motor, in which the brushes remain in contact with the commutator when the short-circuiting coil is forced under the ends of the commutator bars.

The **bearing brackets** are strong and rigid and can be bolted to the frames for floor, wall, or ceiling mountings, but standard motors will be furnished arranged for floor mounting only. Cast with the brackets are the bearing housings and oil wells.

The **bearings** of the smaller motors are bronze bushings, pressed into the housings and pinned in

ROTOR AND BRUSHHOLDER

ROCKER RING AND BRUSHES

place. The bearings of larger motors are babbitt-lined sleeves. On small motors metal rings on both the commutator and pulley ends, and on large motors a brass cap on the commutator end and felt washers between metal rings on the pulley end render the bearings dust-proof.

Brushes—The carbon brushes are pressed against the commutator by steel or bronze springs. With the exception of the smallest motor the spring tension is removed and the brushes leave the commutator when the motor attains full speed. The brushholders are carried by a rocker ring which is mounted on a machined seat on the front bearing

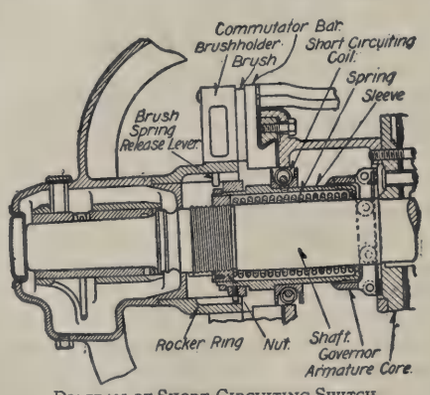
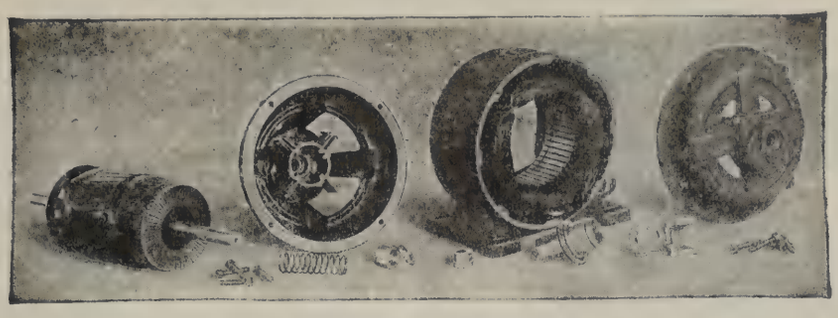


DIAGRAM OF SHORT-CIRCUITING SWITCH

housing. The position of this ring determines the direction of rotation of the motor. Standard motors are shipped arranged for clockwise rotation viewed from end opposite the pulley.

The **terminals** of the type AR motors are brought out to terminal blocks on the side of the motors. The connections are so arranged that the motors can be connected to circuits of either 110 or 220 volts by following instructions on the tag accompanying the motor.

TYPE AR ALTERNATING-CURRENT MOTORS—Continued



1 H.P. TYPE AR MOTOR DISASSEMBLED

Lubrication—Oil-ring lubrication is used and the oil wells are provided with an overflow gauge. a drain plug, except on smallest size, and a covered opening for filling the well and inspecting the oil-ring.

Finish—Motors built on 167 frame and smaller are finished in glossy black; larger motors in dull gray black.

Accessories

The **rheostats** used with type AR motors when especially low starting current is desired are of the face-plate type with low-voltage release. The resistors are mounted on the rear of the faceplate so that the whole device is self-contained. Each

SLIDE RAIL
(Slide Rails are furnished with Frames Nos. 460, 540 and 550).

rheostat has a device for disrupting the arcs formed when the circuit is opened.

Paper **pulleys** can be furnished for all type AR motors.

Slide rails, as shown above, can be furnished for motors on the 400 frames and larger. For smaller motors sliding bases provided with screws for adjusting belt tension can be supplied.

Performance Guarantees

The temperature rise of all parts, when operating under normal rated conditions as specified on the nameplate and at 100 per cent rated load, will not exceed 40 degrees Centigrade.

Motors having a capacity of 1 horsepower or larger will operate under normal rated conditions and at 125 per cent rated load for a period of 2 hours with a temperature rise not exceeding 55 degrees Centigrade. Motors in this class will also carry 150 per cent rated load momentarily.

The starting torque of the type AR motor will be from 2 to 4 times full load torque, the pull-in torque will be from 1 to 1½ times full load torque and the break-down, or maximum, torque will be from 1¾ to 2 times full load torque.

Type AR motors will operate successfully with normal rated current and frequency at any voltage less than 10% above or below normal.

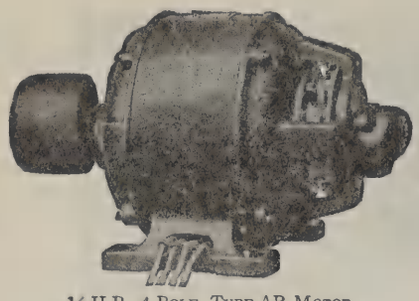
If the frequency does not vary more than 2 or 3 per cent from normal it will not be necessary to adjust the short-circuiter spring. Variations in frequency greater than this will require readjustment of short-circuiter. If a motor is run at other than normal frequency the combined voltage and frequency variation must not exceed 10 per cent; for example: If the frequency is 10 per cent below normal the voltage must not exceed normal, but if the frequency is but 5 per cent below normal it will be permissible to operate on a voltage 5 per cent above normal.

Care and Operation

The rotor of this motor has a commutator and is wound similarly to a direct-current armature. While starting, the rotor windings are connected by short-circuited brushes which are pressed against the commutator and the motor is accelerated as a repulsion motor. At nearly full speed, the rotor coils themselves are automatically short-circuited, and in motors built on the 143 frame and above, the brush pressure is relieved so as to allow the brushes to leave the commutator. The motor then operates similar to an induction motor with squirrel-cage rotor and, therefore, has constant-speed characteristics.

The nameplate reading should agree with the circuit to which the motor is to be connected and see that the shaft and oil rings turn freely and also that all the brushes are bearing evenly upon the commutator.

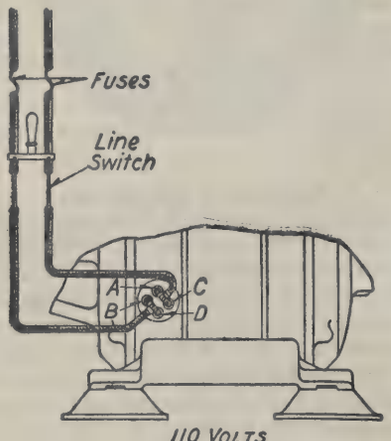
STARTING RHEOSTAT



½-H.P., 4-Pole, Type AR Motor

This Company will assume no responsibility for the operation of the type AR outside the limitations given. Low voltage will reduce both starting and maximum torque in proportion to the square of the reduction in voltage, and, therefore, should be guarded against.

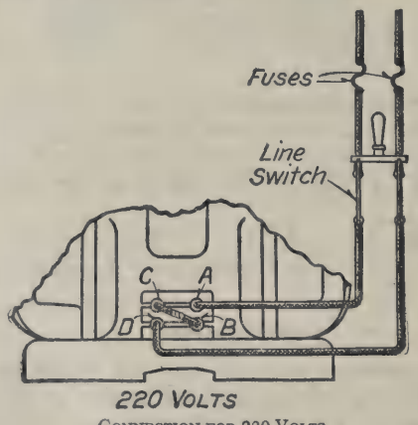
Lubrication—Before starting the motor fill the oil reservoirs with best quality clean dynamo oil until the oil level is within a short distance of the top of the overflow hole. The oil should be withdrawn occasionally and fresh oil substituted, the intervals depending upon the class of service and the surrounding conditions. The old oil can be filtered and used again.



Connection for 110 Volts
Class 300 Frame and Larger

Voltages and Connections—This motor can be connected for operation on circuits of either of the voltages shown on the nameplate. The parallel connection is for the lower voltage and the series connections is for the higher voltage. The motor should be connected directly to the line through a circuit-breaker or a line switch and fuses. To start or stop the motor simply close or open the circuit-breaker or line switch.

If the motor does not come to full speed and continues to spark at the brushes, the motor is overloaded. If this happens the load must be lightened or a larger motor used.



Connection for 220 Volts
Class 300 Frame and Larger

Short-Circuiter—This motor is provided with an automatic governor which operates at a speed slightly below full load, short-circuiting the rotor winding and removing the spring tension on the brushes except on motors of ½ horsepower, 1750 r.p.m. and smaller, in which case the brush tension is not removed.

The adjusting nut for the governor spring is around the shaft on the commutator end and is accessible upon removal of the commutator end bracket. Tightening this nut will increase the spring tension causing the governor to operate at a higher speed, which will probably be necessary for frequencies above normal. Loosening the nut will have the reverse effect and will be required for frequencies below normal.

To Reverse Direction of Rotation—The direction of rotation is determined by the position of the brushes.

On the larger motors the direction of rotation is

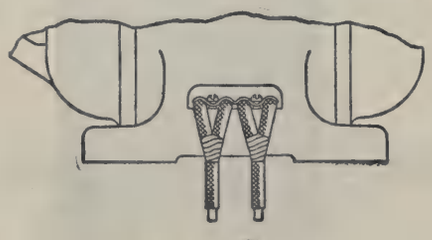


Fig. 1

110-Volt Connection
Class 100 Frame and Smaller

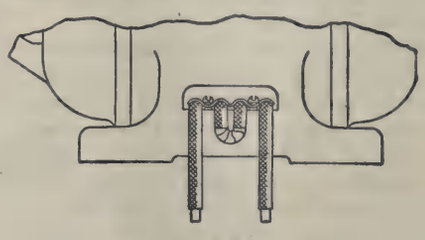


Fig. 2

320-Volt Connection
Class 100 Frame aud Smaller

TYPE AR ALTERNATING-CURRENT MOTORS—Continued

indicated by a scale in the rocker ring and a pointer on the front bearing bracket. The scale consists of three lines marked RR, N, and RL, respectively. When the rocker ring is turned so that the pointer is opposite RR, the motor will run in a right-hand or clockwise direction (facing the commutator); and when the pointer is opposite RL, the rotation will be left-hand or counter-clockwise. N is the neutral point; the armature will not turn if the pointer is opposite this line.

On the smaller motors the direction of rotation is indicated by two chisel marks on the bearing bracket and one on the rocker ring. The motor will rotate in the direction in which the rocker ring is displaced from the neutral point, which is midway between the two lines on the rocker ring.

To reverse the motor, therefore, loosen the rocker ring set-screw and turn the ring until the pointer or chisel mark is opposite the line for the reverse direction of rotation.

To Renew Brushes—To remove the brushes from the holder, turn the rocker ring so that the brushes are brought between the arms of the bearing bracket, and loosen the screws of the clips that hold the brushes in place. The brushes of the ½ horsepower, 4-pole motor can be removed by simply lifting the springs and removing the screws that fasten the shunt to the rocker-ring. After inserting new brushes, turn the rocker-ring so that the pointer or the chisel mark is opposite the line for the proper direction of rotation.

For Wall or Ceiling Mounting—Turn the brackets through 90 degrees or 180 degrees to keep the oil reservoirs directly below the bearings. For 4-pole motors, that is, motors having the brushes spaced 90 degrees apart, no other change will be necessary. For 2-pole motors which have the brushes diametrically opposite, no change in the brush position will be necessary for ceiling mounting, but for wall mounting it will be necessary to shift the rocker ring 90 degrees from its original position so that the brushes will be in the same relative position to the stator winding as when the motor was mounted on the floor. For 6-pole motors which have the brushes spaced 60 degrees apart no change of brush position will be necessary for ceiling mounting, but for wall mounting the rocker ring must be shifted 30 degrees from the original position in order to put brushes in the same relative position to the stator winding as when mounted on the floor.

RATINGS AND APPROXIMATE WEIGHTS

H.P.	No. Poles	Full Load R.P.M.	Frame No.	Standard*† Pulley Dia. x Face Inches	Special † Pulley Min. Dia. X Max. Face Inches	Approx. Shipping Weight in Lbs. Motor With Pulley	Add for Sliding Base	Add for Rheostat
				60 Cycles				
½	4	1750	065	3½x2½	2 x 3	85	20‡	..
½	6	1160	173	3½x2½	2¼x 3	130	20‡	..
¾	4	1750	144	3½x2½	2¼x 3	135	20‡	..
¾	6	1160	165	3½x2½	2½x 3	145	20‡	..
1	4	1750	145	3½x2½	2½x 3	145	20‡	35
1	6	1160	167	3½x3	2¾x 3	160	20‡	35
1½	4	1750	147	3½x3	2¾x 3	160	20	35
2	4	1750	326	4 x3	3 x 6½	240	25	35
2	6	1160	330	4 x4	3 x 6½	285	25	35
3	4	1750	330	4 x4	3 x 6½	285	25	35
3	6	1160	460	5 x4½	4 x10	475	35**	35
5	4	1750	460	5 x4½	4 x10	475	35**	35
5	6	1160	555	7 x6	4 x10	655	50**	35
7½	4	1750	555	7 x6	4 x10	655	50**	40
7½	6	1160	555	7 x6	4 x10	655	50**	40
10	4	1750	555	7 x6	4 x10	655	50**	50
10	6	1160	575	7 x6	6 x10	775	50**	50
				50 Cycles				
½	4	1460	065	3½x2½	2 x 3	80	25	..
½	6	970	163	3½x2½	2¼x 3	140	25	..
¾	4	1460	143	3½x2½	2¼x 3	130	25	..
¾	6	970	165	3½x2½	2½x 3	150	25	25
1	4	1460	145	3½x2½	2½x 3	140	25	35
				40 Cycles				
½	6	1170	163	3½x2½	2¼x 3	140	25	..
1	4	1170	167	3½x3	2¾x 3	155	25	35
2	6	1170	330	4 x4	3 x 6½	280	30	35
				25 Cycles				
½	2	1450	143	3½x2½	2¼x 3	130	25	..
¾	2	1450	145	3½x2½	2½x 3	140	25	..
1	2	1450	127	3½x3	2¾x 3	155	25	35
2	2	1450	330	4 x4	3 x 6½	280	30	35

We will not, under any circumstances, guarantee motors if operated with pulleys of dimensions smaller than those listed above

*Dimensions specified are in inches and refer to diameter and face respectively.

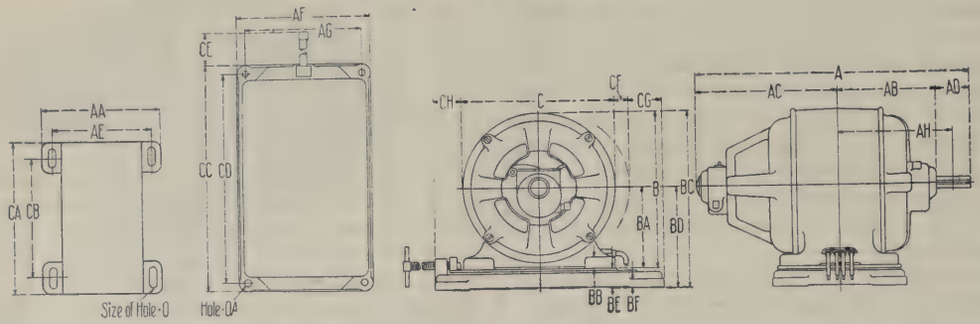
†Pulleys require special offset hub in most cases. Pulleys of wider face require special shaft extension.

‡Motors in frames 167 and smaller have feet slotted for belt adjustment so the sliding bases can be omitted.

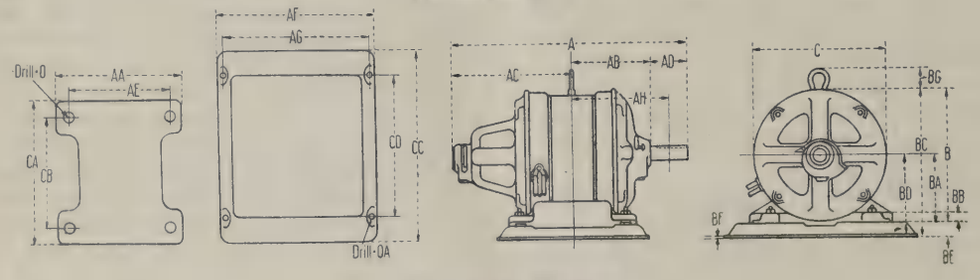
**Frames 400, 555 and 575 are provided with rails instead of sliding bases.

SMALL TYPE AR ALTERNATING-CURRENT MOTORS—Continued

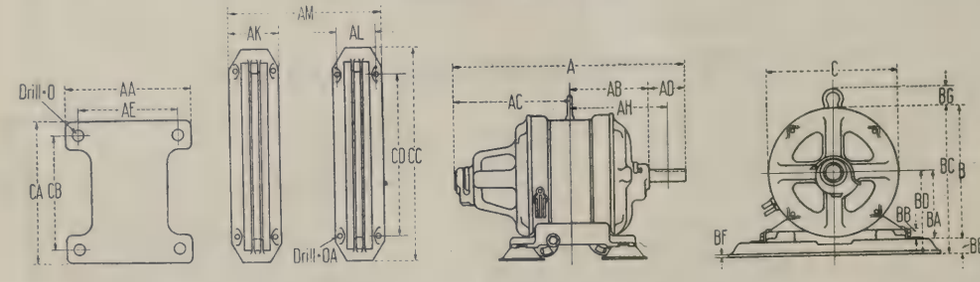
OUTLINE DIMENSIONS



Frames 065 to 167



Frames 320 to 350



Frames 460 to 550

Frame No.	Shaft Dia.	Keyway Width	Keyway Depth	Keyway Length	A	†AA	AB	AC	AD	AE	†AF	AG	AH	AK	AL	AM	*B
065	3/4	3/16	3/32	2 1/4	14 3/8	6	5 1/4	7	2 1/4	5	7 1/4	6	6 1/4	...	...	...	8 13/16
143–163	3/4	3/16	3/32	2 1/4	17 1/16	6 5/8	5 7/8	8 13/16	2 1/4	5 1/2	8 3/4	7 1/2	7	...	...	...	10 13/32
145–165	3/4	3/16	3/32	2 1/4	18 1/16	7 5/8	6 3/8	9 1/16	2 1/4	6 1/2	8 3/4	7 1/2	7 1/2	...	...	...	10 13/32
127–147–167	7/8	3/16	3/32	2 3/4	19 1/16	7 5/8	6 3/4	9 13/16	2 3/4	6 1/2	8 3/4	7 1/2	8 1/8	...	...	...	10 13/32
326	1 1/4	5/16	1/4	2 7/16	22 13/16	12	7 3/4	11 13/16	3 1/2	9 1/2	14 3/4	13 3/4	9 1/2	...	...	...	14 5/16
330	1 1/4	5/16	1/4	2 7/16	24 3/16	12	8 3/8	12 5/16	3 1/2	9 1/2	14 3/4	13 3/4	10 1/8	...	...	...	14 5/16
350	1 1/4	5/16	1/4	2 7/16	24 3/16	12	8 3/8	12 1/2	3 1/2	9 1/2	14 3/4	13 3/4	10 5/16	...	...	...	14 5/16
460	1 5/8	3/8	1/4	4 13/16	32 1/4	13 5/8	11 7/8	14 11/16	5 11/16	11 1/4	....	....	14 3/4	5 3/8	4 1/16	16 5/8	17 5/8
555	1 7/8	7/16	5/16	4 7/8	35 7/8	15	13 5/16	16 1/8	6 5/16	12 1/2	....	....	16 21/32	6 1/4	4 3/4	18 3/4	21 1/8
575	1 7/8	7/16	5/16	4 7/8	37 7/8	17	14 5/16	17 1/8	6 5/16	14 1/2	....	....	16 21/32	6 1/4	4 3/4	20 3/4	21 1/8

Frame No.	*BA	BB	*BC	*BD	BE	BF	BG	C	†CA	CB	†CC	CD	CE	CF	CG	CH	O Width	O Length	OA
065	4 5/8	3/4	10 1/4	5 5/16	1 5/16	5/16	...	8 5/8	8 1/2	6 3/4	13 3/4	12 1/2	2 11/16	2	5/16	2 5/16	3/8	1 1/8	13/32
143–163	5 3/8	3/4	11 11/16	6 1/16	1 1/16	5/16	...	10 1/16	9 7/8	7 7/8	15	13 3/4	2 11/16	2	5/16	2 5/16	1/16	1 1/16	13/32
145–165	5 3/8	3/4	11 11/16	6 1/16	1 1/16	5/16	...	10 1/16	9 7/8	7 7/8	15	13 3/4	2 11/16	2	5/16	2 5/16	1/16	1 1/16	13/32
127–147–167	5 3/8	3/4	11 11/16	6 1/16	1 1/16	5/16	...	10 1/16	9 7/8	7 7/8	15	13 3/4	2 11/16	2	5/16	2 5/16	1/16	1 1/16	13/32
326	7 3/8	1 1/4	15 5/8	8 11/16	1 1/16	5/16	1 3/4	13 7/8	15	10 7/8	20	14 3/4	...	..	...	...	3/4	...	9/16
330	7 3/8	1 1/4	15 5/8	8 11/16	1 1/16	5/16	1 3/4	13 7/8	15	10 7/8	20	14 3/4	...	..	...	...	3/4	...	9/16
350	7 3/8	1 1/4	15 5/8	8 11/16	1 1/16	5/16	1 3/4	13 7/8	15	10 7/8	20	14 3/4	...	..	...	...	3/4	...	9/16
460	9	1 1/2	19 1/16	10 1/16	1 7/16	1/4	1 7/16	17 1/4	18 1/8	13 3/4	26	20	...	..	...	...	3/4	...	3/4
555	10 3/4	1 5/8	22 3/4	12 5/8	1 5/8	5/16	1 9/16	20 3/4	20 1/4	15 3/4	31 1/4	24	...	..	...	...	7/8	...	7/8
575	10 3/4	1 5/8	22 3/4	12 5/8	1 5/8	5/16	1 9/16	20 3/4	20 1/4	15 3/8	31 1/4	24	...	..	...	...	7/8	...	7/8

*This dimension will never be exceeded. When exact dimension is required liners up to 1/16-inch may be necessary.
†Approximate.
Table correct at date of publication; for latest data apply to nearest district office of this Company.

TYPE CSA ALTERNATING-CURRENT MOTORS

SQUIRREL-CAGE CONSTANT SPEED POLYPHASE

CONTINUOUS SERVICE ¼ TO 2 H.P.

TYPE CSA MOTOR, FRAMES 700 AND 800

Westinghouse type CSA squirrel-cage alternating-current polyphase small motors supplement the standard line of type CS motors, thus forming a complete line of polyphase squirrel-cage motors ranging from ¼ to 650 horsepower. These motors have been developed after years of experience in motor design and a careful study of the conditions under which small motors are called upon to operate in the many varied industries where they are employed.

Type CSA motors are suitable for continuous-duty, constant-speed service and are applicable for driving small machines in nearly every industry. They are simple, light in weight, very compact, and extremely clean and quiet in operation and have high power factor and efficiency.

Repairs, when necessary, can be made quickly, as all parts are standard and are carried in stock, permitting quick shipment to be made.

Construction

The frame is a strong cylindrical iron casting with the feet cast integral. The feet are slotted for holding down bolts and belt adjustment. The core is built up of steel punchings riveted together and then pressed into the frame and securely fastened. The primary windings, composed of individual coils, are placed in the partially closed slots of the core.

ROTOR OF TYPE CSA MOTOR

The **rotor** is of the squirrel-cage type. Copper bars pass through the slots, through holes in the short-circuiting rings, and are then riveted over and soldered. The core and windings are pressed on an axle-steel shaft

The **primary core** is built up of steel punchings riveted together and then pressed into the frame and securely fastened.

The **primary winding** is composed of individual coils placed in the partially closed slots of the core.

The coils are carefully insulated from the core and separated from each other on the ends by layers of insulating material. After winding and connecting, the wound stator is thoroughly dried and dipped in a high-grade insulating compound, after which it is carefully baked in a specially constructed oven.

A ventilating plate mounted on the rotor forces air through the motor, cooling the cores and windings and preventing localized heating.

The bearing brackets of classes 700 and 800 motors are cast separate from and bolted to the frame, thus permitting ready removal of the rotor from either end. In the smallest size, class 643, this feature is not essential as the rotor is much smaller, consequently one bracket is cast integral with the frame. This construction permits a more compact design and minimum weight.

STATOR OF THE TYPE CSA MOTOR FRAMES 700 AND 800

The **bearings** are bronze sleeves pressed into the housings and secured by means of pins. They are practically dust proof, cannot drip oil, and will stand years of service without renewal.

Terminals—Leads are brought out through the lower part of frames 700 and 800 and secured by means of cleats. The leads of frame 643 are brought out through insulated bushings in the motor bracket.

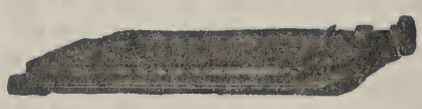
Lubrication—On the smallest size, which finds extensive use on portable machines, grease cups are used. This construction permits the motor to be

tilted or momentarily inverted without danger of spilling the lubricant. The larger motors, since they are usually mounted permanently in one position, are fitted with oil-ring lubrication.

Accessories

Starter—No starting device other than a fused knife switch is required since liberal starting torque with minimum starting current enables these motors to be connected directly to the line.

Paper pulleys are standard.



SLIDING BASE

Sliding bases with belt tightening device can be supplied for type CSA motors where frequent adjustment of belt tension is necessary.

Performance Guarantees

The temperature rise of all parts, when operating under normal rated condition as specified on the nameplate and at 100 per cent rated load, will not exceed 40 degrees Centigrade.

Motors having a capacity of 1 horsepower, 1750 r.p.m. or larger will operate under normal rated conditions and at 125 per cent rated load for a period of 2 hours with a temperature rise not exceeding 55 degrees Centigrade. Motors in this class will also carry 150 per cent rated load momentarily.

The starting torque with rated voltage will be approximately 1½ times full load torque, and the break-down or maximum torque will be approximately 2 times full load torque.

Type CSA motors will operate successfully at normal rated load and frequency at any voltage not more than 10 per cent above or below normal, but not necessarily in accordance with the standards of performances established for operation at normal rating.

Care and Operation

Note nameplate reading to see that it agrees with circuit to which the motor is to be connected.

Lubrication—If the motor has bearings of the oil-ring type, fill each reservoir with a good grade of dynamo or machine oil until the oil level rises nearly to the top of the overflow hole. If the motor has bearings of the grease-cup type, unscrew the cup below each bearing and fill with unmedicated vaseline or good machine oil. Replace the cup, making certain that the wick presses against the shaft, then tighten the cup securely to prevent its working loose.

Motors having the cup type of lubrication are shipped with the reservoirs filled, but the above precautions should always be taken as good lubrication is of prime importance to all electric motors. Although these bearings will run much longer under normal service conditions, replenishing the lubricant in all types of bearings once a month is strongly recommended. About once a year the reservoirs of the oil-ring type bearings should be emptied and cleaned out with gasoline or kerosene to remove any dirt or sediment from the oil.

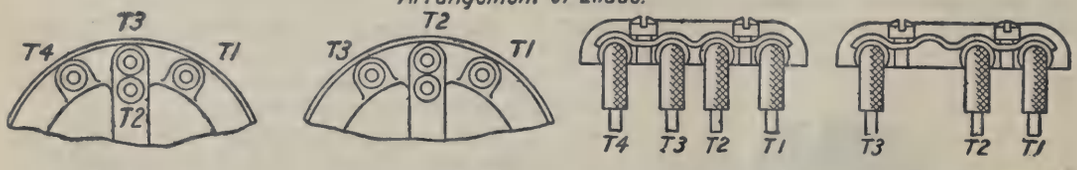
Connections—If the circuit is 2-phase, 4-wire, connect leads from one phase to motor terminals T1 and T3, and leads from other phase to terminals T2 and T4. If the circuit is 2 phase, 3-wire, connect outside leads to terminals T1 and T2, and middle lead to T3 and T4. If circuit is 3-phase connect any lead to any terminal. To obtain proper direction of rotation see instructions below.

Reversing Motor—To reverse a two-phase, four-wire motor, the two leads of one phase should be interchanged, T1 and T3 or T2 and T4. To reverse a two-phase, three-wire motor, the two outside leads should be interchanged. To reverse a three-phase motor, any two leads may be interchanged. These changes and connections may be made at the terminal of the motor or by a double-pole, double-throw switch conveniently located.

For Wall or Ceiling Mounting—Remove bracket screws and turn brackets through 90 or 180 degrees to keep the oil reservoirs directly below the journals.

NOTE—Motors on class 600 frame cannot be mounted on wall or ceiling.

Arrangement of Leads.



Small 2 Phase *Small 3 Phase* *Large 2 Phase* *Large 3 Phase*

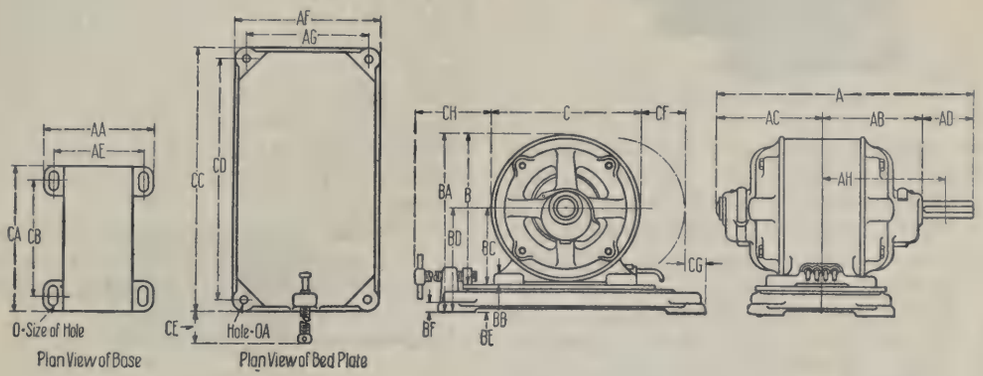
TYPE CSA ALTERNATING-CURRENT MOTORS—Continued

RATINGS

60 Cycle, 110-220-440-550 Volts§

Hp.	Approx. Rpm. at Full Load	Poles	Frame No.	Paper Pulleys†† Standard Dia. x Face	Paper Pulleys†† Special ‡‡ Dia. ■ Face	Hp.	Approx. Rpm. at Full Load	Poles	Frame No.	Paper Pulleys†† Standard Dia. x Face	Paper Pulleys†† Special‡‡ Dia. ■ Face
¼	1750	4	643	3 x1¾	1¾x2	1	1750	4	745	3½x2½	3 x3¼
½	1750	4	743	3½x2½	2¼x3½	1	1160	6	863	3½x3	3 x4
½	1160	6	763	3½x2½	2½x3¼	1½	1750	4•	843	3½x3	3 x4
¾	1750	4	743	3½x2½	2½x3¼	1½	1160	6	866	4 x3¾	2¾x4½
¾	1160	6	765	3½x2½	3 x3¼	2	1750	4	846	4 x3¾	2¾x4½
25 Cycle, 110-220-440-550 Volts											
½	1450	2	725	3½x2½	2¼x3¼	1	1450	2	825	3½x3	2¼x4
½	715	4	843	3½x3	2¼x4	1	715	4	846	4 x3¾	2¾x4½

OUTLINE DIMENSIONS



Frame No.	Keyway Length	Keyway Depth	Keyway Width	Shaft Dia.	A	AA ‡	AB	AC	AD	AE	AF	AG	AH	†B	†BA	BB	†BC
623*–643*–663*	1½	3/16	3/16	5/8	9 9/16	4 1/16	3 11/32	4 3/32	1½	3¾	5⅞	5 1/16	4 23/32	7 5/16	8 3/16	1/2	3 11/16
723–743–763	2¼	3/16	3/16	3/4	11 17/32	5¼	4 3/32	4 27/32	2¼	4¼	7¼	6	5 7/8	8 13/16	10 3/16	5/8	4 5/16
725–745–765	2¼	3/16	3/16	3/4	12 3/32	6	5 1/16	5 7/32	2¼	5	7¼	6	6¼	8 13/16	10 3/8	5/8	4 5/8
823–843–863	2¾	3/16	3/16	7/8	14 3/32	6 5/8	5 3/4	5 23/32	2¾	5½	8¾	7½	7¼	10 3/32	11 29/32	3/4	5 3/8
825–845–865	2¾	3/16	3/16	7/8	15 3/32	7 5/8	6 1/4	6 23/32	2¾	6½	8¾	7½	7¾	10 3/32	11 29/32	3/4	5 3/8
827	3 11/16	3/16	1/4	1 1/16	18 1/16	7 5/8	7 1/16	7 1/16	3 11/16	6½	10	8½	9 3/8	10 3/32	12 11/32	3/4	5 3/8
846–866	3 11/16	3/16	1/4	1 1/16	17 11/16	7 5/8	6 11/16	7 1/16	3 11/16	6½	10	8½	9	10 3/32	12 11/32	3/4	5 3/8

Frame No.	†BD	BE	BF	C	‡CA	CB	CC	CD	CE	CF **	CG	CH	O Length	O Width	OA	Approx. Net Wt. Lbs. Bare Motor	Approx. Net Wt. Lbs. Add for Sl'g b'e
623*–643*–663*	4 11/16	7/8	3/16	7	7	5 3/4	9 3/4	9 1/16	1 3/4	1¼	3/4	2½	1 3/16	1/16	3/32	25	5
723–743–763	6 1/16	1 1/8	3/16	8 5/8	8½	6 3/4	13 3/4	12 1/8	2 11/16	2	1¼	4 5/16	1 1/8	3/8	1/8	41	12
725–745–765	6 1/16	1 1/8	3/16	8 5/8	8½	6 3/4	13 3/4	12 1/8	2 11/16	2	1¼	4 5/16	1 1/8	3/8	1/8	48	12
823–843–863	6 7/8	1½	1/16	10 1/16	9 7/8	7 7/8	15	13 3/4	2 11/16	2	1 3/16	4 11/32	1 5/16	1/16	1/32	68	23
825–845–865	6 7/8	1½	1/16	10 1/16	9 7/8	7 7/8	15	13 3/4	2 11/16	2	1 3/16	4 11/32	1 5/16	1/16	1/32	76	23
827	7 1/16	1 1/16	5/16	10 1/16	9 7/8	7 7/8	18½	17	3 1/16	2½	1 3/16	6 11/32	1 5/16	1/16	1/32	105	30
846–866	7 1/16	1 1/16	5/16	10 1/16	9 7/8	7 7/8	18½	17	3 1/16	2½	1 3/16	6 11/32	1 5/16	1/16	1/32	97	30

*This motor has grease-cup lubrication, and leads are brought out through bushings at top of bracket; not shown in cut.
**Maximum travel on base.
†This dimension will never be exceeded but may vary to 1/16-inch less than shown in table.
‡Approximate.
§All voltages listed are for either 2 or 3 phase, except 550 volts which is for 3 phase only.
††Dimensions specified are in inches and refer to the diameter and face respectively.
‡‡We will not under any circumstances guarantee motors if operated with pulleys smaller than those listed in this column.

SMALL TYPE CW ALTERNATING-CURRENT MOTORS

WOUND ROTORS **ADJUSTABLE VARYING SPEED** **POLYPHASE**

½ TO 1 H. P.

TYPE CW MOTOR, FRAMES 100

Some applications such as compressors, blowers, printing presses, fans, etc., often require adjustable varying speed motors. The type CW wound-rotor motor provides the adjustable varying speed feature where it is possible to use polyphase alternating-current motors.

These motors are built in a complete line of sizes from ½ to 650 horsepower, for all commercial circuits, but only the small sizes from ½ to 1 horsepower will be described in this catalogue. A description of the larger motors will be found in catalogue No. 33.

Construction

Stator—The frame of the small type CW motors, Class 100, are cylindrical iron castings with feet cast integral similar to the large size type CA motors. The feet have slotted holes for holding-down bolts and adjustment of belt tension. Within the frames are securely mounted the primary punching in the slots of which are threaded the primary windings.

The **rotor** diameter and weight has been reduced to a minimum so that these motors are especially adapted for quick starting, stopping and reversing. The secondary core consists of steel laminations bolted or riveted together to form a unit which is mounted on the shaft. The rotor has semi-enclosed slots and is wound by threading in coils, shaped to facilitate winding and repairing. A fan on the shaft insures positive ventilation.

The **shaft** is of ample cross-section for rigidity and is axle steel, which is much tougher and stronger than machinery steel.

The **collector rings** are shrunk on an insulated sleeve which is pressed on the shaft. The connections to the rings are thoroughly insulated.

The **bearing brackets** are cast separate from the frames, permitting the brackets to be rotated 90 or 180 degrees for either wall or ceiling mounting. The motors are regularly supplied for floor mounting but can be arranged for wall or ceiling mounting if it is specified on the order.

In the brackets opposite the pulley end are the cartridge-type brushholders which project through the bracket arm, as shown on next page in figure of front bracket, and allow easy inspection and renewal of the brushes. For the sake of compactness only one brush per ring is used and these brushes are copper-graphite on account of the consequent relatively high current per brush. Each brush, however, is provided with a copper shunt to relieve the springs of current and assure good contact at all times.

The **bearings** are bronze sleeves of the old ring type fitted with one lubricating ring and made practically dust proof by metal caps and rings so that the life of the bearing is prolonged.

Lubrication—Oil-ring lubrication is used. Openings in the bearing housing with a spring-closed cover are provided for filling the oil well, inspecting the oil ring, and permitting overflow of excess lubricant.

STATOR

Accessories

Paper pulleys with a crown face are standard for all small type CW motors.

Controllers for adjustable varying speed are furnished in either the drum or face-plate type. Type FA drum controllers are used for adjustable varying speed reversing service. Face plate con-

trollers for a 50 per cent reduction in speed and type RF controllers are used for adjustable varying speed non-reversing service. These controllers are all manually operated.

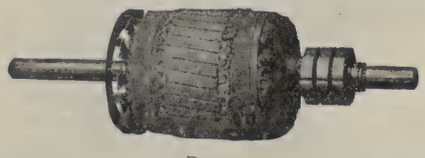
Sliding bases can be supplied when desired for frequent adjustment of belt tension, although they are not necessary since the feet are slotted.

Performance Guarantees

The temperature rise of all parts, when operating under normal rated conditions as specified on the name plate and at 100 per cent rated load, will not exceed 40 degrees Centigrade.

Motors having a capacity of 1 horsepower, 1750 r.p.m. or larger will operate under normal rated conditions and at 125 per cent rated load for a period of 2 hours with a temperature rise not exceeding 55 degrees Centigrade. Motors in this class will also carry 150 per cent rated load momentarily.

The starting torque may be adjusted from full load torque to a torque equivalent to the break-



ROTOR

down or maximum torque by proper adjustment of the controller handle.

The break-down or maximum torque will not be less than 2 times full load torque.

Type CW motors will operate successfully at normal rated load and frequency at any voltage not more than 10 per cent above or below normal, but not necessarily in accordance with the standard of performance established for operation at normal rating.

INTERIOR OF FRONT BRACKET AND EXTERIOR OF REAR BRACKET

Care and Operation

A wound-rotor motor provides high-starting torque with low-starting current when resistance is inserted in the rotor circuits. But it should be borne in mind that the power rating, however, decreases as the speed is decreased although the torque remains the same. For example a 1 horsepower, 1750 r.p.m. motor operated at 875 r.p.m. will exert only ½ horsepower.

Connections—The diagram shows connections of a three-phase motor with primary line switch and secondary starter or controller. The primary leads to the motor stator should be brought through a circuit-breaker or a switch with fuses. With a three-phase installation, any lead from the line can be connected to any terminal of the motor. With a two-phase four-wire installation, connect the leads from one phase to the motor primary terminals marked T1 and T3, and the leads from the other phase to terminals T2 and T4. If the circuit is two-phase three-wire, connect the outside leads to terminals T1 and T2 and the middle lead to T3 and T4. The order in which the starter or controller leads are connected with the motor secondary terminals is immaterial.

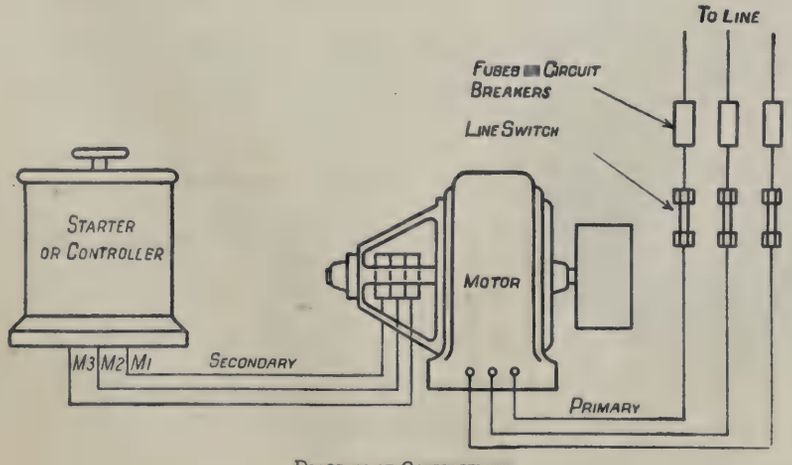
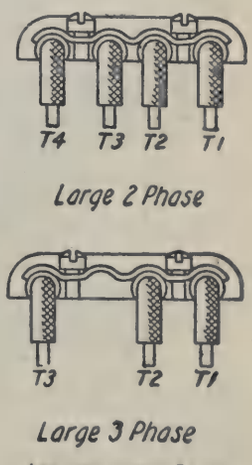


DIAGRAM OF CONNECTIONS



ARRANGEMENT OF LEADS

SMALL TYPE CW ALTERNATING-CURRENT MOTORS—Continued

To Reverse Motor—To reverse a two-phase four-wire motor, interchange the two leads of one phase. To reverse a two-phase three-wire motor, interchange the two outside leads. To reverse a three-phase motor, interchange any two leads. These changes and connections may be made at the terminals of motor or by a double-pole, double-throw switch conveniently located.

For wall or ceiling mounting, turn the brackets through 90 or 180 degrees in order to keep the oil reservoirs directly under the shaft.

Lubrication—Before starting, fill the oil reservoirs with the best quality of clean dynamo oil; overflow plugs, if present, must always be kept open when filling reservoir. The old oil should be withdrawn occasionally and fresh oil substituted, the intervals depending on the class of service. The old oil can be filtered and used again.

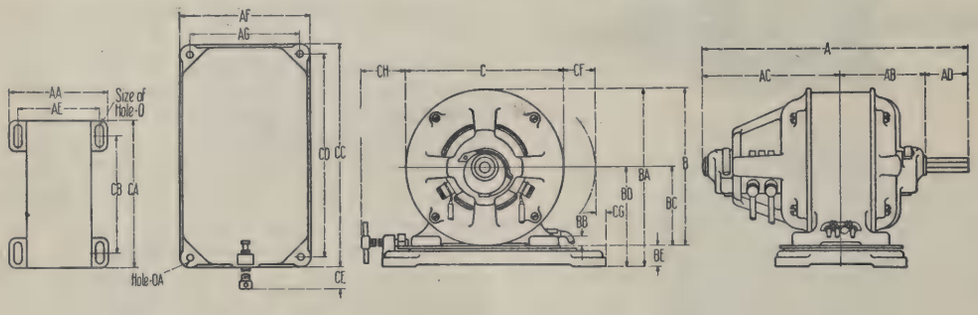
RATINGS AND APPROXIMATE WEIGHTS

110, 220, and 440 Volts, 2 or 3 Phase; 550 Volts, 3 Phase

60 Cycles

H.P.	No. Poles	Approx. Full Load R.P.M.	Frame No.	Standard Pulleys Diam. x Face	Special Pulley‡ Min. Dia. x Face Inches	APPROXIMATE SHIPPING WEIGHT IN LBS Bare Motor With Pulley	Additional for Controller and Resistors Face Plate	Type RF	Type FA	Additional for Sliding Base
½	6	1160	163	3½x3	2½x3¼	95	42	142	97	30
¾	4	1750	143	3½x3	2¼x3¼	95	42	142	97	30
¾	6	1160	163	3½x3	2¼x3¼	95	42	142	97	30
1	4	1750	143	3½x3	2½x3½	95	42	143	98	30
1	6	1160	166	4 x3¾	2¾x4½	125	54	144	99	46

OUTLINE DIMENSIONS



Frame No.	Keyway Width	Keyway Depth	Keyway Length	Shaft Dia.	A	AA	AB	AC	AD	AE	B†	BA†	BB†	BC*	BD*
143 } 163 }	3/16	3/32	3	7/8	17 23/32	6 5/8	5 3/4	8 31/32	3	5 1/2	10 3/8	11 23/32	3/4	5 3/8	6 7/8
144 } 164 }	1/4	3/32	3 11/16	1 1/16	19 3/32	6 5/8	6 7/16	8 31/32	3 11/16	5 1/2	10 3/8	11 23/32	3/4	5 3/8	6 7/8
146 } 166 }	1/4	3/32	3 11/16	1 1/16	20 3/32	7 5/8	6 15/16	9 1/32	3 11/16	6 1/2	10 3/8	12 11/32	3/4	5 3/8	7 1/16

Frame No.	BE	C†	CA	CB	CC	CD	CE	CF	CG	CH	O Width	O Length	OA	Approx. Net Wt. Lbs. Bare Motor	Add for Sliding Base
143 } 163 }	1 1/2	10 1/16	9 7/8	7 7/8	15	13 3/4	2 11/16	2	1 3/32	4 11/32	1/16	1 1/16	13/32	78	23
144 } 164 }	1 1/2	10 1/16	9 7/8	7 7/8	15	13 3/4	2 11/16	2	1 3/32	4 11/32	1/16	1 1/16	13/32	85	23
146 } 166 }	1 15/16	10 1/16	9 7/8	7 7/8	18 1/2	17	3 3/16	2 1/2	2 3/32	6 11/32	1/16	1 1/16	1/16	105	30

*This dimension will never be exceeded, but may vary to 1/16 inch less than shown in table.
†Approximate.
‡Motors not guaranteed if operated with pulleys smaller than those listed in this column.
For latest ratings and dimensions refer to nearest district office of this company.

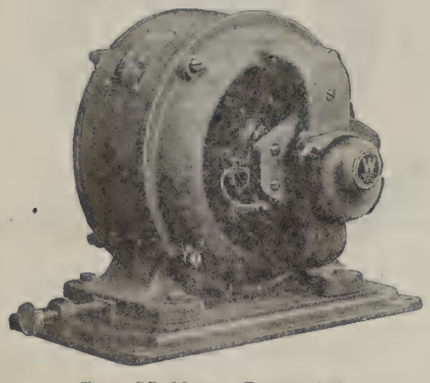
TYPE CD DIRECT-CURRENT MOTORS

SHUNT AND COMPOUND **OPEN** **$\frac{1}{20}$ TO 3 H.P**

In places where direct-current circuits are available the Westinghouse type CD motor is suitable for driving such small devices as washing machines, vacuum cleaners, job presses, conveyors, drill presses, pumps, etc. Type CD motors are well designed for strength and compactness and will operate successfully with hard usage and unskilled handling to which they are often subjected.

Construction

Frames 700 to 900 inclusive consist of a forged steel ring to which the feet are bolted. The pole pieces of these frames are built up of laminated steel, securely riveted together and bolted to the frame. This construction reduces the weight per horsepower to a minimum.

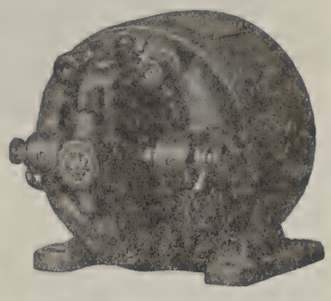


TYPE CD MOTOR, FRAMES 700

On the two smaller sizes, frames 300 and 400, the frames are strong iron castings with the feet and poles cast integral.

The **field coils** are form wound, thoroughly taped and dipped in high grade insulating moisture-resisting compound.

The **armature** core is built up of steel punchings rigidly mounted on a shaft of ample size and strength manufactured from axle steel, which is much stronger and tougher for the same dimensions than the machinery steel generally used. The shaft extension on the 300 and 400 frames has a "flat," since with the grooved pulleys used on the smaller sizes a set-screw is sufficient to hold the pulley in position and is much easier to handle. On the larger sizes a crowned pulley is used in order to carry the power developed by the larger ratings, and for the greater amount of power transmitted it is desirable to use a key to keep the pulley from slipping on the shaft.

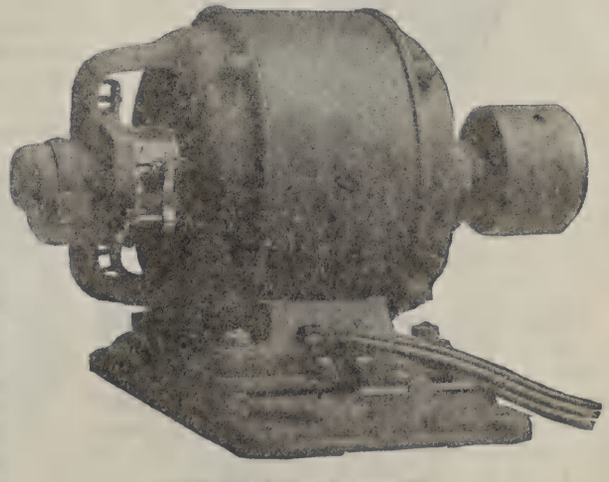


TYPE CD MOTOR, FRAMES 300 AND 400

A **ventilating fan** mounted on the shaft circulates air through the frame and around the windings, effectually cooling them and preventing "hot spots."

The **commutators** are built up of hard-drawn copper segments insulated with high grade mica. All motors are designed so that practically sparkless commutation is obtained at all loads, insuring low temperature and long life of commutator and brushes.

The **bearing brackets** are made of cast iron and both are separate from the frame in all sizes, permitting easy inspection and repairs. The brackets are designed so that they fully protect the windings



TYPE CD MOTOR, FRAMES 900

and commutator from injury but allow easy access for inspection and brush renewal.

ARMATURE FOR 1½ H.P. MOTOR

Standard motors are furnished arranged for floor mounting. Inverted or ceiling mounting can be obtained on all frames by turning the brackets 180 degrees. The 900 frame class may be arragned for side mounting by turning the brackets 90 degrees and shifting the brushes 90 degrees in the reverse direction. Requests for motors arranged for side wall mounting with frames 800 and smaller should in every case be referred to the Works.

The **brushholders** on frames 300 and 400 are of the cartridge type, the brush being supported in an insulated tube and held against the commutator by a helical spring. Larger motors have brushholders of the sliding box type in which brush tension is obtained by a flat coiled spring. On the smaller sizes the current can be transmitted successfully between the brushholder and the brush by the contact of the brush on the walls of the holder.

REAR BRACKET OF 800 FRAME MOTOR SHOWING OIL-RING LUBRICATION

The 700 and larger frames are provided with flexible copper shunts for carrying the current to the brush, thus diverting the current from the spring.

Terminals—The terminal leads of motors built on frames 300 and 400 inclusive are brought out to insulated binding posts on the front bearing bracket. Connections can be thus quickly and easily made. The use of insulating knobs on the binding posts practically eliminates the possibility of shock or accidental short-circuit.

The large motors are generally used in industrial service where permanent wiring is installed, therefore, the leads are brought out through the lower part of the frame and held securely by cleats.

Lubrication on frames 300 and 400 is by means of wick-fed grease cups permitting these motors to be mounted on small portable apparatus which may be tilted or momentarily inverted without spilling the lubricant. The oil ring type of lubrication successfully used for many years on electrical machinery is employed on frames 700 to 900 inclusive.

The **interchangeability** of No. 300 and No. 400 type CD with alternating-current type CA motors,

INTERIOR OF FRONT BRACKET SHOWING BRUSHHOLDERS OF 800 FRAME

rating for rating, in mounting and principal dimensions makes it necessary for the user to provide only one mounting for either direct or alternating-current motors on these frames which may be direct-connected, geared or belted.

The **finish** is a glossy black japan, very durable and attractive.

Accessories

A **sliding base** suitable for floor, wall or ceiling suspension can be supplied with class 700 and larger frames when it is desired to provide a convenient method for frequent belt adjustment of considerable length. A small adjustment may be obtained without the use of a sliding base as the feet of all frames are provided with slots for this purpose.

700 FRAME SHOWING FIELD COILS AND POLES

TYPE CD DIRECT-CURRENT MOTORS—Continued

FRAME BRACKETS FOR THE 500 FRAME

Pulleys—Crowned paper pulleys are supplied with frames 700 and larger, and grooved steel pulleys with the smaller frames.

Starting Rheostats—Starting rheostats should be used with all shunt and compound-wound motors of ½ horsepower and larger, but are unnecessary with smaller motors of standard speeds starting not oftener than once an hour. For applications requiring more frequent starting, the full conditions of operation should be referred to the Works at East Pittsburgh.

SLIDING BASE

Performance Guarantees

The temperature rise of all parts, when operating under normal rated conditions as specified on the nameplate and at 100 per cent rated load, will not exceed 40 degrees Centigrade.

Motors having a capacity of 1 horsepower, 1750 r.p.m. or larger will operate under normal rated conditions and at 125 per cent rated load for a period of two hours with a temperature rise not exceeding 55 degrees Centigrade. Motors in this class will also carry 150 per cent rated load momentarily.

At normal operating temperature and voltage, individual motors may vary 7½ per cent above or below rated speed.

Variation in speed from full load cold to full load hot shall not exceed 10 per cent, based on the full load speed hot.

Type CD motors will operate successfully with normal rated current at any voltage not more than 10 per cent above or below normal but not necessarily in accordance with the standards of performance established for operation at normal rating.

Care and Operation

Shunt-wound motors have close speed regulation from no-load to full-load and are used on all applications where the torque required for starting and accelerating does not greatly exceed full-load torque. Standard type CD compound motors are provided with a light series winding such that fairly close speed regulation is obtained. When starting is frequent, rapid acceleration necessary, or violent fluctuations of load are encountered, a compound-wound motor should be applied. Certain applications where starting or accelerating conditions are unusual require a motor more heavily compounded than standard. Such a motor can be wound on

BRACKETS FOR THE 900 FRAME

STARTING RHEOSTAT

special order. Series-wound motors are used where load is constant, or where the starting and accelerating conditions are excessive and rheostatic control is provided. The most common application of series motors are to fans and hoists. Series-wound motors are built to order only, and should never be used where the load may be light, or can be disconnected entirely as they will speed up to a point dangerous to the windings.

All shunt and compound-wound motors of 1750 r.p.m. or less may be operated at 15 per cent above normal speed by inserting resistance in the shunt field.

Note the nameplate reading to see that it agrees with the circuit to which the motor is to be connected.

Lubrication—If the motor has bearings of the oil-ring type, fill each reservoir with a good grade of dynamo or machine oil until the oil level rises nearly to the top of the overflow hole. If the motor has bearings of the grease-cup type, unscrew the cup below each bearing and fill with unmedicated vaseline or good machine oil. Replace the cup making certain that the wick presses against the shaft, then tighten the cup securely to prevent its working loose.

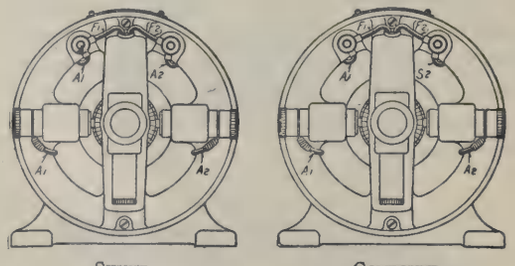
Motors having the grease-cup type of bearings are shipped with the reservoirs filled but the above precautions should always be taken as good lubrication is of prime importance to all electric motors. Although these motors will run much longer under normal service conditions, replenishing the lubricant in all types of bearings once a month is strongly recommended. About once a year the reservoirs of the oil-ring type of bearings should be emptied and cleaned out with gasoline or kerosene to remove any dirt or sediment from the oil.

Commutator and Brushes—The commutator surface should be kept clean and smooth. Ordinarily it will require only occasional wiping off with a piece of canvas. The carbon brushes supplied with this motor have been carefully selected for this particular service and, for the best results, only this make and grade should be used.

CONNECTIONS

All standard stock motors are shipped arranged for clockwise rotation when viewed from the commutator end.

In the illustrations the armature leads are indicated by the letters A1 and A2, the shunt field leads by the letters F1 and F2, and series field leads by the letters S1 and S2. In the following instructions, brief reference is made to these leads by letter only. the letter in every case referring to the figure and not to the leads themselves since the latter are not marked or tagged. In reading the instructions, the relative position of the leads should be noted in the illustrations.



SHUNT COMPOUND

DIAGRAM OF CONNECTIONS ON FRAMES 300 AND 400

Connections Without Starter For Frames 300 and 400

For Clockwise Rotation—Connect one line to each binding post.

For Counter Clockwise Rotation—Interchange leads A1 and A2 at the brushholders for compound-wound motors and F1, and F2 at the binding posts for shunt-wound motors.

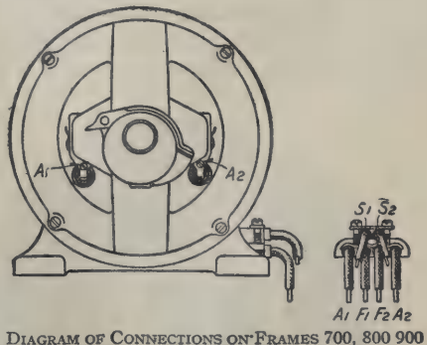


DIAGRAM OF CONNECTIONS ON FRAMES 700, 800 900
LEADS S_1 AND S_2 ARE OMITTED FOR SHUNT-WOUND

Connections Without Starter For Frames 700, 800 and 900

For Clockwise Rotation—For shunt motors, connect adjacent leads in pairs A1-F1 and A2-F2, and connect one pair to each line wire. For com-

TYPE CD DIRECT-CURRENT MOTORS—Continued

pound motors connect pair A1-F1 to one line wire, S2-F2 to the other, and join S1 to A2.

For Counter Clockwise Rotation—For shunt motors connect alternate motor leads in pairs, A1-F2, A2-F1, and connect one pair to each line wire. For compound motors connect pair A2-F1 to one line wire, S2-F2 to the other, and join S1 to A1. For both kinds, turn the brushholder block clockwise until the arrow on the brushholder block is opposite the lower chisel mark on the bearing housing.

Connections With Starter for Frames 700, 800 and 900

In all cases connect one line wire with the starter terminal marked LINE+, and the other with LINE—.

For Clockwise Rotation—For shunt motors connect A1 with starter terminal ARM, F1 with starter terminal FLD and pair A2-F2 with starter terminal LINE—.

For compound motors connect A1 to starter terminal ARM, F1 to FLD, pair S2-F2 to starter terminal LINE— and join S1 to A2.

For Counter Clockwise Rotation—For shunt motors connect A2 with starter terminal ARM, F1 to FLD and pair A1-F2 to starter terminal LINE—. Turn the brushholder block clockwise until the arrow on the block is opposite the lower chisel mark on the bearing housing.

For compound motors connect A2 to starter terminal ARM, F1 to FLD, pair S2-F2 to starter terminal LINE—, and join S1 and A1. Turn brushholder block as instructed in preceding paragraph.

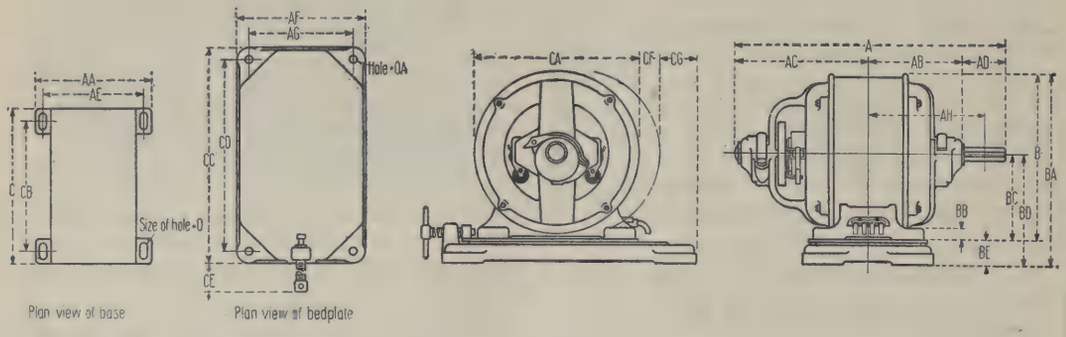
RATINGS

Hp.	Approx. Rpm. at Full Load	Frame No.	Std. Pulley Dia. x Face	Approx. Net Wt. Lbs.	
				Bare Motor	Add for Sliding Base
115-230 Volts Shunt and Compound Wound					
1/20	1700	323	1⅛*	10	..
1/12	1725	423	1½*	15	..
⅓	1725	723	3½x2½	45	12
½	1140	725	3½x2½	54	12
¾	1725	725	3½x2½	54	12
¾	1140	823	3½x3	84	23
1	1725	823	3½x3	84	23
1	1140	825	3½x3	100	23
1	565	923	4x3	170	30
1½	1725	825	3½x3	100	23
1½	1180	923	4x3	170	30
1½	800	925	4x3	195	30
2	1725	923	4x3	170	30
2	1180	925	4x3	195	30
3	1725	925	4x3	195	30
32 Volts Compound Wound					
½	1725	723	3½x2½	45	12
550 Volts Shunt and Compound Wound					
1	1000	923	4x3	170	30
1½	1300	923	4x3	170	30
1½	1000	925	4x3	195	30
2	1850	923	4x3	170	30
2	1350	925	4x3	195	30
3	1900	925	4x3	195	30

*Single groove pulley for ¼-inch round belt, diameter applies to pitch circle.
†Single groove pulley for 5/16 inch round belt, diameter applies to pitch circle.

TYPE CD DIRECT-CURRENT MOTORS—Continued

OUTLINE DIMENSIONS



Frame No.	Keyway			Flat for Set Screw	Shaft Dia.	A	AA	AB	AC	AD	AE	AF	AG	AH	B	BA
	Width	Depth	Length													
323	..	..	...	$\frac{1}{8}$	$\frac{3}{8}$	$7\frac{5}{16}$	$3\frac{1}{2}$	$2\frac{5}{8}$	$3\frac{11}{16}$	1	$2\frac{13}{16}$	....	...	$3\frac{1}{16}$	$4\frac{25}{32}$	....
423	..	..	...	$\frac{3}{64}$	$\frac{7}{16}$	$8\frac{3}{16}$	$3\frac{5}{8}$	$2\frac{31}{32}$	$4\frac{3}{32}$	$1\frac{1}{8}$	$2\frac{7}{8}$	....	...	$3\frac{17}{32}$	$5\frac{7}{16}$	....
*625	$\frac{3}{16}$	$\frac{3}{16}$	$1\frac{1}{2}$	$\frac{3}{64}$	$\frac{5}{8}$	$11\frac{1}{2}$	5	$4\frac{7}{32}$	$5\frac{25}{32}$	$1\frac{1}{2}$	$4\frac{1}{4}$	$5\frac{7}{8}$	$5\frac{3}{16}$	$4\frac{11}{32}$	$7\frac{5}{16}$	$8\frac{3}{16}$
723	$\frac{3}{16}$	$\frac{3}{16}$	$2\frac{1}{4}$	..	$\frac{3}{4}$	$13\frac{7}{8}$	$5\frac{1}{4}$	$4\frac{3}{4}$	$6\frac{7}{8}$	$2\frac{1}{4}$	$4\frac{1}{4}$	$7\frac{1}{4}$	6	$5\frac{7}{8}$	$8\frac{13}{32}$	$10\frac{3}{8}$
725	$\frac{3}{16}$	$\frac{3}{16}$	$2\frac{1}{4}$	..	$\frac{3}{4}$	$14\frac{5}{8}$	6	$5\frac{1}{8}$	$7\frac{1}{4}$	$2\frac{1}{4}$	5	$7\frac{1}{4}$	6	$6\frac{1}{4}$	$8\frac{13}{16}$	$10\frac{3}{8}$
823	$\frac{3}{16}$	$\frac{3}{16}$	$2\frac{3}{4}$	..	$\frac{7}{8}$	$17\frac{3}{16}$	$6\frac{5}{8}$	$5\frac{3}{4}$	$8\frac{11}{16}$	$2\frac{3}{4}$	$5\frac{1}{2}$	$8\frac{3}{4}$	$7\frac{1}{2}$	$7\frac{1}{8}$	$10\frac{13}{32}$	$11\frac{29}{32}$
825	$\frac{3}{16}$	$\frac{3}{16}$	$2\frac{3}{4}$	..	$\frac{7}{8}$	$18\frac{3}{16}$	$7\frac{5}{8}$	$6\frac{1}{4}$	$9\frac{3}{16}$	$2\frac{3}{4}$	$6\frac{1}{2}$	$8\frac{3}{4}$	$7\frac{1}{2}$	$7\frac{5}{8}$	$10\frac{13}{32}$	$11\frac{29}{32}$
923	$\frac{5}{16}$	$\frac{1}{4}$	$3\frac{7}{8}$	..	$1\frac{1}{4}$	$24\frac{5}{32}$	$8\frac{3}{4}$	$8\frac{1}{16}$	$12\frac{1}{4}$	$3\frac{7}{8}$	$7\frac{1}{8}$	10	$8\frac{1}{2}$	10	$12\frac{13}{32}$	$14\frac{17}{32}$
925	$\frac{5}{16}$	$\frac{1}{4}$	$3\frac{7}{8}$	..	$1\frac{1}{4}$	$25\frac{9}{32}$	$8\frac{3}{4}$	$8\frac{5}{8}$	$12\frac{13}{16}$	$3\frac{7}{8}$	$7\frac{1}{8}$	10	$8\frac{1}{2}$	$10\frac{9}{16}$	$12\frac{13}{32}$	$14\frac{17}{32}$

Frame No.	BB	BC†	BD†	BE	C	CA	CB	CC	CD	CE	CF	CG	O		OA
													Width	Depth	
323	$\frac{3}{8}$	$2\frac{7}{16}$	...	...	$4\frac{5}{8}$	$4\frac{11}{16}$	$3\frac{3}{4}$	....	....	...	...	...	$\frac{9}{32}$	$\frac{17}{32}$	...
423	$\frac{13}{32}$	$2\frac{3}{4}$	...	...	$5\frac{1}{4}$	$5\frac{3}{8}$	$4\frac{1}{4}$	....	....	...	...	...	$\frac{9}{32}$	$\frac{21}{32}$	...
*625	$\frac{1}{2}$	$3\frac{13}{16}$	$4\frac{11}{16}$	$\frac{7}{8}$	7	7	$5\frac{3}{4}$	$9\frac{3}{4}$	$9\frac{1}{16}$	$1\frac{3}{4}$	$1\frac{1}{4}$	$\frac{3}{4}$	$\frac{5}{16}$	$\frac{13}{16}$	$\frac{9}{32}$
723	$\frac{5}{8}$	$4\frac{5}{8}$	$6\frac{1}{16}$	$1\frac{1}{16}$	$8\frac{1}{2}$	$8\frac{5}{8}$	$6\frac{3}{4}$	$13\frac{3}{4}$	$12\frac{1}{2}$	$2\frac{11}{16}$	2	$1\frac{1}{4}$	$\frac{3}{8}$	$1\frac{1}{8}$	$\frac{13}{32}$
725	$\frac{5}{8}$	$4\frac{5}{8}$	$6\frac{1}{16}$	$1\frac{1}{16}$	$8\frac{1}{2}$	$8\frac{5}{8}$	$6\frac{3}{4}$	$13\frac{3}{4}$	$12\frac{1}{2}$	$2\frac{11}{16}$	2	$1\frac{1}{4}$	$\frac{3}{8}$	$1\frac{1}{8}$	$\frac{13}{32}$
823	$\frac{3}{4}$	$5\frac{3}{8}$	$6\frac{7}{8}$	$1\frac{1}{2}$	$9\frac{7}{8}$	$10\frac{1}{16}$	$7\frac{7}{8}$	15	$13\frac{3}{4}$	$2\frac{11}{16}$	2	$1\frac{3}{32}$	$\frac{7}{16}$	$1\frac{5}{16}$	$\frac{13}{32}$
825	$\frac{3}{4}$	$5\frac{3}{8}$	$6\frac{7}{8}$	$1\frac{1}{2}$	$9\frac{7}{8}$	$10\frac{1}{16}$	$7\frac{7}{8}$	15	$13\frac{3}{4}$	$2\frac{11}{16}$	2	$1\frac{3}{32}$	$\frac{7}{16}$	$1\frac{5}{16}$	$\frac{13}{32}$
923	$\frac{7}{8}$	$6\frac{1}{2}$	$8\frac{1}{16}$	$1\frac{15}{16}$	$12\frac{1}{4}$	$12\frac{5}{16}$	$9\frac{3}{4}$	$18\frac{1}{2}$	17	$3\frac{3}{16}$	$2\frac{1}{2}$	$1\frac{7}{32}$	$\frac{9}{16}$	$1\frac{7}{16}$	$\frac{9}{16}$
925	$\frac{7}{8}$	$6\frac{1}{2}$	$8\frac{1}{16}$	$1\frac{15}{16}$	$12\frac{1}{4}$	$12\frac{5}{16}$	$9\frac{3}{4}$	$18\frac{1}{2}$	17	$3\frac{3}{16}$	$2\frac{1}{2}$	$1\frac{7}{32}$	$\frac{9}{16}$	$1\frac{7}{16}$	$\frac{9}{16}$

†This dimension will never be exceeded but may vary $\frac{1}{16}$-inch less than shown in table.
*This frame covers a type CD generator only.

TYPE CDH DIRECT-CURRENT MOTORS

COMPOUND WOUND SPLASH PROOF ⅛ AND ¼ H.P.

32, 115 AND 230 VOLTS

Type CDH direct-current motors have been designed and constructed in order to incorporate in a direct-current motor the splash-proof feature which has been so popular in the Westinghouse type CAH alternating-current motors. This unique design of housing provides ample ventilation, maximum accessibility, and at the same time complete protection of the winding and all live parts from splashing water or accidental contact. It also provides a most effective "Safety First" feature.

TYPE CDH MOTOR

Large commutators and box type brushholders with large brush area, make these motors particularly well adapted for operation from low-voltage storage battery plants, now being installed in great numbers on farms and in suburban residences. Motors wound for 32 volts are in great demand for application to house pumps, washing machines, cream separators, and other like machines.

The 115 volt and 230 volt motors have a wide field of application on light labor saving machines used in homes, offices, stores, manufacturing plants, etc. These motors are interchangeable mechanically with alternating-current motors of similar ratings, and hence they appeal strongly to the manufacturer of motor-driven devices.

Construction—The internal parts of these motors are built along the same lines, and are very similar to those of the type CD motors, which have proven so satisfactory during the seven years they have been on the market.

Frame and Field Poles—The frame consists of a seamless forged-steel ring to which the cast-iron foot, and end brackets are bolted. The pole pieces which are built up of sheet steel laminations securely riveted together under pressure, are bolted to the steel ring. This construction permits the use of form-wound field coils, easily replaceable in case of injury. The shunt and series field coils are effectively insulated from each other, and from the frame and pole pieces by several layers of tape. The complete coil is treated with an insulating moisture resisting compound and baked in an oven until thoroughly dry.

Steel frame motors are light in weight, compact, sturdy, and uniform in performance.

Armature—The armature core is built up of electrical sheet steel laminations pressed on a knurled shaft made from a special grade axle steel, such as used for the axles of all Westinghouse motors.

The commutators are made of hard drawn copper segments insulated from each other by mica strips built up from carefully selected mica. They are insulated from ground by a Bakelite compound molded under high pressure.

Brushholders—The two box-type brushholders of pressed steel protected from rust by a special treatment, are carried on a supporting plate of Bakelite Micarta. Even and correct tension on the brushes is maintained by a phosphor bronze coiled spring. This brush rigging is exceptionally rigid and rugged, and marks a distinct advance over the type of brush holders previously used on motors of these sizes.

The brushes used on the 32-volt motors are provided with a flexible copper shunt. The brushes of the 115 and 230-volt motors, do not require shunts, since there is sufficient area of contact between brush and box to conduct the small current involved in their operation.

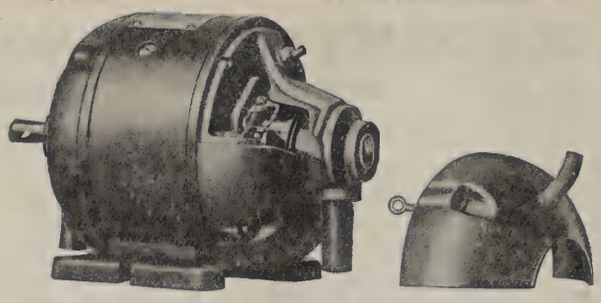
ARMATURE OF TYPE CDH MOTOR

Bearing Bracket—The bearing brackets are of cast iron, each bracket being bolted to the frame by four screws, which permit turning the bracket through 90 or 180 degrees when the motor is mounted on the side-wall or ceiling. The commutator end bracket is provided with a cover which when removed allows easy access to brushes, commutator and terminals. All terminal connections are inside this cover, so that no live parts are exposed to accidental contact, and yet are readily accessible for changing.

Bearing—The bearings are bronze bushings pressed into the bearing housings which form part of the bearing brackets. These bronze sleeve bearings together with the efficient lubricating system provided results in long life, freedom from bearing trouble, and quiet operation.

Lubrication—Grease cups of large capacity, and provided with a wool wick pressed against the shaft by a coiled steel spring, are screwed into the lower part of the bearing housing. When filled with a good grade of unmedicated vaseline or machine oil, attention is required only at infrequent intervals.

TYPE CDH DIRECT-CURRENT MOTORS—Continued



TYPE CDH MOTOR SHOWING UPPER END BRACKET REMOVED

Ventilation—Type CDH motors are effectively ventilated by means of a fan mounted on the armature shaft. Due to this fan and the shape of the brackets, a steady circulation of air is maintained through the motor, cooling all parts of the windings.

Mounting—Type CDH motors may be arranged for mounting on floor, side-wall, or ceiling. For directions as to mounting see following section on Care and Operation, or Instruction Card which accompanies each motor.

Interchangeability—Alternating-current motors type CAH of similar ratings to the type CDH motors listed, have the same mounting dimensions, making it possible for the user to provide one mounting for either alternating or direct-current motors regardless of the method of drive employed.

Accessories—The pulley furnished with the number 425 and number 525 frames is a single groove iron pulley with a 2″ diameter pitch circle for a $\frac{5}{16}$″ diameter round belt.

Sliding bases with a belt tightening device can be supplied where frequent adjustments of belt tension are necessary.

Standard motors are furnished with two short leads connected to binding posts underneath the commutator cover, and extending through an insulated bushing in the cover. Cord and plug (10 feet of cord) can be furnished when desired at an additional price.

Performance Guarantees—The temperature rise of all parts, when operating under normal rated conditions as specified on the nameplate and at 100 per cent rated load, will not exceed 50° C. At normal operating temperature and voltage, individual motors may vary 7½ per cent above or below rated speed.

Type CDH motors will operate successfully with normal rated current and at any voltage not more than 10 per cent above or below normal, but not necessarily in accordance with the standard of performance established for operation at normal rating.

Variation in speed from full-load cold to full-load hot will not exceed 10 per cent, based on the full-load speed hot.

Care and Operation

Note the nameplate reading to see that it agrees with the circuit to which the motor is to be connected.

Lubrication—Unscrew the cup below each bearing and fill with unmedicated vaseline or good machine oil. Replace the cup, making certain that the wick presses against the shaft, then tighten the cup securely to prevent it working loose. Replenishing the lubricant once a month is strongly recommended, though these bearings will run much longer under usual service conditions.

Motors are shipped with the grease cups filled, but the precautions mentioned should always be taken, as good lubrication is of prime importance to all electric motors.

Commutation and Brushes—The commutator surface should be kept clean and smooth. Ordinarily it will require only occasional wiping with a piece of canvas. The carbon brushes supplied with this type of motor have been carefully selected for the particular class of service for which these motors are used, and hence for best results only this make and grade of brush should be used.

Mounting—Mount the motor as rigidly as possible with the shaft level and the grease cups directly below the journals. Adjust the motor so that the pulley or pinion is directly in line with the pulley or gear it is to drive. When the motor is properly lined up the armature will run free or "float" midway between the bearings without striking against the spacing collars.

To Arrange for Ceiling Mounting—Disconnect leads to the brushholders, and to the one binding post; remove the bearing brackets and turn them through 180 degrees to keep the grease cups below the bearings and then connect the leads to the brushholders and binding post according to the data given on instruction card furnished with each motor.

To Arrange for Wall Mounting—Disconnect leads to brushholders and binding post; remove and interchange front and rear brackets, and turn them through 90 degrees in the direction that will keep the grease cups directly below the bearings when the motor is mounted ready for operation, and then connect leads to brush holders and binding post according to the data given on the instruction card furnished with each motor. On motors of the 400 frame size, the foot must be removed and turned around.

Connections—Standard stock motors are shipped arranged for clockwise rotation when looking at the commutator end.

To Reverse Direction of Rotation—In order to reverse the direction of rotation follow the data given on instruction card furnished with motor.

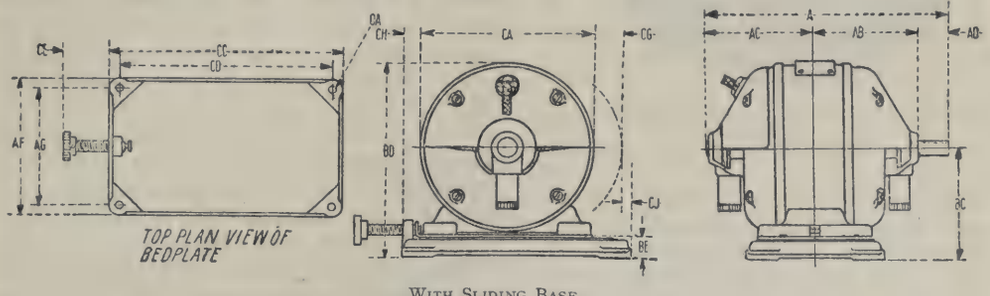
TYPE CDH DIRECT-CURRENT MOTORS—Continued

RATINGS

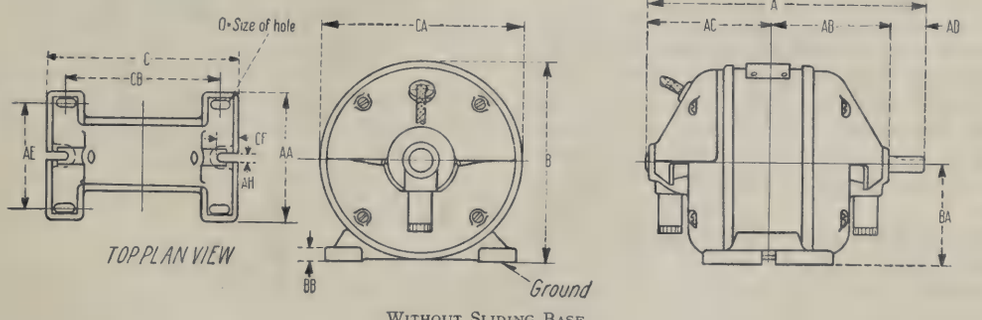
Hp.	Full Load Rpm.	Frame No.	Std. * Pulley	Approx. Net Wt. Lbs.	
				Bare Motor	Add for Sliding Base
115—230—32 Volts					
1/8	1725	425	2	15½	3½
1/4	1725	525	2	23	3½

*Single groove pulley for 5/16-inch round belt. diameter applies to pitch circle.

OUTLINE DIMENSIONS



With Sliding Base



Without Sliding Base

Frame No.	Shaft Diam.	Screw For Flat-Depth	A	AA	AB	AC	AD	AE	AF	AG	AH	B	BA†	BB	BC
425	1/2	3/64	8 13/32	5 5/8	3 1/2	4 21/32	1 1/8	2 7/8	5 1/16	4 7/16	5/16	5 9/16	2 7/8	1/2	3 3/4
525	1/2	3/64	9 13/32	4 1/8	3 7/8	3 13/32	1 1/8	3 3/32	5 1/8	4 7/16	5/16	6 13/32	3 11/32	7/16	4 9/64

Frame No.	BD	BE	C	CA	CB	CC	CD	CE	CF	CG*	CH	CJ	O	OA‡	Approx Net Wt. Lbs.	
															With Bedplate	Without Bedplate
425	6 7/16	7/16	5 5/8	5 3/8	4 9/16	8 1/2	7 13/16	1 3/4	19/32	1	1 1/16	1 1/16	5/16 x 5/8	9/32	19	15½
525	7 13/64	21/64	6 1/8	6 1/8	4 15/16	8 1/2	7 13/16	1 3/4	23/32	1	1 11/16	1 1/16	5/16 x 5/8	9/32	26½	23

*Travel of motor on sliding base.
†This dimension will never be exceeded, but may vary to 1/16-inch less than shown in table.
‡Cast hole.
The above dimensions are for reference only; for official dimensions refer to our nearest district office.

WESTINGHOUSE-VENTURA ELECTRIC FANS

WESTINGHOUSE-VENTURA FAN SHOWING ALTERNATING-CURRENT MOTOR

Westinghouse-Ventura fans are designed for ventilating, cooling, and exhaust service, and are especially suitable for use where the air passages to and from the fan are open and unobstructed. These fans are quiet running, very efficient in operation, simple to install, and can be operated from the lighting circuit.

By exhausting hot and vitiated air and furnishing pure air in proper quantities in offices and factories, employes are made more efficient in their work. Pure and cool air in hotels, restaurants, stores, and theatres adds to the comfort of customers and means an increase in patronage; in schoolrooms, public institutions, etc., pure air is essential to comfort and health.

Odors and fumes originating from kitchens ranges can be directed into hoods and exhausted quietly and without creating drafts by Ventura fans. Fumes from paint shops can be removed in the same way.

Westinghouse-Ventura fans can be used to advantage in almost every building, and manufacturing plant, especially the following:

Hotels	Laundries
Restaurants	Printing plants
Public buildings	Garages
Theatres	Residences
Moving picture theatres	Factories
Offices	Stores
Natatoriums	Foundries
Bakeries	Paint shops
Paper mills	Chemical works
Rubber factories	Laboratories
Dye houses	Cleaning and dyeing establishments

They are used for ventilating and cooling:

Kitchens	Smoking rooms
Lavatories	Workrooms
Engine rooms	Halls

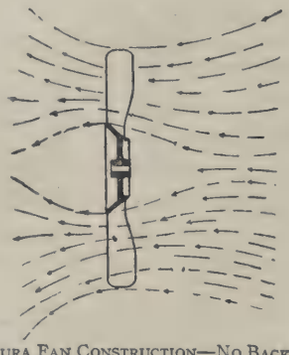
and for removing:

Smoke	Foul air	Dust	Gases
Steam	Hot air	Odors	

Construction

The fan consists of four main parts: the fan wheel, ring, arms, and motor. The wheel is mounted on the motor shaft; the motor is supported by three arms which are attached to the ring.

The fan wheel is made up of ten steel blades securely riveted to a large central disc. It is light in weight and perfectly balanced so that operation without vibration is assured. The blades are unusually broad and are abruptly turned out at the ends. This shape gives the fan particularly high efficiency, because it causes the air to be thrown almost directly ahead, making the fan very effective when discharging through a thick wall. The central disc effectually prevents back flow of the air. The speed of the air thrown from the ends of the blades of any fan is high and the propulsive force is great but these factors decrease rapidly toward the center. As a result, in the old types of disc fan, a back flow is established in the outlet, and any additional speed simply brings more air back through the center of the fan, as shown on next page. With the Westinghouse-



VENTURA FAN CONSTRUCTION—NO BACK FLOW

Ventura fan, however, the propulsive force is greater than in the old type of fan because of the greater number and improved shape of blades, and the central disc is of such size and shape as to prevent back flow, as shown above.

The ring is a substantial iron casting. Holes are provided for mounting bolts.

The arms are bolted to the ring and to the motor and form a rigid support for the motor.

The Motor—Westinghouse single-phase or polyphase motors similar in construction to CA and CSA motors are furnished for alternating-current circuits. Series-wound motors similar in construction to CD motors are furnished for direct-current circuits. These motors are especially designed for this service and are totally enclosed so as to be pro-

tected from dust, dirt and moisture. A thrust bearing takes up the backward thrust caused by the fan wheel.

The direction of rotation should be such that the air passes over the motor before entering the fan. Otherwise the thrust of the fan is away from the thrust bearing which will cause rapid wear of the sleeve bearing.

Application

Westinghouse-Ventura fans are suitable for use in service where the air is drawn directly from the room to be ventilated and is exhausted into the open, or where the inlet and exhaust pipes are so large in diameter and short in length that there is very little resistance to the passage of the air. This type of fan is not suitable for use where there is considerable resistance to the passage of air, as in the case where the air is led through long pipes or pipes of small diameter.

The main flue for Westinghouse-Ventura fans should not be less in diameter than the frame ring and should be as short and with as few bends as possible. Elevator shafts are often used as main flues, especially in buildings having low ceilings.

Means for admitting fresh air should be provided, and it is often desirable to use two fans; one to draw in fresh air, and the other to exhaust the hot or vitiated air. The best results are obtained when the fan is so placed that the incoming air is drawn through the entire length of the room.

There are two methods of determining the size or number of fans required: (a) The "change-of-air" method is more frequently used. Assume that it is desirable to change the air of a kitchen 20 feet square and 9 feet high every two minutes. The cubic contents of this room is 3600 cubic feet; the No. 3½ fan, having a capacity of 1860 cubic feet per minute, is the fan desired, as shown in the table of ratings below.

OLD STYLE FAN CONSTRUCTION SHOWING BEHAVIOR OF AIR

(b) By the "number-of-occupants" method, a fan is selected which will furnish a certain number of cubic feet of air per minute for each occupant. This method is applicable for ventilating only and does not usually have any cooling effect.

If the installation is such that extremely hot air or fumes are to be exhausted it will be necessary to use particular care in the installation because if the outgoing air is very hot (in excess of 110° Fahrenheit), there is danger of burning out the motor. If this condition is unavoidable some other type of fan should be used, in which the hot air does not pass directly over the motor.

In laundries the fan, if used for exhausting, should be as low in the wall as possible so that the heavy, moisture-laden air will be drawn out of the room. Seven feet above the floor is a good height for safety as well as for good results.

Starting and Control

A simple snap or knife switch is the only starting device required. For direct-current fans, a small speed-regulating rheostat can be furnished which permits of six speeds from full speed to 50 per cent of full speed.

VOLUMES OF AIR RECOMMENDED

Room	Complete change of air every	Number of cubic feet of air per occupant per minute
Hotel dining rooms, restaurants	5 to 10 minutes depending on height of ceiling	.....
Offices, halls, schools, etc.	.....	20 to 30
Smoking rooms	.....	30 to 50
Kitchens, laundries, laboratories, etc.	1 to 3 minutes	.....
Moving-picture theatres	.....	20 to 30

RATINGS AND STYLE NUMBERS

Alternating Current

No. of Fan	Wheel Diam.	H.P.	Approx. R.P.M.	Capacity in Cu. Ft. Per Min.	SINGLE-PHASE 110-Volt Style No.	SINGLE-PHASE 220-Volt Style No.	TWO-PHASE 110-Volt Style No.	TWO-PHASE 220-Volt Style No.	THREE-PHASE 110-Volt Style No.	THREE-PHASE 220-Volt Style No.	Approx. Shipping Wt., Lbs.
3½	18¾	.085	870	1860	187345	187346	224904	224905	224906	224907	130
4	21¼	.11	880	2770	187347	187348	224908	224909	224910	224911	160
5	26¾	.17	700	4420	187349	187350	224912	224913	224914	224915	215
6	32	.26	575	6530	187351	187352	224916	224917	224918	224919	285
7	37¼	.42	565	9830	246318	246319	246320	246321	246323	246324	365

Direct Current

No. of Fan	Wheel Diam.	H.P.	Approx. R.P.M.	Capacity in Cu. Ft. Per Min.	SERIES-WOUND D.C. FANS Style No. Outfit Without Rheostat 115-Volt	230-Voly	Style No. Rheostat 115-Volt	230-Volt	Approx. Shipping Wt., Lbs.
3½	18¾	.085	870	1860	187353	187354	188588	188589	130
4	21¼	.11	880	2770	187355	187356	188588	188589	160
5	26¾	.17	700	4420	187357	187358	188590	188591	215
6	32	.26	575	6530	187359	187360	188590	188591	325
7	37¼	.42	565	9830	246327	244328	252512	252513	365

Outfits complete consist of fan wheel, ring and motor with attaching arms.
In ordering, always give style number.
For latest rating refer to leaflet.

THE SEW-MOTOR

Sewing becomes a pleasure with a little Westinghouse Sew-Motor to run the machine and do away with that tiresome treadling. All general makes of machines, new or old, except a few obsolete models can be readily equipped with this motor and operated at a cost of only a fraction of a cent per hour for electric current. Each outfit, as furnished, consists of the motor, base plate, controller, and all minor necessary attachments for mounting the motor on the machine. It weighs only about 7 pounds complete and embraces all modern as well as many exclusive features of design.

Description

The outfit usually sold will be Style No. 249779 which has a flat baseplate making it suitable for mounting on all general makes of family sewing machines of the drop-head or stationary type.

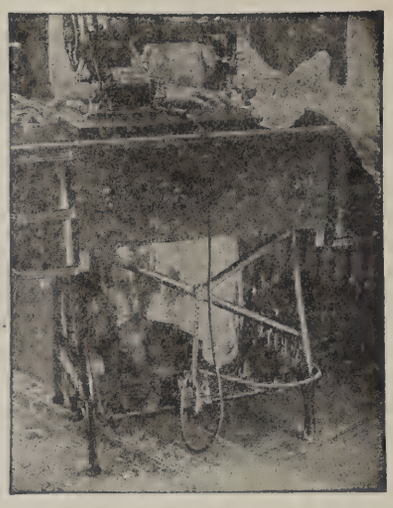
For the drop-head Singer sewing machine manufactured since the first of 1914, however, Style No. 252400 is furnished. This outfit has a special base which allows the Sew-Motor to drop with the head of the machine. Style No. 249779 can be mounted on this particular type of machine but the head cannot be dropped with the motor attached. Consequently Style No. 252400 should be used for the Singer machine of this type.

For the Wilcox & Gibbs automatic sewing machine, a machine of high class, a special Westinghouse sewing machine outfit has been designed and sold exclu sively to the Wilcox & Gibbs Sewing Machine Company, 658 Broadway, New York, who market the machine complete with motor, exclusively, through their own selling organization.

The motor is a small light-weight universal series wound type which can be operated on circuits of

COMPLETE OUTFIT WEIGHS ONLY ABOUT 7 POUNDS

115-volt direct-current or 110-volt alternating current of any frequency up to 70 cycles. It has no exposed electrical contacts, as the connection is made through a plug and a 10-foot well insulated and reinforced cable connected within the motor. The motor, as shipped, drives the handwheel of the machine toward the operator. If it is necessary to



MOTOR IN OPERATION

reverse the motor, it is easily done by removing the nameplate and interchanging the connections of the field leads, as shown in directions accompanying each motor. Large grease cups provide ample lubrication with little attention and only infrequent refilling.

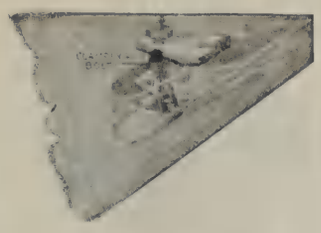
The baseplate of outfit Style No. 249779 for all general makes of machines is a flat "L" shaped steel strip provided with a pivot upon which the motor is mounted in such a way that a spring holds the motor in a position to maintain a constant belt tension at all times. The baseplate is easy to mount on the machine by slipping a guide into the front belt hold and tightening a thumb nut in the rear belt hole. Under each point resting on the machine top are felt washers to prevent marring the sewing machine.

The baseplate for outfit Style No. 252400 is so arranged that it can be simply fastened to the Singer machine head by a single thumb screw and the motor operated as with the other base.

The controller is a compact little pressed-steel box arranged with a spring clip so that it may be slipped over the back of the treadle out of the way and off the floor. A chain from the operating lever of the controller is attached directly above the controller to the frame work of the machine. Within the controller in series with the motor are two coils of fine resistor wire. When the treadle is pressed down the circuit through the motor is completed and the machine starts. Greater pressure on the treadle cuts out the coils turn by turn and increases the speed of the motor until the desired speed is obtained. Thus it is possible to take a stitch at a time or many hundred a minute to suit the material worked upon.

Attachments—All attachments necessary for con-

THE SEW-MOTOR—Continued



INSERTING CLAMPING BOLT

veniently attaching the motor to the machine are supplied. With the cord for connecting the motor to the controller is furnished a neat little separable plug for disconnecting the motor when closing the machine. Two screw hooks are supplied upon which to loop up the cord when the machine is not in use, should their use be desired, and a short belt is furnished to replace the long belt originally used on the sewing machine.

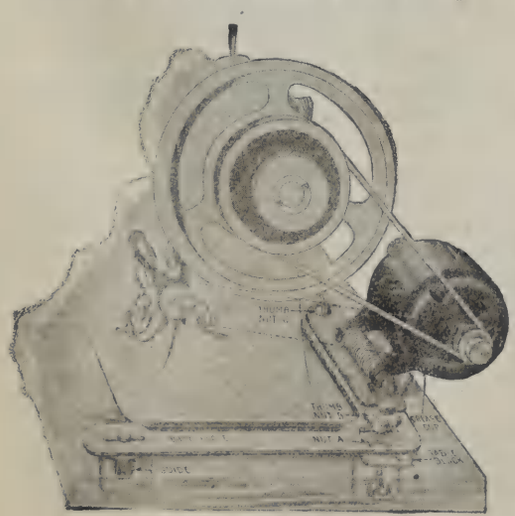
Mounting—The mounting of the motor on the machine is simple and can be done by anyone in just a moment.

Remove belt from hand wheel pulley on sewing machine.

Insert clamping bolt in rear belt hole, as shown above, and fasten the table block in position, with the nut A as shown below.

Place the motor in position so that the clamping bolt slips through the slot in the base plate and the guide on the end of the base plate slips into the front belt hole. Fasten in place with the thumb nut B, as shown below. The end of the base plate under thumb nut C should, if possible, rest on the iron base plate of the machine head. To level the motor base plate in case the iron base plate of the machine is level with the rest of the machine top, moisten and glue the extra felt washer, supplied with the motor, to the felt washer already under this end of motor base plate.

The Singer base, is attached to the sewing machine as shown below, and fastened in place with the thumb screw A.



MOTOR MOUNTED ON MACHINE

Slip belt, supplied with the motor, over the hand wheel pulley and motor pulley, pressing the motor toward the machine head against the spring action. The spring should provide the proper belt tension. If the belt is too long or too short, loosen the screw holding the guide in the front belt hole and the thumb nut B in the rear belt hole and shift the motor and base plate as required. Tighten the screw and thumb nut B after the proper position of motor is found.

MOTOR WITH SINGER BASE MOUNTED ON MACHINE

Mount the controller box on the rear of the treadle by means of the spring clamp as shown on the previous page. Raise the rear of the treadle to very nearly its highest position and attach the chain to any stationary part of the machine frame directly above the controller. If no part is convenient, the screw eye, supplied with the motor, may be screwed into the under side of the woodwork, and the chain attached to this, taking care that the chain does not interfere with the closing of the machine.

It is suggested that the pitman rod be disconnected from the treadle, although this is not required.

Connect separable plug between motor and controller and attach the screw plug to any convenient lamp socket.

Operation—Start the motor by pressing slightly on the treadle with the foot and control the speed of the machine by the amount of pressure on the treadle.

Stop the motor by removing the pressure from the treadle.

Wind the bobbin by slipping the belt from the hand wheel to the bobbin pulley, if belt driven. If friction drive, wind the bobbin in the usual way.

Sit directly in front of the needle and operate the treadle with the right foot so as to keep the back straight.

THE SEW-MOTOR—Continued

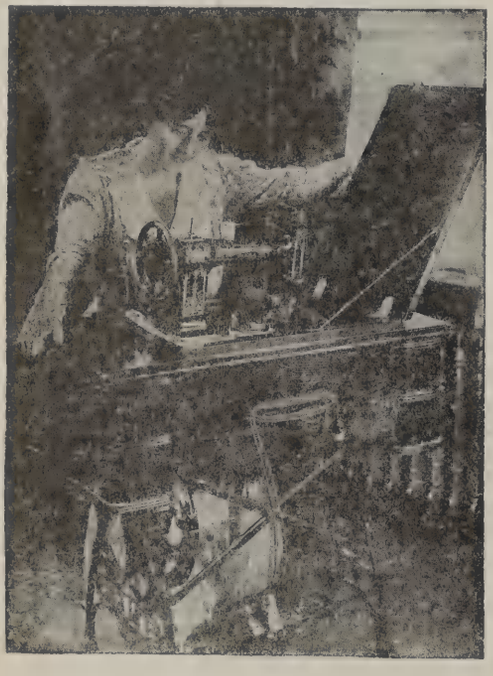
Reversing—Motors, as shipped, will drive the hand wheel of the machine toward the operator. If it should turn in the opposite direction, remove the name plate by taking out the four screws. Remove insulation tubes from connectors as shown to the right and connect leads A1 to F2 and A2 to F1. Replace insulation tubes and nameplate.

Closing Machine—Remove belt from motor pulley and disconnect the separable plug in lead connecting motor to controller. Loosen thumb nut C, as shown on previous page, and swing the motor around, as shown below, and tighten thumb nut C again. Close the machine in the usual way.

Most machines can be closed with the motor in the position described in the preceding paragraph. Where this is impossible, the machine can be closed by removing the belt from motor pulley, loosening thumb nut B, as shown on previous page, and removing motor and base plate from the machine.

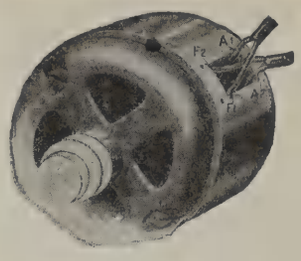
Two screw hooks are supplied with the motor for screwing into the back of the machine to hold the connecting cords when the motor is not in use.

In case it is necessary to tip back the sewing machine head for any reason, loosen thumb nut B and remove motor and baseplate from machine.



CLOSING MACHINE

Oiling—Once every two or three months oil motor by simply unscrewing the two grease cups, one of which is shown on the previous page and filling them with unmedicated vaseline or a good grade of sewing machine oil. Replace grease cups being sure to screw the cups tightly into place.



CONNECTORS FOR REVERSING

The Ten Big Sew-Motor Advantages

(1) It need not be removed from a modern sewing machine, but drops with the head. Motor and speed regulator do not have to be **put away.**

(2) Although easily attached to the sewing machine, it is **firmly mounted,** and does not simply rest there, where a slight jar will displace it, as is the case with other makes.

(3) Drives the sewing machine by means of a **belt,** not a friction pulley. The belt wraps around the sewing machine pulley and motor pulley giving a large arc of contact and consequently **positive drive** with **no slippage.** Friction drive requires great pressure between sewing machine pulley and motor pulley, wearing out bearings. Friction pulleys must be frequently renewed. Belt-drive and careful construction insure quiet running.

(4) Requires no additional belt for winding bobbin.

(5) Although weighing only 7 pounds with speed regulator, cord and plug, it is built with the same care and skill as the 15,000 horsepower motor used by steel mills.

(6) Does not require frequent oiling as do other makes. No oil leaks out to soil material being sewed. Grease cups, requiring only infrequent filling, lubricate the motor thoroughly.

(7) So mounted upon the sewing machine that the right-hand side **table is free** for the operator's material, scissors, tape, etc.

(8) Allows the operator to "sit straight", witl feet on the treadle and not on a small foot speed regulator as supplied with other makes.

(9) Operates the sewing machine at **any speed** from 1 to 1000 stitches a minute. An ingenious speed regulator, which slips on the treadle and **stays there,** controls the speed. The steel speed regulator is indestructible, and thoroughly insulated.

(10) Bears the name "Westinghouse" and is backed by Westinghouse advertising and sales help service.

Ratings

Style No. Standard Outfit	Description	Style No. Singer Outfit
249779	Universal Motor	252400
263543	32-Volt D.C. Motor	262410

FACTORY SEWING-MACHINE MOTORS

ALTERNATING-CURRENT AND DIRECT-CURRENT

¼ H.P. **60-CYCLES** **1700 R.P.M.**

The Westinghouse factory sewing-machine motor is designed for heavy sewing service such as is encountered in clothing shops, department stores, automobile top repair shops, and awning and sail factories. It can be applied to any make of sewing machine and its use converts slow, tedious work into an easy ,fast operation. The time required per piece is diminished and the cost of labor is reduced.

The motor is very quiet in operation and requires practically no attention. The needle is under the absolute control of the operator at all times. A slight pressure of the foot on the treadle is the only effort required to operate the machine even at a speed many times that obtainable when foot power is used. A single stitch can be made, the machine can be run continuously at full speed, or at any intermediate speed. As the foot moves the treadle through only a short distance, the labor of operation is reduced to a minimum. Individual drive of factory sewing machines is rapidly finding favor over the older form of group drive. It permits faster work, allows greater range of speeds and does not cause complete shutdown of the group when one machine meets with an accident.

MOTOR ATTACHED TO THE MACHINE

Description

Motor and Clutch—Modifications of the standard types CA alternating-current and CD direct-current

ALTERNATING-CURRENT MOTOR

motors are used on these outfits. The electrical characteristics of the alternating-current motor are the same as those of the standard starting duty clutchless type CA motor; those of the direct-current motor are the same as those of the compound-wound type CD motor. All the details of the mechanical construction of these motors are the same as those pertaining to the class 600 types CA and CD with the following exceptions:

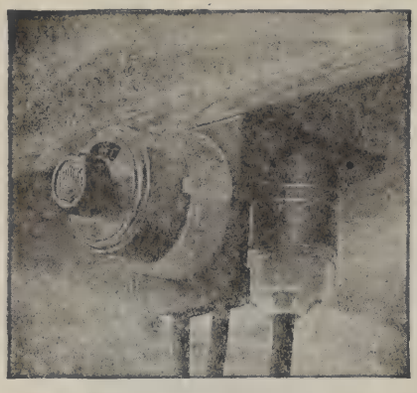
The motor is furnished standard for inverted mounting and is fitted with a support for fastening to the under side of the sewing-machine table. The frame is machined to take the brake arm support, which is held to the frame by means of two tap bolts.

The shaft is longer than the standard and carries a combination clutch and pulley. Also the bearing is longer as it carries the pulley and a thrust bearing.

Full description of the motors will be found in this catalogue under types CD direct-current and CA alternating-current motors, respectively.

The construction of the clutch and the brake is clearly shown on the next page.

DIRECT-CURRENT MOTOR



SWITCH MOUNTED ON TABLE

The combined pulley and brake wheel, which also acts as a part of the clutch, runs free on an extension of the motor shaft bearing. A felt ring lubricates the pulley and a dust-proof oil hole is provided for supplying new oil to the felt when it is required. A thrust bearing is placed between it and the motor frame. The drum which forms the other part of the clutch, is keyed to the shaft and revolves with it at full motor speed all the time the motor is in use. The inside of the brake wheel is lined with a circle of leather to insure a good friction contact.

Fastened to the motor frame by means of tap bolts is the cast-iron brake lever support to which the brake lever is pivoted. The adjustable contact screw at the end of the brake lever takes up the play produced as the brake wears down and is fitted with a hard fibre end which acts on the hardened steel end of the clutch disc when the treadle is pressed. This fibre-to-steel contact insures minimum wear without the use of a lubricant, and as the contacts are rounded the contact surface is small, insuring but slight friction. A spring holds the brake lever closed when the treadle is not pressed.

Application

The factory sewing-machine outfit is composed of a motor having a clutch mounted on one end of the shaft, an adjustable link or rod for connecting the treadle of the machine to the brake lever, and an angle-iron support on which are mounted a detachable plug and a snap switch.

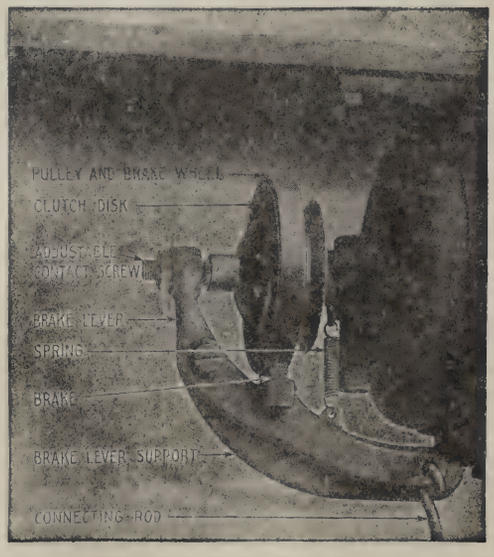
The motor is mounted under the sewing-machine table, at the back, and is secured by means of four bolts. The treadle is disconnected from the wheel and the belt connecting the two wheels is removed. A belt is run from the motor pulley to the small hand wheel of the machine and the treadle is then connected to the brake arm on the motor by means of the connecting rod.

The electrical connections are made from the supply circuit through the separable socket, thence through the switch to the motor. The support carrying the socket and the switch is designed to be mounted at the front or side of the machine, under the table as shown herewith.

Operation

The operation of the sewing machine is not affected in any way, the only difference being that unnecessary work is eliminated and the capacity is greatly increased. The motor is started by means of the snap switch and runs continuously, the machine being started and stopped by the operation of the treadle. A slight pressure on the treadle causes the brake lever to act on the clutch disc causing it to engage the pulley. At the same time the brake on the pulley is released and the motor operates the machine.

Speed Variation—Speed variation is obtained by varying the pressure applied to the treadle. When the pressure on the treadle is removed, a spring causes the brake lever to return to its original position, opening the clutch and applying the brake, causing the machine to stop instantly.



DETAILS OF CLUTCH MECHANISM

RATINGS AND APPROXIMATE WEIGHTS

H.P.	Full Load R.P.M.	Frame No.	Volts	Style* No.	Motor Complete Shipping Wt., Lb.
Alternating-Current—Single-Phase—60-Cycles					
⅛	1725	643	110	230093	40
⅛	1725	643	220	230094	40
Direct-Current—Compound Wound					
⅛	1725	623	115	230095	42
⅛	1725	623	230	230096	42

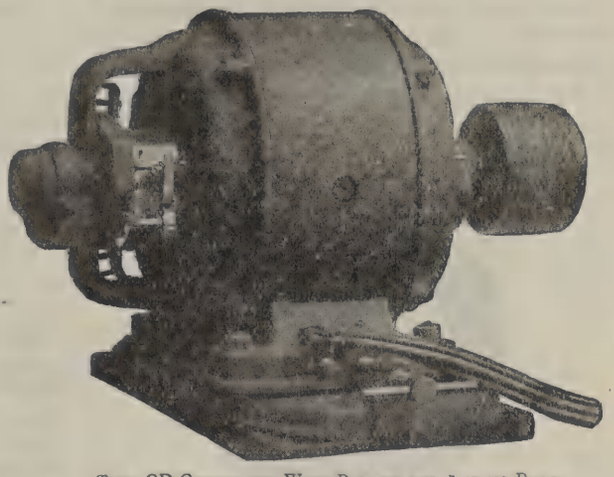
*Style numbers cover motor complete with clutch, brake, control rod, and snap switch. The motors are arranged for mounting in an inverted position, directly beneath the sewing-machine table.

TYPE CD DIRECT-CURRENT GENERATORS

SHUNT AND COMPOUND WOUND **¼ TO 2 KW.** **40, 125 AND 250 VOLTS**

Westinghouse type CD generators of small capacity are suitable for use as part of farm lighting outfits, for lighting country residences, and for furnishing light and power to small industrial plants in localities where central station power is not available. Their applications include battery charging and exciter service.

They are characterized by simple and rugged construction, light weight, small size and excellent commutation. These generators can be easily installed, and require little attention beyond occasional oiling of the bearings and wiping of the commutator with a piece of dry canvas.



TYPE CD GENERATOR WITH PULLEY AND SLIDING BASE

Construction

The type CD generator is similar to the type CD motor in construction except that the windings are proportioned to give the desired electrical characteristics as a generator.

Classes of Service

The inherent electrical characteristics of generators are different for each of the following classes of service, although the mechanical construction is the same in each case. The difference in electrical characteristics for the various classes of service is stated under the application heads. To insure proper application, mention the kind of service desired when ordering a generator.

Lighting—Generators used for lighting purposes must have good voltage regulation between no load and full load, and stability of voltage for moderate changes of load, consequently, type CD compound-wound generators are used for this service.

The compounding effect of CD compound-wound generators is approximately 6 per cent of the rated voltage, speed remaining constant, and shunt field rheostat being properly adjusted. They give under the conditions stated:

No-Load Voltage	Full-Load Voltage
118	125
235	250

Stock machines are connected for clockwise rotation viewed from commutator end. If counter-clockwise rotation is desired, this should be stated when ordering. A diagram of connections for either direction of rotation is furnished with each generator.

Note—When type CD generators are desired to operate with a variation of more than 5 per cent from rated voltage and speed, a special compound winding and a special field rheostat are required to maintain good voltage regulation.

Battery Charging—Generators for charging storage batteries, of all capacities, are generally shunt wound. When the range of charging voltage is

BRACKETS SHOWING BRUSHHOLDERS

TYPE CD DIRECT-CURRENT GENERATORS—Continued

wide, special care has to be taken that stability of voltage is obtained.

The chief objection to the use of a compound-wound generator in battery charging service is that there is danger of a reversal of polarity, if the battery is allowed to discharge through the generator.

The inherent voltage characteristic of a shunt-wound generator is such that current cannot flow from the battery into the generator as long as the

INTERIOR OF FRONT BRACKET

generator is running at normal speed, and the polarity will not be reversed even though the generator speed is momentarily reduced.

Farm Lighting Generators and Batteries—The battery voltage, and hence the generator voltage, used for farm lighting outfits, depends somewhat on the capacity required, but the question of first cost, and cost of battery renewal are also determining factors.

Some farm lighting outfits use 110-volt storage batteries, which require a 125-volt generator for charging.

The 32-volt batteries requiring 16 cells of the lead type or 27 cells of the nickel-iron-alkaline type are practically standard for farm lighting outfits. Their capacities generally range from 40 ampere-hours to 80 ampere-hours on an 8-hour basis. These 32-volt batteries require a finishing charge of approximately 40 volts, regardless of the size of battery, and the Westinghouse type CD 40-volt shunt-wound generator is designed and constructed especially for charging batteries of such a voltage.

Types of Drive—Westinghouse battery-charging type CD generators may be either belt driven, or direct connected to the prime mover.

Speeds—The standard speeds for type CD battery-charging generators of both types of drive, are those listed, but these generators can be supplied for other speeds.

Accessories for Farm Lighting Outfits

Field Rheostat—A suitable field rheostat is included with the standard generators listed. Some outfits omit the field rheostat, and secure the necessary adjustment of voltage by changing the speed of the engine either by hand or by means of an electrically-operated governor.

Control Panel—The control panel used with the belted generators consists of slate with black marine finish, on which the following pieces of apparatus are mounted; double-pole line knife switch; enclosed fuses in the service lines; ammeter; voltmeter; reverse-current circuit-breaker and field rheostat.

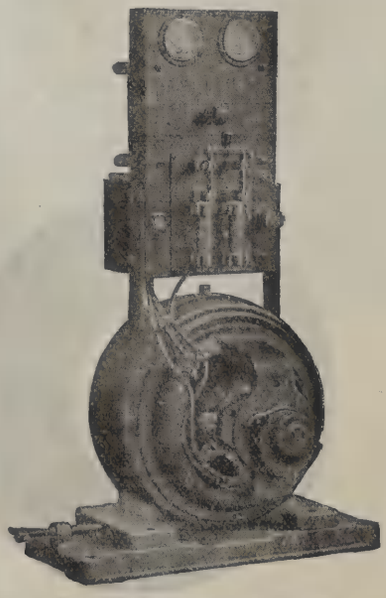
Control panels for direct connected outfits may contain all the apparatus used with belt-driven outfits, or may be somewhat simplified.

The smaller generators may have the control panels mounted on the generator frame, the whole outfit forming a very neat and compact unit.

Special Apparatus for 32-Volt Outfits—The following Westinghouse apparatus of acknowledged reliability and efficiency, is available for operation on 30 to 32-volt circuits: Fans of the desk and bracket type, both oscillating and non-oscillating. General purpose motors. Sew-Motors for sewing machines. Also the following machines may be purchased equipped with Westinghouse motors: Washing machines, ironing machines, pumps, and cream separators. The Westinghouse Lamp Company can supply lamps of the following watt sizes for use on 30 to 32-volt circuits, namely, 5, 10, 15, 20, 25, 40 and 50 watts.

Exciters

In generators for exciter service, close voltage regulation is not necessary. Voltage adjustment over a wide range is often required and it is customary to furnish shunt-wound generators with rheostats which will cover a voltage range from one-fifth full rated voltage at one-fifth full-load current



TYPE CD GENERATOR AND PANEL

38-55-A

TYPE CD DIRECT-CURRENT GENERATORS—Continued

STATOR OR FRAME

up to rated voltage at full-load current. Compound-wound generators sometimes used for this class of service are wound to deliver approximately constant voltage from no load to full load.

Accessories for All Classes of Generators

Pulley—Crown paper pulleys are standard.

Sliding Base—Where adjustment of belt tension is frequent or where a greater adjustment than that allowed by the slots in the feet is desired, sliding bases can be supplied.

Field Rheostat—A wall mounting field rheostat is furnished as standard with each generator for regulating the voltage. A switchboard mounting field rheostat can be furnished when desired.

*RATINGS AND APPROXIMATE WEIGHTS

125 and 250 Volt Compound Wound Generators for General Service

Kw.	Amperes at 125 Volts	Amperes at 250 Volts	Full Load R.P.M.	Frame No.	Standard Pulley Data Dia. x Face Inches	Approx. Shipping Wt. in Lbs. Generator, Sliding Base, Pulley and Rheostat	Deduct for Omission of ‡Sliding Base
¼	2	1	1725	625	3 x1¾	55	7
½	4	2	2150	723	3½x2½	85	15
¾	6	3	2150	725	3½x2½	100	15
1	8	4	2150	823	3½x3	160	20
1½	12	6	2150	825	3½x3	175	20
1½	12	6	1450	925	4 x3	290	35
2	16	8	2000	923	4 x3	290	35
2	16	8	1750	925	4 x3	290	35

40 Volt, Shunt Wound Generators for Charging 32-Volt Batteries

Kw.	Full Load R.P.M.	Frame No.	Standard Pulley Data Style No.	Standard Pulley Data Dia. x Face Inches	Generator With Sliding ‡Base Pulley and Rheostat *Style No.	Generator With Sliding ‡Base Pulley and Rheostat Shipping Weight Lbs.	Deduct for Omission of Sliding Base Style No.	Deduct for Omission of Sliding Base Shipping Wt. in Lbs.
.50	1800	723	100443	3½x2½	283070	65	188501	15
.65	1725	725	100443	3½x2½	283071	75	188501	15
.80	1800	823	100444	3½x3	283072	115	188502	35
1.00	1700	823-C	100444	3½x3	283073	160	188913	35

†Style number covers generators only—sliding base, pulley and rheostat are not included.

‡All frames have feet slotted (except 823-C frame which has drilled holes in feet) for belt adjustment, and sliding base may be omitted.

For outline dimensions refer to Type CD Motors.

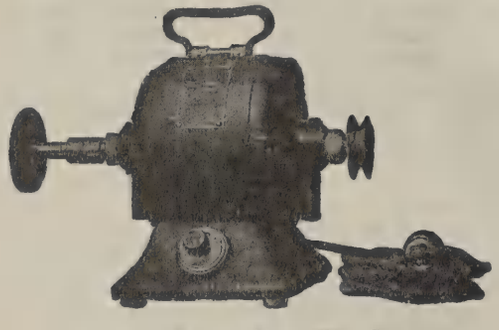
BUFFING, POLISHING AND GRINDING MOTORS

ALTERNATING AND DIRECT-CURRENT

⅙ H.P. Alternating-Current Buffing, Polishing and Grinding Motor

Westinghouse buffing, polishing and grinding motors are suitable for light polishing and grinding of all kinds. They are used by jewelers, dentists and opticians for buffing and polishing, and for operating small tools by means of Ritter chucks; by machine shops and garages for buffing and light grinding, and by hotels, restaurants, and in the home for cleaning silver, polishing metalware, sharpening knives, tools, etc. With the addition of a flexible shaft the motor becomes a portable tool, and is convenient for cleaning and polishing decorative metal work, metal parts of automobiles, etc.

These little motors are clean, quiet in operation, and are easily installed and operated. The wiring and connections are simple; starting and stopping



Alternating-Current Motor With Grinding Wheel and Pulley

are effected by a small switch in the base, and little attention beyond occasional lubrication is needed. The cost per hour for power is very small.

Construction

The motor frame is a cylindrical iron casting. It is absolutely dust-proof and affords full protection to the interior parts.

The base is a hollow casting bolted to the frame and is of just the right height to allow the necessary clearance between the buffing wheel and motor support.

The shaft is extended at both ends for chucks which carry the buffing and grinding wheels.

A flexible shaft can be obtained from the Stow Manufacturing Company, Binghamton, N. Y. In ordering, specify rating of motor.

The bearings are bronze bushings pressed into housings in the bearing brackets. They are of the wick-fed, self-oiling type with ample provision against dripping. Machine oil or unmedicated vaseline is recommended as a lubricant.

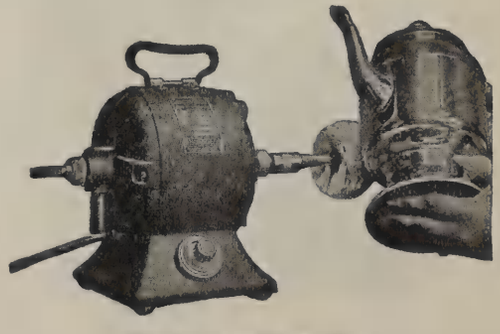
Direct-Current Motor With Grinding and Buffing Wheels

Speed—The speed chosen is the most desirable single speed which eliminates the complications of multi-speed motors and results in a simpler, more rigid and less expensive motor.

Finish—Glossy black japan.

Ordering

In ordering a buffing and grinding outfit give style number of motor and attachments. Connecting cord and plug are furnished with the motors. Table I gives the ratings and style numbers of the motors. Table II gives the list of attachments and style numbers.



Polishing the Nickel Ware

BUFFING, POLISHING AND GRINDING MOTORS—Continued

Ratings and Style Numbers

Table I—1/6 H.P. Direct and Alternating-Current Motors

Alternating Current 60 Cycles Single Phase

H.P.	Volts	Approx. Full Load R.P.M.	Style No. Motor Only
1/6	110	3500	273963
1/6	220	3500	273964
		Direct-Current	
1/6	115	2550	273965
1/6	230	2550	273966

RITTER CHUCKS FOR BUFFING MOTORS

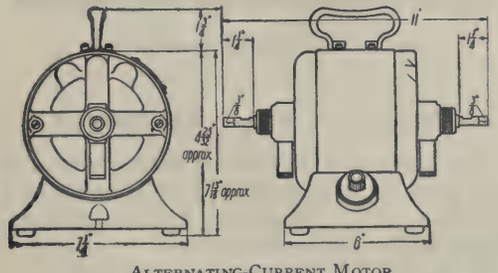
Table II—Attachments for Direct-Current and Alternating-Current Motors

Article	Style No.
Right-hand tapered chuck	164229
Left-hand tapered chuck	164230
Right-hand flange chuck	164231
Left-hand flange chuck	164232
Buffing wheel, 3-in. diam., 30 ply	121666
1 in. dia. stick of rouge, 3 in. long	134613
Carborundum wheel, 3 in. dia., 1/4 in. face, 1/16-in. bore	121665
Brush wheel, 3 in. dia	125815
Adapter for Ritter chucks	164228
Set of Ritter chucks*	139589

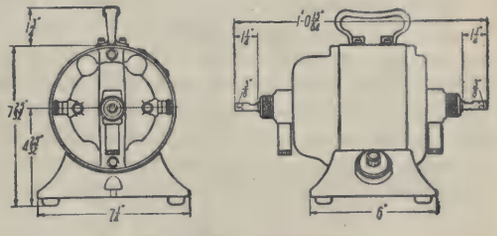
*Sold only in sets of eight, viz,. three right-hand and three-left-hand flange chucks, 1/4 inch, 1/16 inch and 3/8 inch hub, one left-hand tapered chuck for buffing wheels, and an adjustable chuck for drills, burs, etc. An adapter is necessary with each set.

ATTACHMENTS FOR THE MOTORS

DIMENSIONS



ALTERNATING-CURRENT MOTOR



DIRECT-CURRENT MOTOR

SMALL MOTOR-GENERATORS

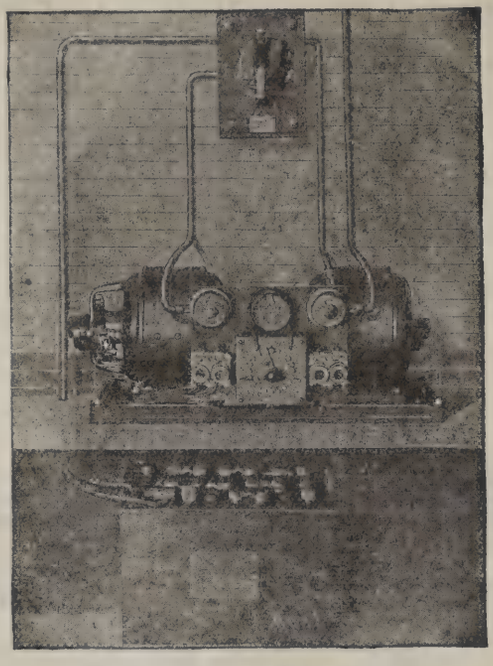
FOR CHARGING LIGHTING, STARTING AND IGNITION BATTERIES

For charging a storage battery, direct current at a voltage slightly higher than that of the battery is necessary. Standard batteries used with gasoline automobiles are 6, 12 or 18 volts. This low voltage direct current can be economically obtained from the lighting or supply circuit by means of a Westinghouse motor-generator for battery charging service.

The motor-generator is made up of an alternating-current motor and a low-voltage direct-current generator suitable for charging several different sizes of batteries.

The No. 1 set is a self-contained, two-bearing set having a common frame. In sets No. 2 and larger, the motors are type CA flexibly coupled to low-voltage shunt-wound type CD generators and mounted on common cast-iron bases. All sets are clean, quiet, simple, and compact so that they require little space or attention.

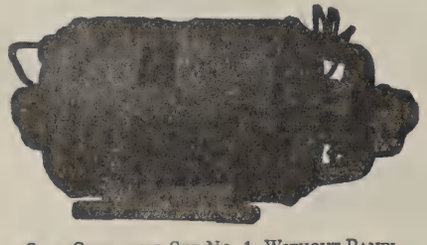
When desired, a control panel with the necessary controlling rheostat, meter, switches and fuses can be supplied mounted on the set and wired ready for operation.



MOTOR-GENERATOR CHARGING BATTERY

Operation

The operation is very simple. The motor is first connected to the supply circuit and is controlled by means of a snap switch. The battery is connected to the generator terminals and the ampere charging rate adjusted by means of the field rheostat to the value shown on the battery nameplate. The charging is continued according to the method recommended by the battery manufacturers. As the generator is shunt wound, its voltage increases as the ampere load decreases; that is, as the battery approaches the charged condition the generator voltage automatically rises producing the higher voltage required for finishing the charge. This voltage characteristic is a great advantage where a lead battery is to be charged because it permits the operator to give the battery an equalizing charge or a long-period, low-rate charge which keeps up the capacity and prolongs the life of the lead battery.



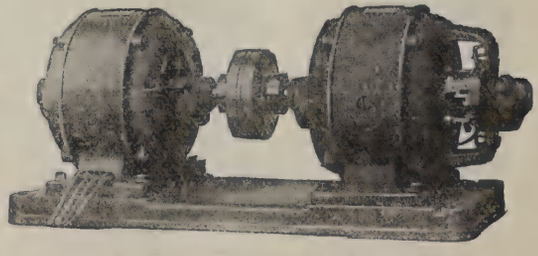
SELF-CONTAINED SET NO. 1 WITHOUT PANEL

Selection of Proper Equipment

The selection of the proper motor-generator to best meet the conditions of a garage requires a knowledge of the charging to be done. The following points must be determined.

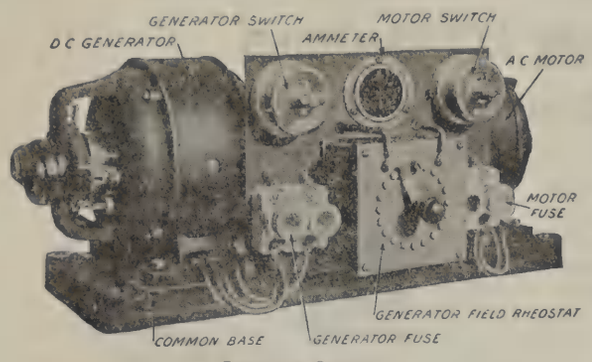
1. The characteristics of the supply circuit.
2. The maximum and minimum charging rates that will be required by the batteries.
3. The probable voltages of batteries.
4. The probable maximum number and type of batteries to be charged in series at one time.

The characteristics of the motor to be used will be determined by (1) while the current and voltage rating of the generator will be determined by (2), (3) and (4).



SET NO. 2, 3, 4, 5 OR 6 WITHOUT CONTROL PANEL

WESTINGHOUSE MOTOR-GENERATORS—Continued

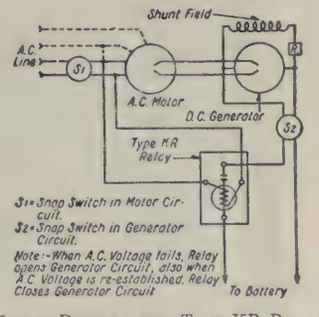


COMPLETE OUTFIT

TYPE KR RELAY, AFFORDING REVERSE CURRENT PROTECTION

KR Relay

To afford reverse current protection or provide against the battery operating the generator as a motor, if the supply voltage for the motor should fail, a type KR relay consisting of a direct-current circuit-breaker with an alternating-current low-voltage release coil on a slate panel for separate mounting can be furnished at a small additional price, when desired.



WIRING DIAGRAM FOR TYPE KR RELAY

RATINGS

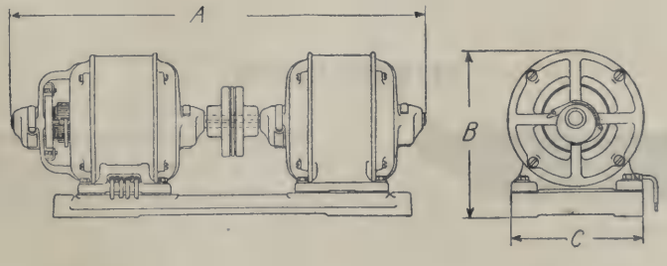
Set No.	Watts	Volts	Amperes	Batteries Charged	R.P.M.
*1	100	12	8	(a)	1725
2	170	12	14	(a)	1725
3	250	32	8	(b)	1725
4	440	32	14	(b)	1725
5	400	50	8	(c)	1725
6	700	50	14	(c)	1725

These sets can be furnished for operation on either a 110 or a 220-volt, 60-cycle, single-phase alternating-current circuit.

*Self-contained set.

(a) Will charge one or two 6-volt batteries, or one 12-volt battery.
(b) Will charge one to five 6-volt batteries, or their equivalent in 12, 18 or 24-volt batteries.
(c) Will charge one to eight 6-volt batteries, or their equivalent in 12, 18 or 24-volt batteries.

APPROXIMATE OVERALL DIMENSIONS



Set No.	Approximate Dimensions in Inches A	B	C
1	$15\frac{9}{16}$	$7\frac{3}{8}$	$7\frac{1}{8}$
2	$24\frac{11}{32}$	$8\frac{5}{8}$	$7\frac{3}{4}$
3	25	$10\frac{7}{16}$	$8\frac{5}{8}$
4	$25\frac{5}{8}$	$10\frac{7}{16}$	$8\frac{5}{8}$
5	25	$10\frac{7}{16}$	$8\frac{5}{8}$
6	$30\frac{1}{16}$	$11\frac{13}{16}$	$10\frac{3}{16}$

SMALL MOTOR ACCESSORIES

POLISHING AND GRINDING ATTACHMENTS

Polishing and Grinding Attachments—The chucks listed below can be attached directly to the motor shaft. They carry the polishing and grinding wheels as listed. They may also be used to carry special wheels which may be purchased from the manufacturers by giving proper bore and width.

TYPE CA MOTOR WITH CHUCKS

Fig.	Item No.	Style No.	Description
1	1	164226	Combination chuck to fit motor frame class 300, types CA and CD.
1	2	189977	Combination chuck to fit motor frame class 400, types CA and CD.
1	3	189978	Combination chuck to fit motor frame class 500, types CA, CD, and frames 400 and 500 types CAH and CDH.
1	4	164233	Combination chuck to fit motor frame class 600, types CA and CD.
2	5	164227	*3 Step jeweler's chuck to fit motor frame class 300, types CA and CD.
2	6	189979	*3 Step jeweler's chuck to fit motor frame class 400, types CA and CD.
2	7	189980	*3 Step jeweler's chuck to fit motor frame class 500, types CA and CD and frames 400 and 500 types CAH and CDH.
3	8	122650-A	Carborundum wheel ¾-inch face, 2½-inch diameter, ½-inch bore; to fit items 1, 2, and 3.
3	9	125787	Carborundum wheel ⅞-inch face, 3-inch diameter, ⅝-inch bore; to fit item 4.
5	10	121666	Buffing wheel 3-inch diameter, 30 ply to fit items 1, 2, 3, and 4.
5	11	121667	Buffing wheel 4-inch diameter, 40 ply to fit item 4.
4	12	125815	Brush wheel 3-inch diameter to fit items 1. 2, 3 and 4.
	13	184511	Connecting cord and plug, 10-foot reinforced cord, with plug and terminal clip for use with ⅙-horsepower motor and smaller.

*For grinding wheels of ¼, $\frac{5}{16}$ and ⅜-inch bore.

CHUCKS AND WHEELS

SLIDING BASES

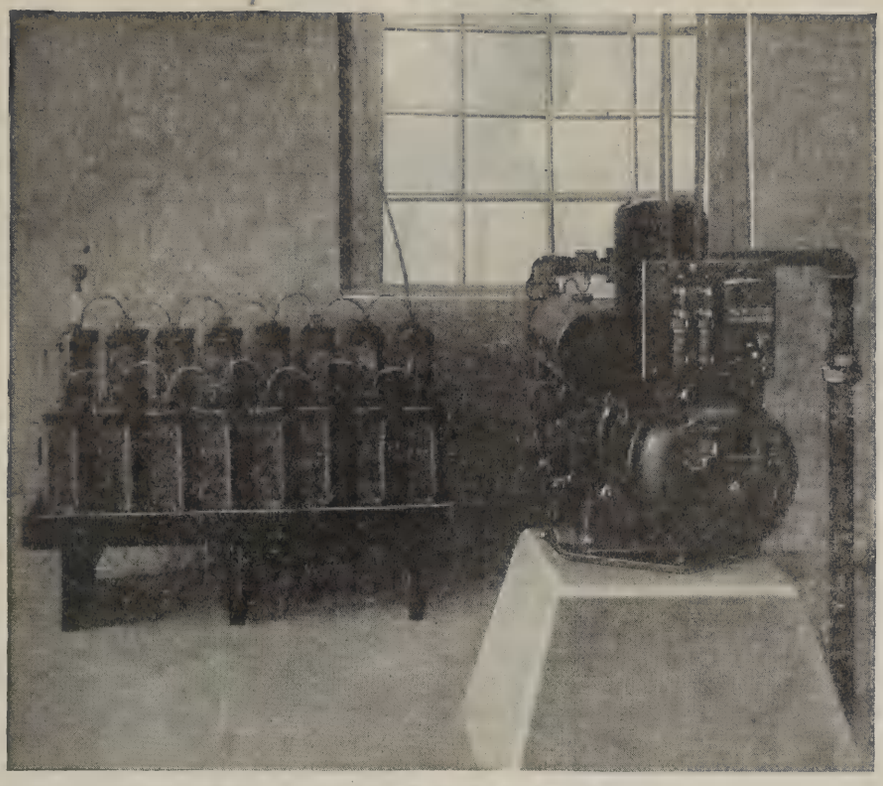
SLIDING BASE

Sliding Bases—Sliding bases with belt-tightening device can be supplied for use with belted motors, where frequent adjustment of belt tension is necessary.

Style No.	Description	Approx. Net Wt.	Approx. Shipping Wt.
184549	Sliding base for class 500 frame, types CA and CD and Class 400 and 500 frames types CAH and CDH	5	7
184554	Sliding base for class 600 frame, types CA, CD, and CSA	5	9
188501	Sliding base for class 700 frame, types CA, CD, and CSA and 065 frame, type AR	25	34
188502	Sliding base for class 800 frame, types CA, CD, and CSA, 103 frame, type CW, and 100 frame, type AR	25	34

WESTINGHOUSE ELECTRIC FARM UNIT

A Complete Electric Light and Power Plant for Farms



1 Kw. Westinghouse Electric Farm Unit Complete

The Westinghouse Electric Farm Unit is a complete light and power plant for farms, country homes, resorts and all other locations where central station current is not available. It consists of a shunt wound, 1000 watt, 1200 rpm. 32 volt generator, direct connected to a 2½ horsepower, single cylinder engine, both mounted on a small 3-point base. A 16-cell "lead acid" storage battery of either 80 ampere-hour or 160 ampere-hour capacity is furnished with the unit.

The engine, generator and switchboard form a very compact unit. With the battery, it requires very little floor space and can be mounted in practically any location desired.

The engine operates at a constant speed, controlled by a fly-ball governor. This provides a constant voltage for the battery while charging and prevents the disastrous effects of a widely fluctuating voltage which is likely to result where the engine speed is not constant.

Either kerosene or gasoline may be used as fuel. The proper mixture is provided by means of a mixing valve which is adjusted before the units are shipped from the factory. A battery ignition system such as used on automobiles is used with this unit.

The generator is especially designed to give a tapering battery charge. Beginning with low voltage and high current and finishing with high voltage and low current, the charging characteristics of this generator meet the battery specifications to the letter and so insure long life to the battery.

When the battery is fully charged, a mechanical automatic device stops the engine. This consists of a cyclometer, driven from the end of the armature shaft, which records the number of hours the unit runs. It is set to correspond with the scale of the special hydrometer furnished with the Westinghouse Electric Farm Unit, which reads in hours required to charge the battery fully, instead of the usual specific gravity. When the zero point on the cyclometer or battery meter is reached the ignition circuit is broken and the engine automatically stops.

Both the engine and the generator are air-cooled. The flywheel acts as a suction blower, drawing in air through the perforated cylinder cover. The generator is cooled independently by means of a blower built directly on the armature shaft. It draws in air through the perforated cover and forces it out through screened openings provided in the frame.

The switchboard contains the starting switch, main line switch with fuses, ignition coil and cutout relay.

Complete Information on Request

WESTINGHOUSE ELECTRIC POWER STAND

The Westinghouse Electric Power Stand is a portable electric motor, designed especially for operating such devices as washing machines, churns, grindstones, separators, etc., on the farm, formerly operated by hand.

The Power Stand complete consists of a ¼ horsepower, compound wound, 32-volt motor mounted on a substantial tripod base. In addition, there is an adjustable, telescopic bracing rod for securing the proper belt tension, and a ten foot extension cord with plug. A handle is provided for carrying the stand from place to place.

The motor of the Westinghouse Electric Power Stand is designed so that it may be mounted on the regular Westinghouse motor sliding base when desired.

It operates at a speed of 2100 and 250 rmp., the speed reduction necessary for hand-operated devices being secured by mounting a pulley shaft on the motor itself, which is driven by enclosed gears from the armature shaft.

Flat-faced pulleys are provided because the torque of slow speed motors can not be transmitted as well with a round belt as with a flat belt. A slow-speed grooved pulley for round belts is supplied for use where the power requirements are small. Flanges are supplied on the flat-faced pulleys so that the belt will not slip off if the two pulleys are not on an exact line.

A thorough analysis of pulley sizes required by the various devices used on farms was made before determining the speed and diameters of the pulleys for the power stand. The back geared pulleys operate at 250 rpm., the grooved pulley being 2¾-inch pitch diameter and the flat-faced pulley 6⅝-inch pitch diameter. The high speed pulleys operate at 2100 rpm., the grooved pulley being 2-inch pitch diameter and the flat-faced pulley 1½-inch pitch diameter. The high speed pulleys are not mounted together like the back-geared ones but are interchangeable.

32-Volt Electric Fans

A complete line of electric fans with 32-volt electric motors for use with the Westinghouse Electric Farm Unit and other farm lighting plants is manufactured by Westinghouse Electric. This includes both desk and wall fans of various sizes and ceiling fans, commonly used for dairies and milk houses. Complete information and prices are given in Section 8-A, Westinghouse Electric Fans, of this catalogue.

32-Volt Heating Appliances

Curling Irons and Warming Pads, designed for use on 32-volt circuits, are listed and illustrated in Section 8-C Westinghouse Electric Ware, of this catalogue. Other 32-volt appliances are in the process of production. These will be announced from time to time.

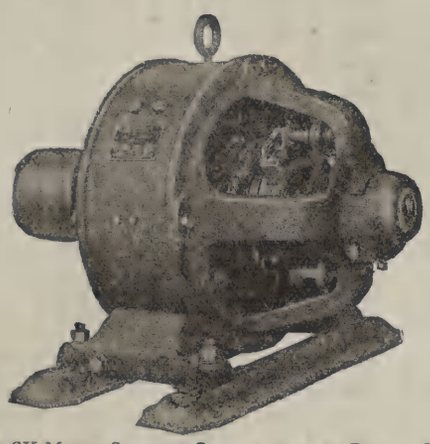
Complete Information on Request

TYPE SK COMMUTATING-POLE MOTORS AND GENERATORS

1½ TO 250 H.P.* DIRECT CURRENT **115, 230 AND 550 VOLTS**

CONSTANT, VARYING AND ADJUSTABLE SPEEDS

Westinghouse type SK motors are designed for general constant-speed and adjustable-speed power service, and therefore find extensive application to machines used in practically every industry. They are equally suitable for driving machine tools and for other classes of service where the load is frequently started, stopped or reversed.



TYPE SK MOTOR SHOWING CONSTRUCTION OF ROLLED OPEN HEARTH STEEL FRAMES 180 AND SMALLER

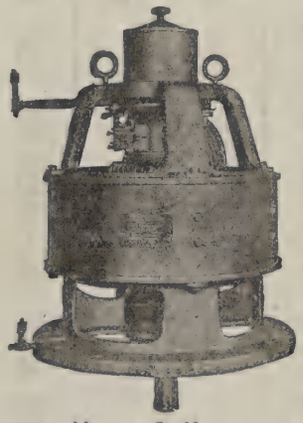
Type SK generators are designed for supplying electrical energy in places where an independent source is desired. They also find a wide use as exciters, and for charging storage batteries.

TYPE SK ELEVATOR MOTOR

*For smaller Ratings see type CD Motors.

ENTIRELY ENCLOSED TYPE SK MOTOR

The chief features of Type SK motors and generators are their admirable operating characteristics. The use of commutating poles insures excellent commutation under all conditions of load and speed with fixed brush position. The efficiency is high and the overload capacity is ample for any service within the range of the machine. The bearings are dust-proof and of large area. Oil-ring lubrication is used. The lubricating system is so designed that no oil from the reservoir can be thrown either outside or inside the motor.



TYPE SK VERTICAL MOTOR. IF NECESSARY FOR SHAFT TO CLEAR FLOOR EXTENDED LOWER BRACKET CAN BE FURNISHED

Besides the standard open type SK motors they are made with splash-proof, semi or totally enclosed frames, with back gears, with conduit terminal box, with idler pulleys and with vertical shafts. Special designs for elevator service can also be furnished.

Complete descriptions of these motors will be found in Westinghouse Catalogue 30.

TYPE SK COMMUTATING-POLE MOTORS AND GENERATORS—Continued

MOTOR RATINGS

H.P.	APPROX. R.P.M.						Frame No.	PULLEYS		
	115 VOLTS		230 VOLTS,		550 VOLTS			Standard Pulley Dia. X Face	With Standard Shaft Extension Min. Dia. X Max. Face	With Special Shaft Extension Min. Dia. X Max. Fac
	Min.	Max **	Min.	Max. **	Min.	Max. **				
...	....	....	....	....	....	....	10	4 x 3	3½ x 4	2½ x 10
...	....	....	....	....	....	....	10	4 x 3	2½ x 6	2½ x 10
2	850	1700	850	1700	900	1800	20	4 x 4	3½ x 7	3 x 11
...	....	....	....	....	....	....	10	4 x 3	3½ x 4	2½ x 10
3	1150	2100	1150	2100	1200	1800	20	4 x 4	3½ x 7	3 x 11
3½	850	1700	850	1700	900	1800	30	5 x 4½	4 x 8	3 x 13
5	1800	2070	1800	2070	1800	2070	20	4 x 4	3½ x 7	3 x 11
5	1100	2000	1100	2000	1200	2000	30	5 x 4	4 x 8	3 x 13
5	850	1700	850	1700	....	....	40	6 x 5	5 x 8	4 x 13
5	....	....	....	....	850	1300	50	7 x 6	6 x 8	5 x 13
7½	....	....	1700	1950	1750	2000	30	5 x 4½	4 x 8	3 x 13
7½	1150	1725	1150	1725	1150	1725	40	6 x 5	5 x 8	4 x 13
7½	850*	1700	850	1700	850	1275	60	7 x 6	6 x 8	5 x 13
10	....	....	1700	1950	1700	1950	40	6 x 5	5 8	4 x 13
10	1700*	1950	....	....	....	....	50	7 x 6	6 x 8	5 x 13
10	1150*	1700	1150*	1700	1150	1625	60	7 x 6	6 x 10	5 x 13
10	850*	1700	850	1700	850	1700	70	8 x 7	6 x 10	6 x 13
10	600	1200	600	1200	600	1200	90	9 x 8	7 x 11	7 x 14
15	....	....	1700*	1950	1700*	1950	50	7 x 6	6 x 10	5 x 13
15	1100*	1650	1100*	1650	1100*	1650	80	8 x 7	6 x 10	6 x 14
15	825	1650	825	1650	825	1650	90	9 x 8	7 x 11	7 x 14
15	675*	1350	675*	1350	....	....	100	10 x 9	8 x 11	7 x 15
20	....	....	1700*	1950	1700*	1950	70	8 x 7	6 x 10	6 x 13
20	1100	1650	1100	1650	1100	1650	90	9 x 8	7 x 11	7 x 14
20	900*	1350	900*	1350	900*	1350	100	10 x 9	8 x 11	7 x 15
20	750*	1500	750*	1500	750*	1500	110	11 x 10	9 x 12	8 x 15
25	1100*	1650	1100*	1650	1100*	1650	100	10 x 9	8 x 11	7 x 15
25	825*	1650	825	1650	825	1650	120	11 x 10	9 x 13	8 x 16
25	600	1200	600	1200	600	1200	130	12 x 12	10 x 14	9 x 20
30	....	....	1700	1950	1700	1950	90	9 x 8	7 x 11	7 x 14
30	1150*	1320	1150*	1320	1150*	1320	110	11 x 10	9 x 12	8 x 15
30	975*	1450	975	1450	975	1450	120	11 x 10	9 x 13	8 x 16
30	725	1450	725	1450	725	1100	130	12 x 12	10 x 14	9 x 20
30	600	1200	600	1200	600	1200	140	13 x 12	11 x 15	9 x 22
40	....	....	1700*	1950	1700*	1950	110	11 x 10	9 x 12	8 x 15
40	1150*	1450	1150	1325*	1150*	1325	120	11 x 10	9 x 13	8 x 16
40	775*	1160	775	1160	775	1150	140	13 x 12	11 x 15	9 x 22
40	600	1200	600	1200	600	1200	150	14 x 12	13 x 15	11 x 20
50	....	....	1700*	1950	1700*	1950	120	11 x 10	9 x 13	8 x 16
50	....	....	1100	1270	....	....	130	12 x 12	10 x 14	9 x 20
50	750*	1125	750	1125	750	1125	150	14 x 12	13 x 15	11 x 20
50	565	1130	565	1130	565	1130	160	16 x 13	14 x 16	12 x 24
60	....	....	1700	1870	1700	1870	130	12 x 12	10 x 14	9 x 20
60	....	....	875	1000	875	1000	150	14 x 12	13 x 15	11 x 20
60	....	....	680	1020	680	1020	160	16 x 13	14 x 16	12 x 24
75	....	....	1700*	1870	1700	1870	140	13 x 12	11 x 15	9 x 22
75	....	....	1100	1270	1100	1270	150	14 x 12	13 x 15	11 x 22
75	....	....	850	980	850	980	160	16 x 13	14 x 16	12 x 24
75	....	....	635	950	635	950	170	18 x 15	16 x 18	14 x 24
75	....	....	475	700	475	700	180	21 x 17	18 x 20	16 x 25
100	....	....	1700*	1870	....	....	142	14 x 12	13 x 15	11 x 20
100	....	....	1100	1210	1100	1210	160	16 x 13	14 x 16	12 x 24
100	....	....	850	980	850	980	170	18 x 15	16 x 18	14 x 24
100	....	....	625	950	....	....	180	21 x 17	18 x 20	16 x 25
125	....	....	720	830	720	860	180	21 x 17	18 x 20	16 x 25
125	....	....	....	....	1100	1210	170	18 x 15	16 x 18	14 x 24
125	....	....	600	690	600	690	190	23 x 19	21 x 20	19 x 25
150‡	....	....	1100*	1210	1100	1210	180	.....	.....	.....
150	....	....	550	630	550	630	200	26 x 21	26 x 21	22 x 28
200†‡	....	....	1100	1210	....	....	181	23 x 19	21 x 20	19 x 28
200‡‡	....	....	850	980	....	....	191	.....	.....	20 x 25
200	....	....	500	575	500	575	210	30 x 24	30 x 24	28 x 30
250	....	....	425	490	425	490	220	34 x 28	34 x 28	32 x 34

*Lengthened commutator- frame designation consists of number followed by "L," thus, 50 L,

‡Coupled service only.

**Maximum speeds listed are for shunt-wound motors only. For compound-wound motors the speed can be adjusted by shunt field control up to 15 per cent above the minimum speed except where otherwise noted,

††115 and 230 volts compound-wound motors up to and including 10 h.p. of all speeds may be used for self-starting service.

‡‡These are pedestal type motor.

§Varying Speed.

All motors listed above will operate continuously at full rating without injury on 10 per cent higher or lower than rated voltage.

TYPE SK COMMUTATING-POLE MOTORS AND GENERATORS—Continued

GENERATOR RATINGS

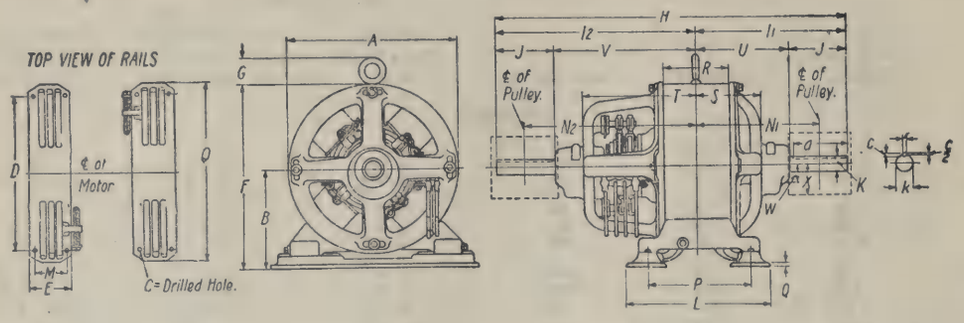
Kw.	Full Load R.P.M.	Amperes	Frame No.	Standard Dia. x Face Inches	PULLEY WITH STANDARD SHAFT EXTENSION Min. Dia. x Max. Face	SPECIAL SHAFT Min. Dia. x Max. Face
			125 VOLTS			
3	1700	24	20	4x 4	4x 7	3⅛x10
3	1500	24	30	5x 4½	4x 7½	3½x10
4½	1740	30	30	5x 4½	4x 7½	4x 10
5	1120	40	40	7x 6	6x 8	5 x11
6	1480	48	40	7x 6	6x 8	5 x11
7	1740	56	40	7x 6	6 x8	5 x11
10	750	80	100-L	10x 9	8x11	7 x15
12½	875	100	100-L	10x 9	8x11	[illegible] x15
14	1450	112	80-L	9x [illegible]	8x10	7 x15
18	1100	144	100-L	10x 9	9x11	8 x15
20	1450	160	90	9x [illegible]	9x11	[illegible] x15
25	1450	200	100-L	10x 9	9x11	8½x15
25	1150	200	120-L	11x10	10x12	8½x17
27½	925	220	130	12x12	11x13	10 x18
30	750	240	140	14x12	13x35	12 x20
35	775	280	150	14x12	13x15	12 x20
			250 VOLTS			
50	835	200	160	18x15	16x16	12 x22
75	900	300	170	18x15	17x18	15 x23
75	650	300	180	21x17	19x20	16 x25
100	900	400	180	21x17	19x20	16 x25
100	700	400	190	25x17	23x20	20 x25
150	600	600	201	30x21	30x21	27 x27

Slow Speed for Direct Connected Service—125 and 250 Volts

Kw.	R.P.M.	Frame	AMPERES 125 V.	250 V.
2⅞	800	30	22.2	11.1
3	450	80	24	12
3¾	800	40	30	15
4	700	50*	32	16
5½	700	70	44	22
6	300	120	48	24
6¼	400	100	50	25
6¾	600	80*	54	27
9	390	130	72	36
9	250	140	72	36
10	550	100-L	80	40
12½	350	140	100	50
12½	250	130	100	50
15	600	120	120	60
15	475	130	120	60
15	300	150	120	60
15	250	160	120	60
18	300	160	144	72
18	250	170	144	72
19	600	130	152	76
20	500	140	160	80
22½	500	150	180	90
25	310	170	200	100
25	240	180	200	100
26½	425	160	212	106
27½	500	160	220	110
30	300	180	240	120
30	220	181	240	120

OUTLINE DIMENSIONS

Frames 10 to 110 Inclusive—With Slide-Rails



Frame No.	Dimensions in Inches Corresponding to Letters in Outline Views															
	A	B*	C	D	E	F	G	H	I_1	I_2	J	K	L	M	N_1†	N_2†	O
10	15	9 1/16	5/8	17 3/4	5 1/8	16 9/16	2 3/8	29 11/16	12 15/16	16 3/4	3 7/8	1 1/4	13 5/8	4	10 13/16	14 5/8	22 7/8
20	15	9 5/16	5/8	17 3/4	5 1/8	16 13/16	2 3/8	31 1/16	14	17 13/16	4 3/8	1 3/8	16 1/8	4	11 7/8	15 11/16	22 7/8
30	16	9 5/16	5/8	17 3/4	5 1/8	17 9/16	2 3/8	34 11/16	15 1/4	19 1/16	4 15/16	1 1/2	16 3/8	4	12 7/8	17	22 7/8
40	17 5/8	10 5/16	3/4	20	5 3/8	19 3/8	3 3/8	37 1/16	15 15/16	21 1/8	5 1/16	1 5/8	16 7/8	4 1/8	13 1/2	18 11/16	26
50	18 1/2	10 15/16	3/4	20	5 3/8	20 3/16	3 3/8	37 9/16	16 7/16	21 1/8	5 7/16	1 5/8	17	4 1/8	14 1/4	18 13/16	26
50-L	18 1/2	10 15/16	3/4	20	5 3/8	20 7/16	3 3/8	38 1/16	16 7/16	21 1/8	5 7/16	1 5/8	17	4 1/8	14 1/4	19 1/16	26
60	18 1/2	10 15/16	3/4	20	5 3/8	20 3/16	3 3/8	40 3/16	17 3/4	22 1/16	6 7/16	1 3/4	17 5/8	4 1/8	14 9/16	19 1/4	26
60-L	18 1/2	10 15/16	3/4	20	5 3/8	20 3/16	3 3/8	40 1/16	17 3/4	23 1/16	6 7/16	1 3/4	17 5/8	4 1/8	14 9/16	20	26
70	20 1/4	12	7/8	24	6 1/4	22 1/8	3 5/16	41 1/4	18	23 1/4	6 11/16	1 7/8	18 3/8	4 3/4	15 1/16	20 1/16	31 1/4
70-L	20 1/4	12	7/8	24	6 1/4	22 1/8	3 5/16	42 3/8	18	24 3/8	6 11/16	1 7/8	18 3/8	4 3/4	15 1/16	21 1/16	31 1/4
80	22 5/8	13 1/8	7/8	24	6 1/4	24 7/16	3 1/4	41 3/4	17 15/16	23 3/4	6 11/16	1 7/8	18 1/2	4 3/4	15	20 7/8	31 1/4
80-L	22 5/8	13 1/8	7/8	24	6 1/4	24 7/16	3 1/4	42 3/4	17 15/16	24 1/16	6 11/16	1 7/8	18 1/2	4 3/4	15	21 7/8	31 1/4
90	22 5/8	13 3/8	7/8	24	6 1/4	24 11/16	3 3/8	44 3/4	18 15/16	25 1/16	7 1/16	2	18 1/16	4 3/4	15 1/4	22 1/8	31 1/4
100	25 1/2	15	1	30	7 1/8	27 3/4	4	44 1/16	19 1/2	25 1/16	7 3/16	2 1/8	19 5/8	5 3/8	16 5/16	22 1/8	38
100-L	25 1/2	15	1	30	7 1/8	27 3/4	4	46 1/8	19 1/2	26 5/8	7 3/16	2 1/8	19 5/8	5 3/8	16 5/16	23 7/16	38
110	25 1/2	15	1	30	7 1/8	27 3/4	4	46 5/16	20 3/8	26 5/16	7 11/16	2 1/4	20 3/8	5 3/8	16 1/16	22 1/4	38

Frame No.	Dimensions in Inches Corresponding to Letters in Outline Views												Approx. Net‡ Weight Lbs.	
	P	Q	R	S	T	U	V	W	X	Key a	Key b	Key c	Armature	Motor Complete
10	8 1/2	1/4	4 7/8	6 3/8	10 3/16	9 1/16	12 7/8	1 7/8	2 7/8	2 7/8	5/16	1/4	50	235
[illegible]	11	1/4	[illegible]	6 1/8	10 3/4	9 5/8	13 1/16	1 7/8	2 7/8	3 3/8	5/16	1/4	65	265
30	11 1/4	1/4	6 3/4	7 3/8	11 1/16	10 1/16	14 1/2	2	3 1/16	4	3/8	1/4	85	350
40	11 1/2	1/4	7 3/4	7 3/16	12 3/4	10 3/4	15 1/16	2 1/8	3 1/4	4 1/4	3/8	1/4	110	440
50	11 5/8	1/4	7 3/4	7 5/8	12 1/16	11	15 1/16	2 1/8	3 5/16	4 1/2	3/8	1/4	125	495
50-L	11 5/8	1/4	7 3/8	7 5/8	13 1/16	11	16 7/16	2 1/8	3 5/16	4 1/2	3/8	1/4	135	510
[illegible]	12 1/4	1/4	[illegible]	7 1/16	12 5/8	11 5/16	16	2 1/8	3 5/16	5 3/8	7/16	5/16	135	535
60-L	12 1/4	1/4	8	7 1/16	13 3/8	11 5/16	16 3/4	2 1/8	3 5/16	5 5/8	7/16	5/16	145	545
70	12 1/8	5/16	[illegible]	7 13/16	13 1/16	11 5/16	16 15/16	2 1/4	3 3/4	5 5/8	7/16	5/16	160	645
70-L	12 1/8	5/16	8	7 13/16	14 3/16	11 5/16	17 13/16	2 1/4	3 3/4	5 5/8	7/16	5/16	170	660
[illegible]	12 1/4	5/16	7 3/4	7 9/16	13 1/2	11 1/4	17 1/4	2 5/16	3 3/4	5 5/8	7/16	5/16	175	715
80-L	12 1/4	5/16	7 3/4	7 7/16	14 7/16	11 1/4	18 1/8	2 5/16	3 3/4	5 5/8	7/16	5/16	185	730
90	12 1/4	5/16	8 3/4	8 1/16	14 13/16	11 3/4	18 5/8	2 5/16	3 3/4	6 1/8	1/2	3/8	210	840
100	12 1/2	5/16	8 1/8	8 7/16	14	12 1/16	18 1/8	2 7/16	3 3/4	6 1/8	1/2	3/8	225	950
100-L	12 1/2	5/16	8 1/8	8 1/16	15 5/16	12 5/16	19 1/16	2 7/16	3 3/4	6 1/8	1/2	3/8	240	970
110	13 1/4	5/16	8 7/8	8 7/16	14 3/8	12 1/16	18 1/2	2 7/16	3 3/4	6 5/8	5/16	3/8	250	1040

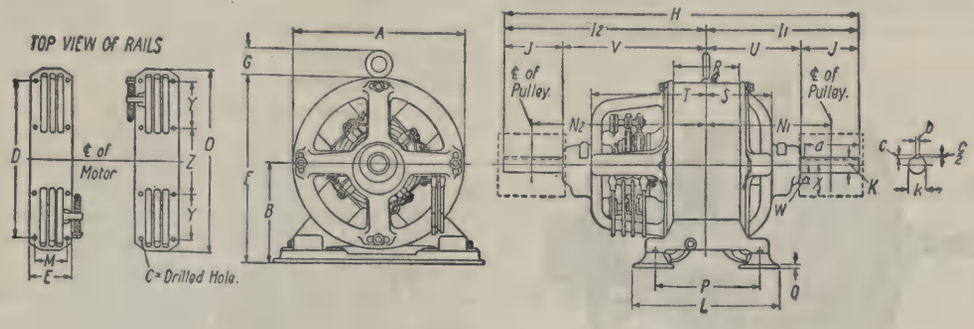
30–19

*This dimension will never be exceeded. When exact dimension is required liners up to 1/32 inch may be necessary.
†This dimension for standard pulley only.
‡Weights are for standard machines with single extended shafts.
Table correct at date of publication; for latest data apply to the nearest office of this Company.

TYPE SK COMMUTATING-POLE MOTORS AND GENERATORS—Continued

OUTLINE DIMENSIONS

Frames 110-L to 181 Inclusive—With Slide-Rails



Frame No.	Dimensions in Inches Corresponding to Letters in Outline Views															
	A	B*	C	D	E	F	G	H	I_1	I_2	J	K	L	M	N_1†	N_2†	O
110-L	25½	15	1	30	7⅛	27¾	4	47⅞	20⅜	27½	7 11/16	2¼	20⅜	5⅜	16 1/16	23 9/16	38
120	27⅞	16⅛	1	30	7⅛	30 1/16	4	50	21 1/16	28 1/16	8	2⅜	21⅜	5⅜	17 1/16	24 1/16	38
120-L	27¾	16⅛	1	30	7⅛	30 1/16	4	51⅝	21 1/16	30 3/16	▮	2⅜	21⅜	5⅜	17 1/16	26 1/16	38
130	29½	18¼	11/16	31½	7¼	33	4 11/16	53 1/16	22⅞	30 9/16	8¾	2⅝	21½	5⅞	19⅛	26 13/16	40½
140	30⅝	18¾	11/16	31½	7¼	34 1/16	4 11/16	57⅜	24 9/16	32 13/16	9½	2⅞	23½	5⅞	20	28¼	40½
140-L	30⅝	18¾	11/16	31½	7¼	34 1/16	4 11/16	59⅛	24 9/16	34 9/16	9½	2⅞	23½	5⅞	20	30	40½
142-L	30⅝	18¾	11/16	31½	7¼	34 1/16	4 11/16	60⅞	25 7/16	35 7/16	9½	2⅞	23½	5⅞	20⅞	30⅞	40½
150	33¼	20¾	13/16	37	9¼	37⅜	4 11/16	58 1/16	24 9/16	33⅞	9½	2⅞	26½	7½	19¾	29 1/16	47
150-L	33¼	20¾	13/16	37	9¼	37⅜	4 11/16	61 13/16	24 9/16	37⅜	9½	2⅞	26½	7½	19¾	32 9/16	47
160	36	22⅛	13/16	37	9¼	40⅛	5 5/16	64½	27 1/16	37 5/16	10¼	3⅜	26½	7½	21¼	31⅝	47
160-L	36	22⅛	13/16	37	9¼	40⅛	5 5/16	68¼	27 1/16	41 5/16	10¼	3⅜	26½	7½	31¼	35⅜	47
170	36⅜	22⅞	▮	40⅝	11	41 1/16	5 5/16	69¾	28 13/16	40 13/16	12	3⅜	29¾	9	22½	34⅜	51⅝
170-L	36⅜	22⅞	1	40⅝	11	41 1/16	5 5/16	73½	28 13/16	44 5/16	12	3⅜	29¾	9	22½	38⅛	51⅝
180	39⅜	24⅜	1	40⅝	11	44 1/16	5 5/16	75 5/16	32	43 5/16	13½	3⅞	30¾	9	24¼	35 1/16	51⅝
180-L	39⅜	24⅜	1	40⅝	11	44 1/16	5 5/16	79 1/16	32	47 1/16	13½	3⅞	30¾	▮	24¼	39 1/16	51⅝
181	39⅜	24⅜	1	40⅝	11	44 1/16	5 5/16	76 1/16	32¾	43 9/16	13½	3⅞	30¾	9	25	36 1/16	51⅝

Frame No.	Dimensions in Inches Corresponding to Letters in Outline Views											Key			Approx. Net Wt. Lbs.‡	
	P	Q	R	S	T	U	V	W	X	Y	Z	a	b	c	Armature	Motor Complete
110-L	13¼	5/16	8⅞	8 9/16	15 11/16	12 11/16	19 13/16	2 7/16	3¾	....	....	6⅝	9/16	⅜	265	1060
120	14¼	5/16	9⅝	8 13/16	16 1/16	13 1/16	20 1/16	2 13/16	3⅞	....	....	6⅞	9/16	⅜	310	1190
120-L	14¼	5/16	9⅝	8 13/16	17 13/16	13 5/16	22 5/16	2 13/16	3⅞	....	....	6⅞	9/16	⅜	335	1210
130	14¼	⅜	10	9⅜	17 1/16	14⅛	21 13/16	2 1/16	4 1/16	10¼	11	7½	⅝	7/16	420	1565
140	16¼	⅜	12	10⅛	18¾	15 1/16	23 5/16	3 1/16	4 13/16	10¼	11	8¼	11/16	½	520	1855
140-L	16¼	⅜	12	10⅛	20⅛	15 1/16	25 1/16	3 3/16	4 13/16	10¼	11	8¼	11/16	½	540	1895
142-L	16¼	⅜	13¾	11	21	15 13/16	25 13/16	3 3/16	4 13/16	10¼	11	8¼	11/16	½	575	2440
150	17¼	7/16	12	10⅛	19 7/16	15 5/16	24⅜	3 3/16	4 13/16	12½	12	8¼	11/16	½	610	2240
150-L	17¼	7/16	12	10⅛	22 15/16	15 1/16	27⅞	3 3/16	4 13/16	12½	12	8¼	11/16	½	630	2280
160	17¼	7/16	12	10⅞	21¼	16 13/16	27 7/16	4	5½	12½	12	8⅞	13/16	9/16	820	2700
160-L	17¼	7/16	12	10⅞	25	16 13/16	30 15/16	4	5½	12½	12	8⅞	13/16	9/16	850	2760
170	18¾	½	12	11⅜	22⅞	16 13/16	28 13/16	4	5½	14¼	12⅛	10¾	13/16	9/16	910	3105
170-L	18¾	½	12	11⅜	26⅝	16 13/16	32 9/16	4	5½	14¼	12⅛	10¾	13/16	9/16	950	3185
180	19¾	½	13	12 1/16	23	18½	29 13/16	4⅜	6 1/16	14¼	12⅛	12	15/16	5/8	1020	3745
180-L	19¾	½	13	12 1/16	26¾	18½	33 9/16	4⅜	6 1/16	14¼	12⅛	12	15/16	5/8	1065	3835
181	19¾	½	14½	12 13/16	23¾	19¼	30 1/16	4⅜	6 1/16	14¼	12⅛	12	15/16	5/8	1035	3775

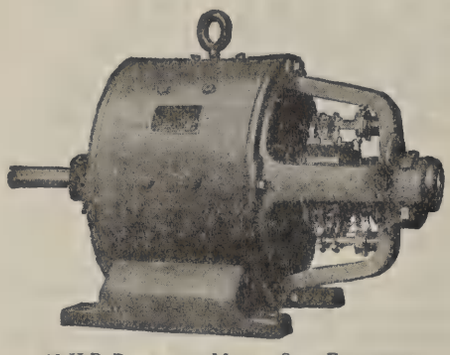
30–21

*This dimension will never be exceeded. When exact dimension is required liners up to 1/32 inch may be necessary.
†This dimension for standard pulley only.
‡Weights are for standard machines with single extended shafts.
Frames 130 to 160 inclusive have 4 poles. Frames 170 and 180 have 6 poles.
Table correct at date of publication; for latest data apply to nearest district office of this Company.

REVERSING PLANER-MOTOR EQUIPMENTS

230 VOLTS **10 TO 75 H.P.**

The Westinghouse reversing planer-motor drive is designed to operate such machine tools as planers, draw-cut shapers, slotters and gear planers. These



10-H.P. Reversing Motor, Semi-Enclosing Covers Not Shown

tools are used in practically all machine shops, such as are maintained by steel mills, bridge and structural iron works, machinery builders, shipyards, automobile plants, railroad shops, and by locomotive and car builders.

The planer equipment consists of a special commutating-pole motor and a controller which is operated automatically by the movements of the driven machine. The motor is direct-connected to the planer and reverses with each stroke; thus belts, tight and loose pulleys, and countershafts are eliminated.

These equipments form a positive, economical and highly efficient drive. The cutting and return speeds can be adjusted independently so that the most economical speed can be used to give the maximum production for any length of stroke, depth of cut, or weight of platen, either heavily or lightly loaded.

The Motor

The motor was designed especially to obtain low flywheel effect and quick reversing. Maximum economy and durability with minimum expense for operation and repairs were the main objects considered.

Good commutation even with extreme overloads is assured by the use of laminated commutating poles and correct electrical and mechanical design; the absence of sparking results in long life for the commutator and brushes, thus the cost of maintenance is reduced to a minimum.

The Control

The control equipment consists of a controller, a master switch, and a push-button pendant switch. Two field rheostats, one for adjusting the motor speed for the cut, and one for the return, are mounted inside the controller cover, the handles being on the outside. Low-voltage protection is obtained by means of a relay. The master switch is mounted on the planer bed and is operated by a tripping mechanism attached to the platen and furnished by the builder of the machine. When it is tripped, the motor starts and is automatically accelerated to the desired speed; at the end of the stroke, the master switch is tripped again, and the motor is stopped by dynamic braking and is immediately started in the reverse direction.

For complete description, refer to Westinghouse Catalogue 30.

Ratings and Weights

H. P.	Frame No.	R. P. M. Min.	R. P. M. Max.	Ship. Weight Pounds
10	91	250	1000	260
20	111	250	1000	335
25	111	250	1000	335
35	131	250	1000	390
50	141	250	1000	470
75	151	250	1000	590

Motor Ratings Recommended

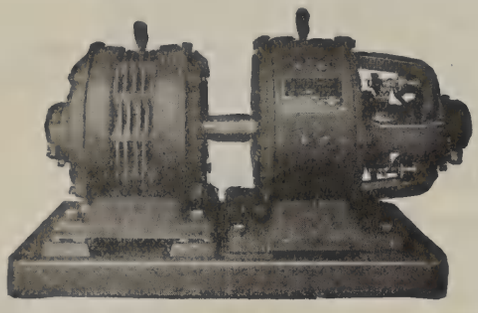
Planer Housing Inches	Length of Platen Feet	Motor H.P.
36	8 to 14	10
42	8 to 16	20—25
48	8 to 12	20—25
48	14 to 18	25—35
60	10 to 12	20—25
60	16 to 20	25—35
72	14 to 20	35—50
84	14 to 20	35—55
96	18 to 22	50—75
Frog and Switch	.....	35

Controller—Cover Swung Back

MOTOR-GENERATORS

FOR MOTION PICTURE MACHINES, INDUSTRIAL SERVICE, AND BATTERY CHARGING

There are certain classes of service for which direct current gives much more satisfactory results than alternating current. Among these may be mentioned passenger elevators where high speed and accurate control of the car is desirable; motion



MOTION-PICTURE MOTOR-GENERATOR (CS-SK) FOR POLYPHASE POWER CIRCUITS
THOSE FOR INDUSTRIAL AND BATTERY CHARGING SERVICE ARE SIMILAR

picture machines, for which direct current gives a steadier, more reliable illumination for the film; for charging storage batteries, which require direct current; and for many industrial applications where good work is dependent on perfect control of the motion.

Where the only available circuits are alternating current, a most satisfactory method of obtaining direct current for such applications is by using a Westinghouse motor-generator. Operating expense is reduced to a minimum, as efficiency of both motors and generators is high and therefore the cost of power lost through internal losses is small. Maintenance cost is very low, as no skilled operator is necessary.

A complete line of motor-generators has been designed, providing machines particularly adapted for every class of service.

For a full description see Catalogue 30.

For Motion Pictures Machines

Westinghouse motor-generators for this service are furnished in a variety of sizes, ranging from one suitable for a single, hand-operated black and white film machine to a size large enough to handle two of the largest motor-operated kinema-color machines.

The generator used for this class of service is a type SK, flat compounded for 75 volts, which has been found by experience to give the most satisfactory operation. A field rheostat is furnished for adjusting this voltage. The voltage, however, is reduced to approximately 51 volts across the arc by means of a ballast resistor having several steps for adjustment. This ballast resistor is necessary to obtain the best pictures. It tends to maintain a constant current through the arc, which is steady and easy to focus and gives a brilliant uniform illumination of the picture projected.

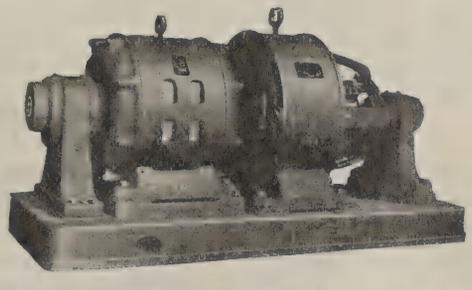
The driving motor, which, with the generator is mounted on a common base, may be type AR, type CS or type SK according to the characteristics of the power circuit.

Control Panels—In addition to the above apparatus, panels can be supplied for controlling the generator circuits. These panels are of black marine slate, and are equipped with the necessary fused switches, meters, and ground detector lamps.

For Industrial Applications

Induction Motor-Generators—Industrial applications require direct current in many instances, such as passenger-elevator service, machine shops, mines, and certain kinds of crane and mill work. Standard Westinghouse motor-generators for this service are designed to supply direct-current circuits of 125 or 250 volts.

These sets are standard compound-wound, one-bearing, type SK generators, driven by type CS induction motors or standard Westinghouse synchronous motors.



INDUCTION MOTOR-GENERATOR—TWO-BEARING PEDESTAL TYPE. FOR 60 CYCLES, 45 TO 100 KW. INCLUSIVE. FOR 25 CYCLES, 30 TO 75 KW. INCLUSIVE

For Battery Charging Service

Motor-generators for charging vehicle storage batteries will be supplied in the same ratings given for industrial applications. For this service the type SK generator will be shunt wound, with a voltage adjustment from 125 to 60 volts by means of shunt field control through a field rheostat. (For description of type SK generators see another page.) This rheostat is mounted on the control section of the switchboard and is operated by a hand wheel on the front of the board. By this means the generator voltage can be maintained at a point just slightly higher than that required for the batteries being charged, thereby eliminating excessive dissipation of energy through resistance.

MOTOR-GENERATORS—Continued

AUTO-STARTER FOR POLYPHASE SQUIRREL-CAGE MOTORS

For battery charging a switchboard is used with the motor-generator, being made up of sections. As usually arranged the meter section is placed at the top, the charging section below and the power control section at the bottom.

Meter sections are equipped with a battery ammeter, a line and battery voltmeter, and, when desired, a line or generator ammeter of the proper capacity.

The number of charging sections depends on the number of charging circuits desired, one section controlling two battery-charging circuits.

RATINGS AND APPPROXIMATE SHIPPING WEIGHTS

For Motion Picture Machines

AR Motors—110 and 220 Volts—Single Phase—60 Cycles

Kilowatts	GENERATOR Amperes	Voltage	SYNCH. R. P. M.	Wt. Lbs.
2¾	36.7	75	1800	1075
4⅛	55	75	1800	1365
5½	72	75	1800	1700
CS Motors—110, 220, and 440 Volts—2 and 3-Phase—60 Cycles				
2¾	36.7	75	1800	650
4⅛	55	75	1800	770
5½	72	75	1800	920
6¾	90	75	1800	995
CS Motors—110, 220 and 440 Volts—2 and 3-Phase—25 Cycles				
3	40	75	1500	925
5¼	70	75	1500	1020
6¾	90	75	1500	1320
SK Motors—D. C.—230 Volts				
2¾	36.7	75	1735	825
4⅛	55	75	1745	1050
5½	72	75	1750	1250
6¾	90	75	1750	1400

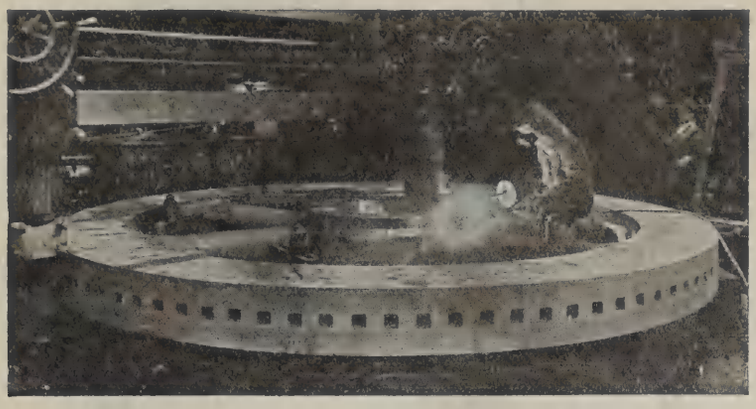
60-Cycles—Induction Motor-Generators—125 and 250-Volt, D. C. Generators

Motor Voltage—220, 440, and 2200, 2 and 3-phase; and 550, 3-phase

Kw. 220, 440 and 550 Volts	Synchronous R.P.M.	Generators Amperes 125 Volts	250 Volts	No. Bearings	WEIGHT POUNDS 220 Volts 2 and 3-Phase	440 Volts 2 and 3-Phase 550 Volts 3-Phase	2200 Volts 2 and 3-Phase
2	1800	16	8	2*	550	550	.....
3	1800	24	12	2*	625	625	.....
4½	1800	36	18	2*	1150	1150	.....
7	1800	56	28	2*	1400	1400	.....
9‡	1800	72	36	3*	1550	1550	2400
12½‡	1800	100	50	3*	1775	1775	2575
16‡	1800	128	64	3*	2100	2100	3000
20‡	1800	160	80	3*	2700	2700	3100
25‡	1800	200	100	3*	3100	3100	3450
30‡	1200	240	120	3*	3950	3950	4350
45‡	1200	360	180	2**	5300	5050	6150
50‡	1200	400	200	2**	5600	5350	6600
65‡	1200	520	260	2**	7450	7200	7600
75‡	1200	600	300	2**	8400	7900	8150
90‡	1200	720	360	2**	8200	8100	8400
100‡	900	800	400	2**	9800	9700	10200
150‡	900	...	600	3**	13300	13300	13300
200‡	900	...	800	3**	16500	16500	16500

*Bracket type.
**Pedestal type.
‡2200 Volts also.

ARC WELDING EQUIPMENTS



ARC-WELDING USED TO REPAIR DEFECTS DEVELOPED IN CASTING DURING PROCESS OF MACHINING—OPERATOR IS USING HOOD

Westinghouse arc-welding outfits are designed to supply the increasing demand for a practical method of fusing metals by means of the electric arc, a process which has become very important in large factories and repair shops where efficiency and economy are necessary factors.

In developing this apparatus special efforts have been made to produce a thoroughly reliable outfit which will be economical in operation, and at the same time be so simple in construction as to require little or no attention from the operator. All current-limiting devices, relays and other complications have been eliminated from the control system, an ordinary circuit-breaker being the only protective device required.

A ballast resistance is used to stabilize the arc and so produce a comparatively uniform heat for the welding operation. A complete outfit consists of a motor-generator with starter for motor and field rheostat for generator; a switchboard on which are mounted voltmeter, ammeter, circuit-breakers, and necessary knife switches; ballast resistor, and welding tools consisting of electrode holders, mask, or shield.

Most equipments are for stationary service but portable outfits are furnished, in which case the apparatus is somewhat modified and mounted upon a serviceable truck.

In the welding operation the following apparatus is used:

Shield—This is used to protect the operator's face and eyes from the effects of the light and heat rays from the arc. It is made of aluminum or steel and provided with colored glass windows of four thicknesses, two of red and two of blue. The shield is made to be held with one hand, and can only be used in such operations as are possible without the use of both hands.

In all cases where the carbon electrode is used for welding and in cutting processes of considerable duration, either the mask or hood as described below must be used.

HOOD

SHIELD

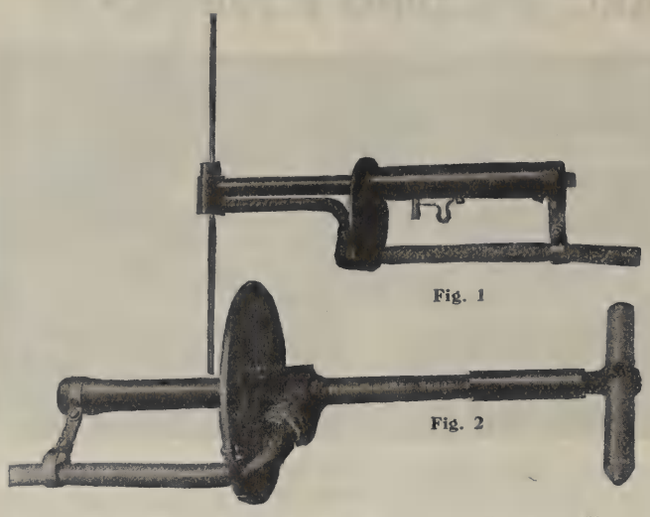


FIG. 1 METAL ELECTRODE HOLDER FIG. 2 CARBON ELECTRODE HOLDER

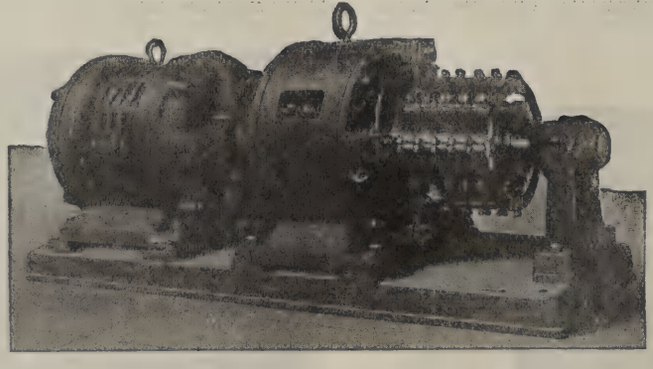
Hood—The purpose of the hood is the same as for the mask, the difference being one of construction only. The hood is made to cover the head completely, resting on the shoulders of the operator. It is made of aluminum with a window of colored glass like the shield and mask. Some operators prefer the use of the hood and it will be furnished in place of the mask at a slight additional cost.

Electrode Holders—Insulated holders are supplied for both metal and carbon electrodes resembling each other in design but differing in the manner in which the electrodes are held. As welding with a graphite electrode requires greater current, and consequently greater heat in the arc, a disc is supplied to protect the hand from the heat. This protective disc is not necessary on the metal electrode holder.

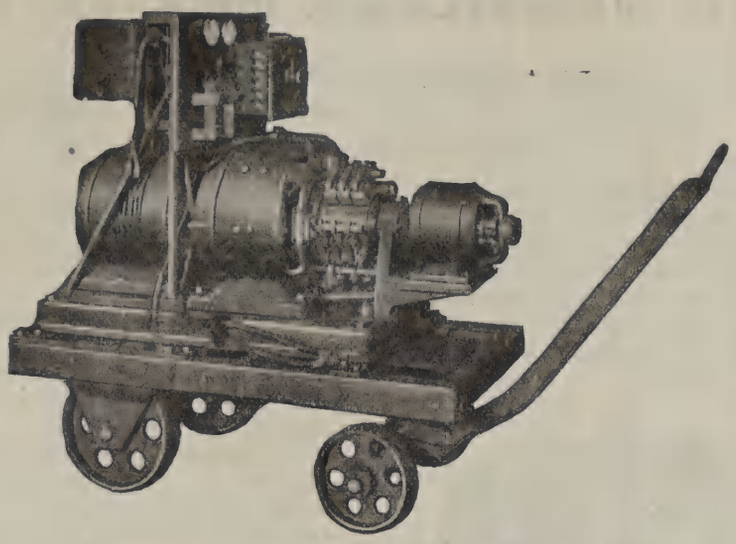
Motor-Generators

The generators have the same mechanical construction as the standard type SK generators but have special windings to provide 60-volt circuits. These generators are designed to carry a heavy momentary over-load and therefore no special protection is necessary at the time of striking the arc, the circuit-breaker being arranged to take care of prolonged overloads. The generator is driven by a Westinghouse motor to suit the requirements of the power circuit, which, with the generator, is mounted compactly on a bedplate.

Each generator is supplied with a switchboard mounting field rheostat for adjusting the generator voltage.



300 AMPERE AC-DC WELDING MOTOR GENERATOR SET



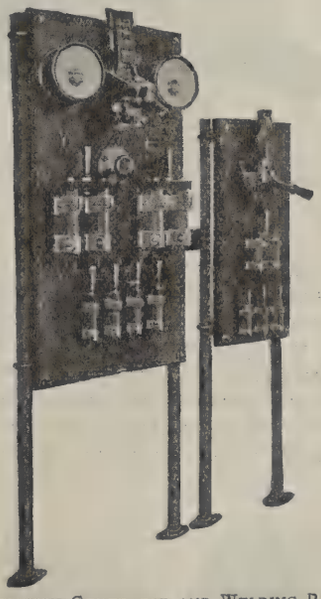
175 AMPERE PORTABLE AC-DC WELDING MOTOR GENERATOR SET.

Motor Starting—With stationary equipments the motor is supplied with a suitable wall-mounting starter, which is provided with low-voltage release and overload protection.

With portable equipments, where weight is a consideration and space is limited, the starter varies according to the kind of motor used. If the motor is for direct current a multipoint switch with separately mounted resistance is used for starting. For three-phase alternating-current circuits the motors are started by means of a star-delta switch. For two-phase motors, if the two-phase circuit is interconnected at the generator or can be inter-connected at the transformer, a four-pole double-throw switch will be supplied for starting the motor. This switch is much lighter and because these sets start without load is just as satisfactory as an auto-starter. If the circuit cannot be interconnected a standard auto-starter will be supplied.

Control

The control equipment for these outfits is supplied in three classes of which Classes I and II are for stationary equipments and Class III for portable outfits.



COMBINATION GENERATOR AND WELDING PANEL WITH OUTLET PANEL ON RIGHT

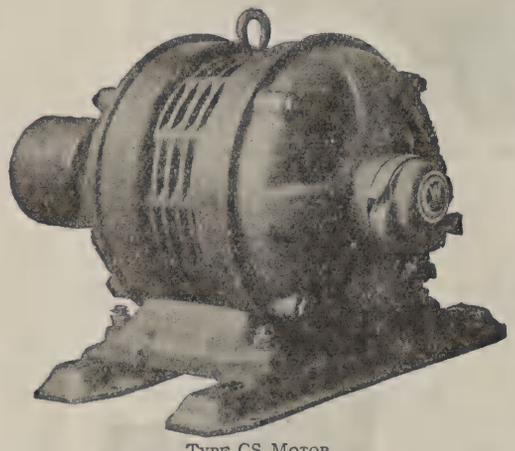
TYPE CS SQUIRREL-CAGE INDUCTION MOTORS

For Constant Speed Continuous Service

2 H.P.* AND HIGHER — AND 3-PHASE — 25 AND 60 CYCLES

110, 220, 440, 550, AND 2200 VOLTS

Westinghouse type CS motors are designed for general constant speed service, and are, therefore, suited for driving machines in practically all industries. These motors are made in all standard sizes of 2 horsepower and larger; for all commercial voltages and frequencies. These motors are available with either the 40 or 50-degree Centrigrade temperature rise guarantee.



TYPE CS MOTOR
FRAMES 200, 300, 400, AND 500
FRAMES 200 AND 300 ARE SUPPLIED WITH BEDPLATE INSTEAD OF SLIDE RAILS

This line of motors is the direct result of years of study and development by Westinghouse engineers who were the first to realize the wonderful possibilities of forged steel in motor building. The use of forged steel in the direct-current type SK motors proved so successful that soon forged steel construction was embodied in the line of type CS motors which were placed on the market at that time.

The design and construction are very simple, the number of parts being few, and interchangeable wherever possible. Thus, when necessary, renewals may be quickly and easily made. Forged open-hearth steel is largely used in the construction, thus providing great strength with reduced weight and size. The rotors are practically indestructible; the bearings have very liberal areas, giving them long life. They are non-leaking, and are protected from dust.

The efficiency, power factor, and overload capacity, are high. Special attention has been given to the efficiency, not only at full load, but also at fractional loads, since high efficiency means low operating costs.

TYPE CS VERTICAL MOTOR, FRAMES 200 TO 500 INCLUSIVE

TYPE CB BACK-GEARED MOTOR WITH GEAR CASE, SHOWING CONSTRUCTION USED ON FRAMES 200 TO 500 INCLUSIVE

Besides the standard type CS motors they are made with vertical shafts, conduit terminal box, back gears, double extended shafts, and special impregnated windings. Special elevator motors can also be furnished.

Complete descriptions of these motors will be found in Westinghouse Catalogue 33.

*For smaller sizes see type CSA Motors.

TYPE CS SQUIRREL INDUCTION MOTORS—Continued

RATINGS 40°

Horse-power	Approx. Rpm. at Full Load	Poles	Frame No.	PAPER PULLEYS FOR TWO-BEARING MOTORS†			Approx. Net Wt. Lbs.	
				For Std. Shaft Extension		Mechanical Limits§	Bare Motor	Add for Bedplate or Slide-rails††
				Standard	Special‡			
				Dia. X Face	Min. Dia. X Max. Face	Min. Dia. X Max. Face		
40°, 25 Cycle, 220-440-550 Volts*								
2	1450	2	231	4 x 3	3 x 5	2½ x 7	135	17
2	715	4	250	4 x 4	3½ x 5	4 x 7	177	17
2	480	6	356-A	5 x 4½	4 x 8	3 x 15	250	31
3	1450	2	241	4 x 4	3 x 5	3 x 5	165	17
3	715	4	354-A	5 x 4½	4 x 8	3 x 15	225	31
3	480	6	444	7 x 6	4 x 10	5 x 14	310	30
5	1450	2	351	4 x 4	4 x 5	3 x 8	205	31
5	715	4	453	7 x 6	4 x 10	5 x 14	385	30
5	480	6	466-A	8 x 7	6 x 10	5 x 14	415	30
7½	1450	2	371-A	5 x 4½	4 x 8	4 x 15	300	31
7½	715	4	471-A	8 x 7	6 x 10	5 x 14	430	30
7½	480	6	556	9 x 8	8 x 10	7 x 12	558	40
10	1450	2	463.5	7 x 6	4 x 10	5 x 14	385	30
10	715	4	563	9 x 8	7 x 10	7 x 15	570	40
10	480	6	572	9 x 8	9 x 10	9 x 12	625	40
15	1450	2	473.5-A	8 x 7	6 x 10	5 x 14	450	30
15	715	4	573	9 x 8	9 x 10	9 x 12	640	40
15	480	6	644	11 x 10	10 x 12	9 x 17	1045	70
20	1450	2	573.5	9 x 8	7 x 10	7 x 15	650	40
20	715	4	645	11 x 10	9 x 12	8 x 17	1085	70
20	480	6	656	11 x 10	12 x 12	10 x 14	1280	70
25	1450	2	583.5-A	9 x 8	8 x 10	7 x 12	816	40
25	715	4	655-A	13 x 12	9 x 14	7 x 22	1385	70
25	480	6	746	13 x 12	12 x 14	10 x 20	1620	70
30	1450	2	583.5-A	9 x 8	8 x 10	8 x 12	816	40
30	715	4	657-A	12 x 12	10 x 14	8 x 20	1445	70
30	480	6	746	14 x 12	12 x 14	10 x 20	1620	120
40	1450	2	645.5	11 x 10	8 x 12	8 x 17	1085	70
40	715	4	753-A	12 x 14	10 x 18	8 x 22	1860	120
40	480	6	756-A	16 x 13	12 x 18	11 x 20	1980	120
50	1450	2	655.5	11 x 10	10 x 12	10 x 17	1280	70
50	715	4	757-A	16 x 13	11 x 18	11 x 25	2030	120
50	480	6	768-A	18 x 15	15 x 18	14 x 22	2290	120
40°, 25 Cycle, 2200 Volts*								
25	715	4	753	13 x 12	9 x 14	7 x 22	1710	120
30	715	4	753	12 x 12	10 x 14	8 x 20	1710	120
30	480	6	756	14 x 12	12 x 14	10 x 20	1840	120
40	715	4	763-A	12 x 14	10 x 18	8 x 22	2080	120
40	480	6	766-A	16 x 13	12 x 18	11 x 22	2210	120
50	715	4	767-A	16 x 13	11 x 18	11 x 25	2250	120
50	480	6	768-A	18 x 15	15 x 18	14 x 22	2290	120
40°, 60 Cycle, 220-440-550 Volts*								
2	1160	6	224	4 x 4	3 x 5	3 x 8	120	17
2	870	8	328	4 x 4	3½ x 5	3 x 13	175	23
3	1750	4	224	4 x 4	3 x 5	3 x 8	120	17
3	1160	6	328	4 x 4	3½ x 5	3 x 9	175	23
3	870	8	356-A	5 x 4½	4 x 8	3 x 18	250	31
5	1750	4	328	4 x 4½	4 x 5	3 x 9	175	23
5	1160	6	356-A	5 x 4½	4 x 8	3½ x 15	250	31
5	870	8	446	6 x 5	4 x 10	4 x 12	333	30
5	690	10	544	7 x 6	5 x 10	4 x 14	435	40
5	575	12	546	8 x 7	6 x 10	4 x 14	470	40
7½	1750	4	354-A	5 x 4½	4 x 8	3½ x 15	225	31
7½	1160	6	452	6 x 5	4 x 10	4 x 12	345	30
7½	870	8	466-A	7 x 6	6 x 10	4 x 14	431	31
7½	690	10	548	8 x 7	6 x 10	5 x 13	521	40
7½	575	12	558	9 x 8	6 x 10	7 x 14	575	40

*All voltages listed are for either 2 or 3-phase, except 550-volts which are for 3-phase only.

†Dimensions specified are in inches and refer to the diameter and face respectively.

‡Pulleys require special offset hub in most cases. Pulleys of wider face require special shaft extension. We will not, under any circumstances, guarantee motors operated with pulleys smaller than listed above.

§These figures do not represent actual dimensions of manufactured pulleys. When paper pulleys are desired manufacturer should be consulted. These pulleys require special shaft extension.

††Frame classes 200, 200-A, 300 and 300-A are furnished with bedplates; frame classes above 300-A are furnished with slide-rails.

TYPE CS SQUIRREL-CAGE MOTORS—Continued

RATINGS 40°

Horse-power	Approx. Rpm. at Full Load	Poles	Frame No.	PAPER PULLEYS FOR TWO-BEARING MOTORS† For Std. Shaft Extension Standard Dia. X Face	Special‡ Min. Dia. X Max. Face	Mechanical Limits§ Min. Dia. X Max. Face	Approx. Net Wt. Lbs. Bare Motor	Add for Bedplate or Slide-rails††
40°, 60 Cycle, 220-440-550 Volts*—Continued								
10	1750	4	354-A	6 x 5	4 x 8	4 x 12	225	31
10	1160	6	464-A	7 x 6	6 x 10	4 x 14	411	30
10	870	8	548	8 x 7	6 x 10	6 x 14	521	40
10	690	10	558	9 x 8	7 x 10	7 x 14	575	40
10	575	12	636	10 x 9	7 x 12	6 x 17	950	70
15	1750	4	471-A	7 x 6	6 x 10	4 x 14	430	30
15	1160	6	554	8 x 7	6 x 10	6 x 14	535	40
15	870	8	572	9 x 8	7 x 10	8 x 14	695	40
15	690	10	636	10 x 9	8 x 12	6 x 17	950	70
15	575	12	646	11 x 10	9 x 12	8 x 17	1110	70
20	1750	4	471-A	9 x 8	7 x 10	7 x 14	430	30
20	1160	6	554	9 x 8	7 x 10	8 x 14	535	40
20	870	8	644	10 x 9	8 x 12	7 x 17	1045	70
20	690	10	654	11 x 10	9 x 12	8 x 17	1215	70
20	575	12	648-A	12 x 12	9 x 14	8 x 20	1305	70
25	1750	4	563	9 x 8	7 x 10	7 x 14	560	40
25	1160	6	556-A	9 x 8	7 x 12	6 x 17	630	40
25	870	8	646	10 x 9	9 x 12	8 x 17	1110	70
25	690	10	744	11 x 10	9 x 14	8 x 22	1530	120
25	575	12	748	12 x 12	10 x 14	9 x 20	1700	120
30	1750	4	573	9 x 8	7 x 10	7 x 14	640	40
30	1160	6	574-A	11 x 10	8 x 12	7 x 17	720	40
30	870	8	646	11 x 10	9 x 12	9 x 17	1110	70
30	690	10	744	14 x 12	10 x 14	x 22	1530	120
30	575	12	747	14 x 12	10 x 14	9 x 20	1700	120
40	1750	4	651	11 x 10	8 x 12	6 x 17	1125	70
40	1160	6	636-A	11 x 10	9 x 12	9 x 17	1080	70
40	870	8	658-A	12 x 12	10 x 14	9 x 20	1470	70
40	690	10	748	14 x 12	11 x 14	11 x 20	1700	120
40	575	12	750	12 x 12	12 x 14	12 x 20	1580	120
50	1160	6	636-A	12 x 12	11 x 14	9 x 20	1080	70
50	870	8	658-A	13 x 12	12 x 14	11 x 19	1470	70
50	690	10	758	14 x 12	14 x 14	13 x 18	2070	120
50	575	12	856	16 x 13	13 x 18	12 x 22	2610	200
40°, 60 Cycle, 2200 Volts*								
15	1750	4	563	7 x 6	6 x 10	4 x 14	560	40
15	1160	6	574	8 x 7	6 x 10	6 x 14	645	40
20	1750	4	591	9 x 8	6 x 10	6 x 14	724	40
20	1160	6	646	9 x 8	7 x 12	5 x 18	1110	70
20	870	8	648	10 x 9	8 x 12	7 x 17	1175	70
25	1750	4	645	9 x 8	6 x 12	5 x 18	1085	70
25	1160	6	654	9 x 8	7 x 12	6 x 17	1215	70
25	870	8	656	10 x 9	9 x 12	8 x 17	1280	70
25	690	10	756	11 x 10	9 x 14	8 x 22	1840	120
30	1750	4	645	11 x 10	6 x 12	6 x 18	1085	70
30	1160	6	654	11 x 10	8 x 12	7 x 17	1215	70
30	870	8	656	11 x 10	9 x 12	9 x 17	1280	70
30	690	10	758	14 x 12	10 x 14	8 x 22	1920	120
30	575	12	766	14 x 12	10 x 14	9 x 20	2060	120
40	1750	4	655	11 x 10	8 x 12	6 x 17	1425	70
40	1160	6	658	11 x 10	9 x 12	9 x 17	1470	70
40	870	8	754	12 x 12	10 x 14	9 x 20	1750	120
40	690	10	766	14 x 12	11 x 14	11 x 20	2060	120
40	575	12	768	14 x 12	12 x 14	12 x 20	2150	120
50	1160	6	754	12 x 12	11 x 14	9 x 20	1750	120
50	870	8	766	13 x 12	12 x 14	11 x 19	2060	120
50	690	10	856	16 x 13	12 x 18	11 x 22	2430	200
50	575	12	856	16 x 13	13 x 18	12 x 22	2430	200

H.P.	Approx. Rpm. at Full Load	Poles	Frame No.	Approx. Net Wt. Lbs. Bare Motor	Add for Bedplate or Slide-rails
40°, 60 Cycle, 220-440-550 Volts.					
5	3450	2	231	135	17
7½	3450	2	241	165	17
10	3450	2	351	208	31
15	3450	2	371-A	300	31

H.P.	Approx. Rpm. at Full Load	Poles	Frame No.	Approx. Net Wt. Lbs. Bare Motor	Add for Bedplate or Slide-rails
For Direct Connected Service					
20	3450	2	463.5	385	30
25	3450	2	473.5-A	450	30
30	3450	2	473.5-A	450	30
50	1750	4	651	1125	70
**50	1750	4	659-A	1525	70

*All voltages listed are for either 2 or 3-phase, except 550 volts which are for 3-phase only.

†Dimensions specified are in inches and refer to the diameter and face respectively.

‡Pulleys require special offset hub in most cases. Pulleys of wider face require special shaft extension. We will not, under any circumstances, guarantee motors operated with pulleys smaller than listed above.

§These figures do not represent actual dimensions of manufactured pulleys. When paper pulleys are desired manufacturer should be consulted. These pulleys require special shaft extension.

††Frame classes 200, 200-A, 300 and 300-A are furnished with bedplates; frame classes above 300-A are furnished with slide-rails. **2200 Volts.

TYPE CS SQUIRREL-CAGE MOTORS—Continued

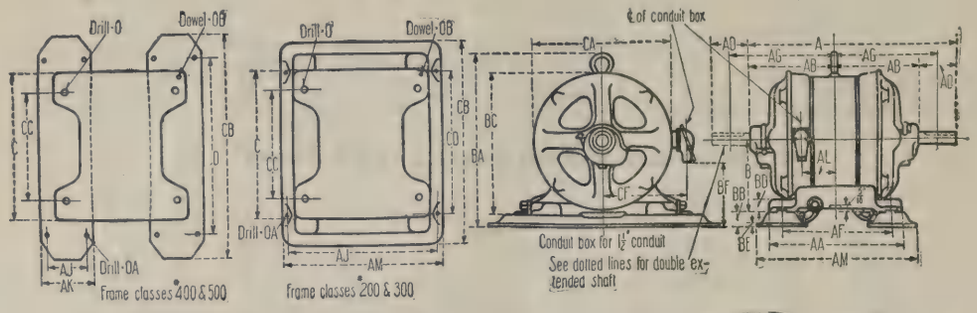
RATINGS 50°

Horsepower	Approximate Rpm. Full Load	Poles	Frame No.	PAPER PULLEYS FOR 2-BEARING MOTORS† For Standard Shaft Extension Standard Dia. X Face	Special‡ Min. Dia. X Face	Mechanical Limits§ Max. Dia. X Face	Approx. Net Wt., Lbs. Bare Motor	Add for Bedplate or Slide Rails**
60 Cycle—220-440-550 Volts, 2 and 3-Phase*								
3	1160	6	224-A	4 x 4	4 x 5	3 x 10	129	17
3	870	8	328-A	5 x 4½	4 x 9	3 x 12	178	23
5	1750	4	222-A	4 x 4	4 x 5	3 x 10	124	17
5	1160	6	244-A	5 x 4	5 x 5	4 x 10	179	17
5	870	8	352-A	6 x 5	4 x 9	3½x 12	218	23
7½	1750	4	240-A	5 x 4	5 x 5	4 x 10	162	17
7½	1160	6	352-A	6 x 5	4½x 9	4 x 12	218	23
7½	870	8	364-A	7 x 6	5 x 9	4½x 12	270	31
10	1750	4	350-A	6 x 5	4 x 9	4 x 12	211	31
10	1160	6	364-A	7 x 6	5 x 9	5 x 12	270	31
10	870	8	462-A	7 x 6	6 x 10	5 x 13	390	30
15	1750	4	362-A	7 x 6	5 x 9	4½x 12	250	31
20	1750	4	453-A	7 x 6	5½x 10	5 x 13	370	30
25	1750	4	461-A	8 x 7	6 x 10	5½x 13	380	30
25	1160	6	556-A	9 x 8	7 x 12	6 x 15	630	40
30	1750	4	471-A	8 x 7	7 x 10	7 x 13	430	30
30	1160	6	556-A	10 x 9	8 x 12	7 x 15	630	40
40	1750	4	563-A	9 x 8	7½x 12	6½x 15	633	40
40	1160	6	582-A	11 x10	9 x 12	[illegible] x 15	755	40
50	1750	4	583-A	10 x 9	8 x 12	7 x 15	768	40

*All Voltages listed for either 2 or 3-phase, except 550 volts which are for 3-phase only.
†Dimensions specified are in inches and refer to the diameter and face respectively.
‡Pulleys require special offset hub in most cases. Pulleys of wider face require special shaft extension.
We will not, under any circumstances, guarantee motors if operated with pulleys smaller than those listed above.
§These figures do not represent actual dimensions of manufactured pulleys. When paper pulley is desired manufacturers should be consulted. These pulleys require special shaft extension.
**Frames 200-A and 300-A are furnished with bedplates. Frames above 300-A are furnished with slide rails.

TYPE CS SQUIRREL-CAGE MOTOR—Continued

OUTLINE DIMENSIONS—40°



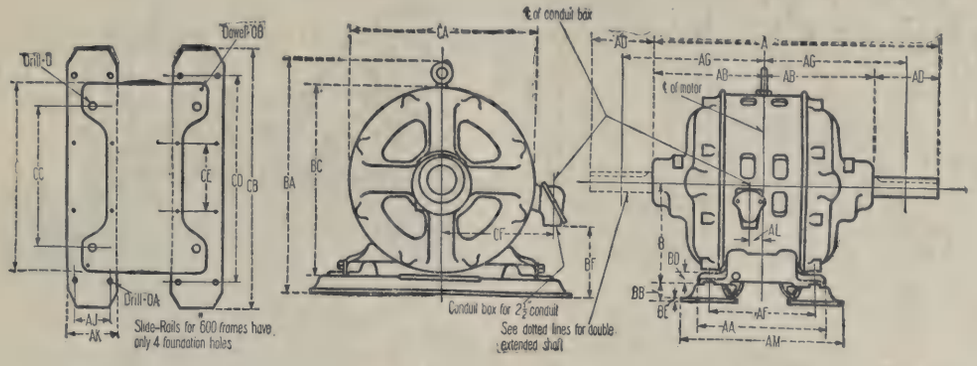
Frame No.		Shaft Dia.	Keyway			Foot Groove		Max. Travel on Base	Dimensions in Inches Corresponding to Letters Given in Outline Views								
			Width	Depth	L'ngth	Width	Depth		A	AA	AB	AD	AF	AG**	AJ	AK	AL	AM
220	to 229	1	¼	3/32	2 1/16	1 3/32	*	2¼	18 3/16	11	7½	3 3/16	9	9 3/16	12½	...	2½	13½
220a	to 229a	1¼	1/16	1/8	2 1/16	1 3/32	*	2¼	19	11	7⅝	3¾	9	9⅝	12½	...	2½	13½
230	to 239	1	¼	3/32	2 1/16	1 3/32	*	2¼	19 3/16	11	[illegible]	3 1/16	9	9 1/16	12½	...	3 1/16	13½
240	to 249	1	¼	3/32	2 1/16	1 3/32	*	2¼	20 1/16	14	8½	3 1/16	12	10 1/16	15½	...	3½	16½
240a	to 249a	1¼	1/16	1/8	2 1/16	1 3/32	*	2¼	21	14	8⅝	3¾	12	11 1/16	15½	...	3½	16½
250	to 259	1	1/4	3/32	2 1/16	1 3/32	*	2¼	21 1/16	14	9	3 1/16	12	10 1/32	15½	...	4	16½
320	to 329	1¼	1/16	1/8	2 7/16	1 3/32	*	2½	19 3/32	12	7¾	3 3/32	9½	9 1/16	13¾	...	2 1/16	14¾
320a	to 329a	1⅜	5/16	1/8	4½	1 3/32	*	2½	22 5/64	12	8 1/32	5 1/16	9½	11 5/16	13¾	...	2 1/16	14¾
350	to 359	1½	1/16	1/8	2 7/16	1 3/32	*	2½	22 3/32	15	9¼	3 3/32	12½	11 1/16	16¾	...	3 1/16	17¾
350a	to 359a	1⅜	5/16	1/8	4½	1 3/32	*	2½	25 3/64	15	10 3/32	5 1/16	12½	12 7/16	16¾	...	3 1/16	17¾
360a	to 369a	1⅝	5/16	1/8	4½	1 3/32	*	2½	26 3/64	15	10 3/32	5 1/16	12½	13 7/16	16¾	...	3 1/16	17¾
370a	to 379a	1⅝	5/16	1/8	4½	1 3/32	*	2½	27 3/64	15	11 3/32	5 1/16	12½	13 7/16	16¾	...	3 1/16	17¾
440	to 449	1⅝	3/8	1/8	5 5/8	1 1/16	3/32	4½	30 1/16	13⅝	11⅝	6 1/32	11¼	14 3/64	4½	5/8	3¼	16⅝
440a	to 449a	1⅞	1/16	3/32	5 5/8	1 1/16	3/32	4½	31 1/16	13⅝	12 1/16	6 1/32	11¼	15 3/64	4½	5/8	3 1/16	16⅝
450	to 459	1⅝	3/8	1/8	5 5/8	1 1/16	3/32	4½	31 1/16	13⅝	12⅝	6 1/32	11¼	15 3/64	4½	5/8	3¼	16⅝
450a	to 459a	1⅞	1/16	3/32	5 5/8	1 1/16	3/32	4½	32 1/16	13⅝	12⅛	6 1/32	11½	16 3/64	4½	5/8	3¼	16⅝
460	to 469	1⅝	3/8	1/8	5 5/8	1 1/16	3/32	4½	32 1/16	15⅝	12⅞	6 1/32	13¼	16 3/32	4½	5/8	4¼	18⅝
460.5	to 469.5	1⅝	3/8	1/8	5 5/8	1 1/16	3/32	4½	32 1/16	15⅝	12⅞	6 1/32	13¼	16 3/32	4½	5/8	4¼	18⅝
460a	to 469a	1⅞	1/16	3/32	5 5/8	1 1/16	3/32	4½	33 1/16	15⅝	13 1/16	6 1/32	13¼	16 3/32	4½	5/8	4¼	18⅝
470a	to 479a	1⅞	1/16	3/32	5 5/8	1 1/16	3/32	4½	34 1/16	15⅝	13 1/16	6 1/32	13¼	17 3/32	4½	5/8	4¼	18⅝
470.5a	to 479.5a	1⅞	1/16	3/32	5 5/8	1 1/16	3/32	4½	34 1/16	15⅝	13 1/16	6 1/32	13¼	17 3/32	4½	5/8	4¼	18⅝
540	to 549	1⅞	1/16	3/32	5 3/4	1 1/4	1/32	4	32 1/16	14	13 1/16	6 1/32	11½	16 1/32	4¾	6¼	3⅜	17¾
550	to 559	1⅞	1/16	3/32	5 3/4	1 1/4	1/32	4	33 1/16	15	13 1/16	6 1/16	12½	16 3/32	4¾	6¼	3⅜	18¾
550a	to 559a	2⅜	1/16	1/16	6 7/8	1 1/4	1/32	4	37 1/16	15	14 1/16	8	12½	18 1/16	4¾	6¼	3⅜	18¾
560	to 569	1⅞	1/16	3/32	5 3/4	1 1/4	1/32	4	34 1/16	15	14 1/16	6 1/16	12½	17 1/32	4¾	6¼	3⅜	18¾
560a	to 569a	2⅜	1/16	1/16	6 7/8	1 1/4	1/32	4	38 1/16	15	15 1/16	8	12½	19 1/16	4¾	6¼	3⅜	18¾
570	to 579	1⅞	1/16	3/32	5 3/4	1 1/4	1/32	4	35 1/32	17	14 1/16	6 1/32	14½	17 3/32	4¾	6¼	4⅞	20¾
570.5	to 579.5	1⅞	1/16	3/32	5 3/4	1 1/4	1/32	4	35 1/16	17	14 1/16	6 1/32	14½	17 3/32	4¾	6¼	4⅞	20¾
570a	to 579a	2⅜	1/16	1/16	6 7/8	1 1/4	1/32	4	39 1/16	17	15 1/16	8	14½	19 1/16	4¾	6¼	4⅞	20¾
580	to 589	1⅞	1/16	3/32	5 3/4	1 1/4	1/32	4	36 1/32	17	15 1/16	6 1/32	14½	18 3/32	4¾	6¼	4⅞	20¾
580a	to 589a	2⅜	1/16	1/16	6 7/8	1 1/4	1/32	4	40 1/16	17	16 1/16	8	14½	20 1/16	4¾	6¼	4⅞	20¾
580.5a	to 589.5a	2⅜	1/16	1/16	6 7/8	1 1/4	1/32	4	40 1/16	17	16 1/16	8	14½	20 1/16	4¾	6¼	4⅞	20¾
590	to 599	1⅞	1/16	3/32	5 3/4	1 1/4	1/32	4	37 1/32	19	15 1/16	6 1/16	16½	18 3/32	4¾	6¼	5⅛	22¾
590a	to 599a	2⅜	1/16	1/16	6 7/8	1 1/4	1/32	4	41 1/16	19	16 1/16	8	16½	20 1/16	4¾	6¼	5⅛	22¾

Frame No.		B‡	BA	BB	BC	BD	BE	BF	C	CA	CB	CC	CD	CF	O	OA	OB†
220	to 229	6¼	13 3/16	1 3/16	12 1/16	1 1/8	1/16	3 1/16	12	11¾	16¾	8⅜	11½	8 3/16	5/8	½	1/16
220a	to 229a	6¼	13 3/16	1 1/16	12 1/16	1 1/8	1/16	3 1/16	12	11¾	16¾	8⅜	11½	8 1/16	5/8	½	1/16
230	to 239	6¼	13 3/16	1 1/16	12 1/16	1 1/8	1/16	3 1/16	12	11¾	16¾	8⅜	11½	8 1/16	5/8	½	1/16
240	to 249	6¼	13 3/16	1 1/16	12 1/16	1 1/8	1/16	3 1/16	12	11¾	16¾	8⅜	11½	8 1/16	5/8	½	1/16
240a	to 249a	6¼	13 3/16	1 1/16	12 1/16	1 1/8	1/16	3 1/16	12	11¾	16¾	8⅜	11½	8 1/16	5/8	½	1/16
250	to 259	6¼	13 3/16	1 1/16	12 1/16	1 1/8	1/16	3 1/16	12	11¾	16¾	8⅜	11½	9⅜	5/8	½	1/16
320	to 329	7⅜	17 5/8	1 3/8	14 3/16	1 1/4	1/16	4¾	15	14	20	10⅞	14¾	9⅜	¾	⅝	1/16
320a	to 329a	7⅜	17 5/8	1 3/8	14 3/16	1 3/8	1/16	4¾	15	14	20	10⅞	14¾	9⅜	¾	⅝	1/16
350	to 359	7⅜	17 5/8	1 3/8	14 3/16	1 1/4	1/16	4¾	15	14	20¼	10⅞	14¼	9⅜	¾	⅝	1/16
350a	to 359a	7⅜	17 3/8	1 3/8	14 3/16	1 1/4	1/16	4¾	15	14	20¼	10⅞	14¼	9⅜	¾	⅝	1/16
360a	to 369a	7⅜	17 3/8	1 3/8	14 3/16	1 3/8	1/16	4¾	15	14	20¼	10⅞	14¼	9⅜	¾	⅝	1/16
370a	to 379a	7⅜	17 3/8	1 3/8	14 3/16	1 3/8	1/16	4¾	15	14	20¼	10⅞	14¼	9⅜	¾	⅝	1/16
440	to 449	9	20½	1 1/16	17 3/16	1 1/2	¼	6 1/16	18 1/16	17¼	26	13⅜	20	11¼	¾	¾	2/16
440a	to 449a	9	20½	1 1/16	17 3/16	1 1/2	¼	6 1/16	18 1/16	17¼	26	13⅜	20	11¼	¾	¾	½
450	to 459	9	20½	1 1/16	17 3/16	1 1/2	¼	6 1/16	18 1/16	17¼	26	13⅜	20	11¼	¾	¾	½
450a	to 459a	9	20½	1 1/16	17 3/16	1 1/2	¼	6 1/16	18 1/16	17¼	26	13⅜	20	11¼	¾	¾	½
460	to 469	9	20½	1 1/16	17 3/16	1 1/2	¼	6 1/16	18 1/16	17¼	26	13⅜	20	11¼	¾	¾	½
460.5	to 469.5	9	20½	1 1/16	17 3/16	1 1/2	¼	6 1/16	18 1/16	17¼	26	13⅜	20	11¼	¾	¾	½
460a	to 469a	9	20½	1 1/16	17 3/16	1 1/2	¼	6 1/16	18 1/16	17¼	26	13⅜	20	11¼	¾	¾	½
470a	to 479a	9	20½	1 1/16	17 3/16	1 1/2	¼	6 1/16	18 1/16	17¼	26	13⅜	20	11¼	¾	¾	½
470.5a	to 479.5a	9	20½	1 1/16	17 3/16	1 1/2	¼	6 1/16	18 1/16	17¼	26	13⅜	20	11¼	¾	¾	½
540	to 549	10¾	24 3/16	1 5/8	21 1/16	1 5/8	1/16	8 3/16	20¼	20¾	31¼	15⅜	24	12 1/16	7/8	7/8	½
550	to 559	10¾	24 3/16	1 5/8	21 1/16	1 5/8	1/16	8 3/16	20¼	20¾	31¼	15⅜	24	12 1/16	7/8	7/8	½
550a	to 559a	10¾	24 3/16	1 5/8	21 1/16	1 5/8	1/16	8 3/16	20¼	20 3/16	31¼	15⅜	24	12 1/16	7/8	7/8	½
560	to 569	10 3/4	24 3/16	1 5/8	21 3/16	1 5/8	1/16	8 3/16	20 1/4	20 3/16	31 1/4	15 3/8	24	12 1/16	7/8	7/8	½
560a	to 569a	10¾	24 3/16	1 5/8	21 1/16	1 5/8	1/16	8 3/16	20¼	20¾	31¼	15⅜	24	12 1/16	7/8	7/8	½
570	to 579	10¾	24 3/16	1 5/8	21 1/16	1 5/8	1/16	8 3/16	20¼	20¾	31¼	15⅜	24	12 1/16	7/8	7/8	½
570.5	to 579.5	10¾	24 3/16	1 5/8	21 1/16	1 5/8	1/16	8 3/16	20¼	20¾	31¼	15⅜	24	12 1/16	7/8	7/8	½
570a	to 579a	10¾	24 3/16	1 5/8	20 13/16	1 5/8	1/16	8 3/16	20¼	20 3/16	31¼	15⅜	24	12 1/16	7/8	7/8	½
580	to 589	10¾	24 3/16	1 5/8	21 1/16	1 5/8	1/16	8 3/16	20¼	20¾	31¼	15⅜	24	12 1/16	7/8	7/8	½
580a	to 589a	10¾	24 3/16	1 5/8	20 13/16	1 5/8	1/16	8 3/16	20¼	20 3/16	31¼	15⅜	24	12 1/16	7/8	7/8	½
580.5a	to 589.5a	10¾	24 3/16	1 5/8	20 13/16	1 5/8	1/16	8 3/16	20¼	20 3/16	31¼	15⅜	24	12 1/16	7/8	7/8	½
590	to 599	10¾	24 3/16	1 5/8	21 1/16	1 5/8	1/16	8 3/16	20¼	20¾	31¼	15⅜	24	12 1/16	7/8	7/8	½
590a	to 599a	10¾	24 3/16	1 5/8	20 13/16	1 5/8	1/16	8 3/16	20¼	20 3/16	31¼	15⅜	24	12 1/16	7/8	7/8	½

*One groove in center of frame. See cut. †May be necessary when motor is used without bedplate or slide-rails.
‡This dimension will never be exceeded. When exact dimensions are required liners up to 1/32 inch may be necessary.
**This dimension to center line of shaft extension.

TYPE CS SQUIRREL CAGE MOTORS—Continued

OUTLINE DIMENSIONS—40°



Frame No.	Shaft Dia.	Keyway			Foot Groove		Max. Travel on Base	Dimensions in Inches Corresponding to Letters Given in Outline Views									
		Width	Depth	L'ngth	Width	Depth		A	AA	AB	AD	AF	AG**	AJ	AK	AL	AM
630 to 639	2 3/8	1/2	1/16	6 7/8	1 1/16	1/4	5 3/4	37 5/8	16 1/2	14 13/16	8	13 1/2	18 13/16	5 3/8	7 1/8	1 5/8	20 5/8
630a to 639a	2 7/8	1/2	1/4	8 1/4	1 1/16	1/4	5 3/4	42 1/8	16 1/2	16 5/16	9 1/2	13 1/2	21 1/16	5 3/8	7 1/8	1 5/8	20 5/8
640 to 649	2 3/8	1/2	1/16	6 7/8	1 1/16	1/4	5 3/4	39 5/8	18 1/2	15 13/16	8	15 1/2	19 13/16	5 3/8	7 1/8	2 3/8	22 5/8
640.5 to 649.5	2 3/8	1/2	1/16	6 7/8	1 1/16	1/4	5 3/4	39 5/8	18 1/2	15 13/16	8	15 1/2	19 13/16	5 3/8	7 1/8	2 3/8	22 5/8
640a to 649a	2 7/8	1/2	1/4	8 1/4	1 1/16	1/4	5 3/4	44 1/8	18 1/2	17 5/16	9 1/2	15 1/2	22 1/16	5 3/8	7 1/8	2 3/8	22 5/8
650 to 659	2 3/8	1/2	1/16	6 7/8	1 1/16	1/4	5 3/4	41 5/8	20 1/2	16 13/16	8	17 1/2	20 13/16	5 3/8	7 1/8	2 3/8	24 5/8
650.5 to 659.5	2 3/8	1/2	1/16	6 7/8	1 1/16	1/4	5 3/4	41 5/8	20 1/2	16 13/16	8	17 1/2	20 13/16	5 3/8	7 1/8	2 3/8	24 5/8
650a to 659a	2 7/8	1/2	1/4	8 1/4	1 1/16	1/4	5 3/4	46 1/8	20 1/2	18 5/16	9 1/2	17 1/2	23 1/16	5 3/8	7 1/8	2 3/8	24 5/8
660 to 669	2 3/8	1/2	1/16	6 7/8	1 1/16	1/4	5 3/4	43 5/8	22 1/2	17 13/16		19 1/2	21 13/16	5 3/8	7 1/8	2 3/8	26 5/8
660a to 669a	2 7/8	1/2	1/4	8 1/4	1 1/16	1/4	5 3/4	48 1/8	22 1/2	19 5/16	9 1/2	19 1/2	24 1/16	5 3/8	7 1/8	2 3/8	26 5/8
740 to 749	2 7/8	1/2	1/4	8 1/4	1 5/8	1/4	6 1/2	43 3/8	19 3/4	16 1/16	9 1/2	15 3/4	21 1/16	5 7/8	7 1/4	2 5/8	23
740a to 749a	3 3/8	1/2	1/4	8 7/8	1 5/8	1/4	6 1/2	46 3/8	19 3/4	18 1/16	10 1/4	15 3/4	23 1/16	5 7/8	7 1/4	2 5/8	23
750 to 759	2 7/8	1/2	1/4	8 1/4	1 5/8	1/4	6 1/2	45 3/8	21 3/4	17 1/16	9 1/2	17 3/4	22 1/16	5 7/8	7 1/4	2 5/8	25
750a to 759a	3 3/8	1/2	1/4	8 7/8	1 5/8	1/4	6 1/2	48 3/8	21 3/4	19 1/16	10 1/4	17 3/4	24 1/16	5 7/8	7 1/4	2 5/8	25
750.5a to 759.5a	3 3/8	1/2	1/4	8 7/8	1 5/8	1/4	6 1/2	48 3/8	21 3/4	19 1/16	10 1/4	17 3/4	24 1/16	5 7/8	7 1/4	2 5/8	25
760 to 769	2 7/8	1/2	1/4	8 1/4	1 5/8	1/4	6 1/2	47 3/8	23 3/4	18 1/16	9 1/2	19 3/4	23 1/16	5 7/8	7 1/4	2 5/8	27
760a to 769	3 3/8	1/2	1/4	8 7/8	1 5/8	1/4	6 1/2	50 3/8	23 3/4	20 1/16	10 1/4	19 3/4	25 1/16	5 7/8	7 1/4	2 5/8	27
760.5a to 769.5a	3 3/8	1/2	1/4	8 7/8	1 5/8	1/4	6 1/2	50 3/8	23 3/4	20 1/16	10 1/4	19 3/4	25 1/16	5 7/8	7 1/4	2 5/8	27
770.5a to 779.5a	3 3/8	1/2	1/4	8 7/8	1 5/8	1/4	6 1/2	52 3/8	23 3/4	21 1/16	10 1/4	19 3/4	26 1/16	5 7/8	7 1/4	2 5/8	27
850 to 859	3 3/8	1/2	3/32	10 3/4	2	1/4	5	48 7/8	22 3/4	18 1/16	12	18 1/4	23 1/16	7 1/2	9 1/4	2 5/8	27 1/2
850a to 859a	3 7/8	1/2	1/8	12	2	1/4	5	53 3/8	22 3/4	19 1/16	13 1/2	18 1/4	26 1/16	7 1/2	9 1/4	2 5/8	27 1/2
860 to 869	3 3/8	1/2	3/32	10 3/4	2	1/4	5	50 7/8	24 3/4	19 1/16	12	20 1/4	24 1/16	7 1/2	9 1/4	2 5/8	29 1/2
860a to 869a	3 7/8	1/2	1/8	12	2	1/4	5	55 3/8	24 3/4	20 1/16	13 1/2	20 1/4	27 1/16	7 1/2	9 1/4	2 5/8	29 1/2
860.5a to 869.5a	3 7/8	1/2	1/8	12	2	1/4	5	55 3/8	24 3/4	20 1/16	13 1/2	20 1/4	27 1/16	7 1/2	9 1/4	2 5/8	29 1/2
870a to 879a	3 7/8	1/2	1/8	12	2	1/4	5	57 3/8	24 3/4	21 1/16	13 1/2	20 1/4	28 1/16	7 1/2	9 1/4	2 5/8	29 1/2
870.5a to 879.5a	3 7/8	1/2	1/8	12	2	1/4	5	57 3/8	24 3/4	21 1/16	13 1/2	20 1/4	28 1/16	7 1/2	9 1/4	2 5/8	29 1/2

Frame No.	B‡	BA	BB	BC	BD	BE	BF	C	CA	CB	CC	CD	CE	CF	O	OA	OB†
630 to 639	13	31 1/4	1 7/8	25 1/16	1 3/4	1/16	6 11/16	26	24 1/8	38	19	30	..	16 1/2	1	1	1/2
630a to 639a	13	31 1/4	1 7/8	25 1/16	1 3/4	1/16	6 11/16	26	24 1/4	38	19	30	..	16 1/2	1	1	1/2
640 to 649	13	31 1/4	1 7/8	25 1/16	1 3/4	1/16	6 11/16	26	24 1/8	38	19	30	..	16 1/2	1	1	1/2
640.5 to 649.5	13	31 1/4	1 7/8	25 1/16	1 3/4	1/16	6 11/16	26	24 1/8	38	19	30	..	16 1/2	1	1	1/2
640a to 649a	13	31 1/4	1 7/8	25 1/16	1 3/4	1/16	6 11/16	26	24 1/4	38	19	30	..	16 1/2	1	1	1/2
650 to 659	13	31 1/4	1 7/8	25 1/16	1 3/4	1/16	6 11/16	26	24 1/8	38	19	30	..	16 1/2	1	1	1/2
650.5 to 659.5	13	31 1/4	1 7/8	25 1/16	1 3/4	1/16	6 11/16	26	24 1/8	38	19	30	..	16 1/2	1	1	1/2
650a to 659a	13	31 1/4	1 7/8	25 1/16	1 3/4	1/16	6 11/16	26	24 1/4	38	19	30	..	16 1/2	1	1	1/2
660 to 669	13	31 1/4	1 7/8	25 1/16	1 3/4	1/16	6 11/16	26	24 1/8	38	19	30	..	16 1/2	1	1	1/2
660a to 669a	13	31 1/4	1 7/8	25 1/16	1 3/4	1/16	6 11/16	26	24 1/4	38	19	30	..	16 1/2	1	1	1/2
740 to 749	15 1/4	36 5/8	2 1/2	29 1/16	2 1/4	3/16	9 1/16	30	28 3/8	40 1/2	22	31 1/2	11	18 1/16	1 1/4	11/16	3/4
740a to 749a	15 1/4	36 5/8	2 1/2	29 1/16	2 1/4	3/16	9 1/16	30	28 3/8	40 1/2	22	31 1/2	11	18 1/16	1 1/4	11/16	3/4
750 to 759	15 1/4	36 5/8	2 1/2	29 1/16	2 1/4	3/16	9 1/16	30	28 3/8	40 1/2	22	31 1/2	11	18 1/16	1 1/4	11/16	3/4
750a to 759a	15 1/4	36 5/8	2 1/2	29 1/16	2 1/4	3/16	9 1/16	30	28 3/8	40 1/2	22	31 1/2	11	18 1/16	1 1/4	11/16	3/4
750.5a to 759.5a	15 1/4	36 5/8	2 1/2	29 1/16	2 1/4	3/16	9 1/16	30	28 3/8	40 1/2	22	31 1/2	11	18 1/16	1 1/4	11/16	3/4
760 to 769	15 1/4	36 5/8	2 1/2	29 1/16	2 1/4	3/16	9 1/16	30	28 3/8	40 1/2	22	31 1/2	11	18 1/16	1 1/4	11/16	3/4
760a to 769a	15 1/4	36 5/8	2 1/2	29 1/16	2 1/4	3/16	9 1/16	30	28 3/8	40 1/2	22	31 1/2	11	18 1/16	1 1/4	11/16	3/4
760.5a to 769.5a	15 1/4	36 5/8	2 1/2	29 1/16	2 1/4	3/16	9 1/16	30	28 1/8	40 1/2	22	31 1/2	11	18 1/16	1 1/4	11/16	3/4
770.5a to 779.5a	15 1/4	36 5/8	2 1/2	34 3/8	2 1/4	3/16	9 1/16	30	28 3/8	40 1/2	22	31 1/2	11	18 1/16	1 1/4	11/16	3/4
850 to 859	17 3/4	42 1/16	3	34 3/8	2 1/4	1/16	12 1/8	34 1/4	33 1/4	47	26	37	12	21	1 1/2	11/16	3/4
850a to 859a	17 3/4	42 1/16	3	34 3/8	2 1/4	1/16	12 1/8	34 1/4	33 1/4	47	26	37	12	21	1 1/2	11/16	3/4
860 to 869	17 3/4	42 1/16	3	34 3/8	2 1/4	1/16	12 1/8	34 1/4	33 1/4	47	26	37	12	21	1 1/2	11/16	3/4
860a to 869a	17 3/4	42 1/16	3	34 3/8	2 1/4	1/16	12 1/8	34 1/4	33 1/4	47	26	37	12	21	1 1/2	11/16	3/4
860.5a to 869.5a	17 3/4	42 1/16	3	34 3/8	2 1/4	1/16	12 1/8	34 1/4	33 1/4	47	26	37	12	21	1 1/2	11/16	3/4
870a to 879a	17 3/4	42 1/16	3	34 3/8	2 1/4	1/16	12 1/8	34 1/4	33 1/4	47	26	37	12	21	1 1/2	11/16	3/4
870.5a to 879.5a	17 3/4	42 1/16	3	34 3/8	2 1/4	1/16	12 1/8	34 1/4	33 1/4	47	26	37	12	21	1 1/2	11/16	3/4

‡This dimension will never be exceeded. When exact dimensions are required liners up to 1/32 inch may be necessary.
†May be necessary when motor is used without bedplate or slide-rails.
**This dimension is centerline of shaft extension.

TYPE CS SQUIRREL CAGE MOTORS—Continued

OUTLINE DIMENSIONS—50°

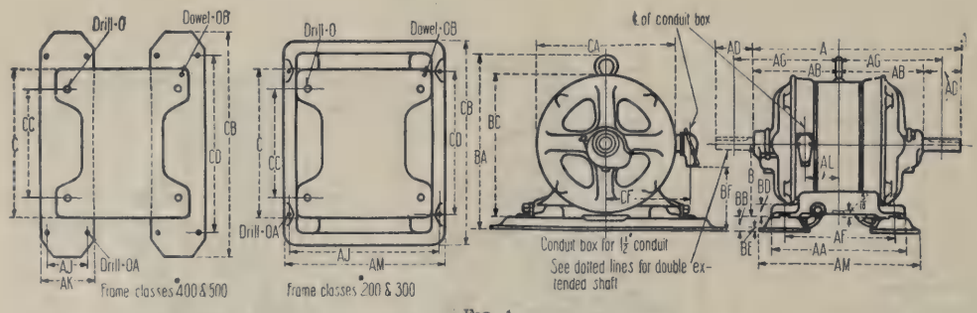


FIG. 1

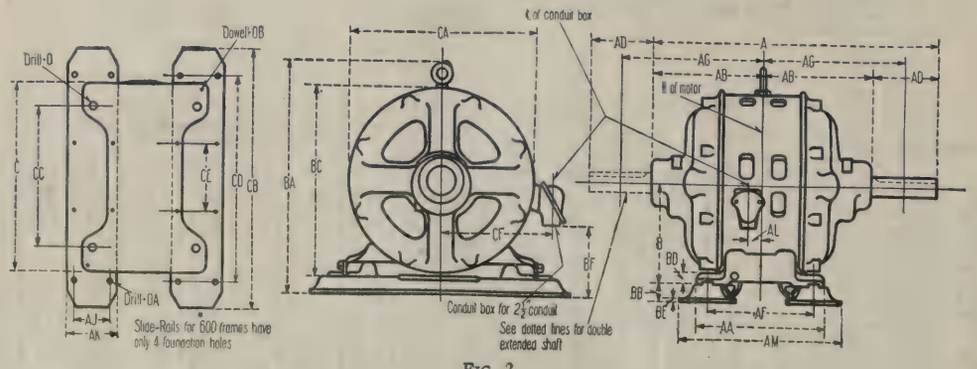


FIG. 2

Frame No.	Fig. No.	Shaft Dia.	Keyway Width	Keyway Depth	Keyway Length	Foot Groove Width	Foot Groove Depth	Maximum Travel on Base	A	AA	AB	AD	AF	AG **	AJ	AK	AL	AM
220a to 229a	1	1¼	5/16	1/8	2 13/16	1 3/32	*	2¼	19	11	7⅝	3¾	9	9 3/16	12½	...	2½	13½
240a to 249a	1	1¼	5/16	1/8	2 13/16	1 3/32	*	2¼	21	14	8⅜	3¾	12	11⅛	15½	...	3½	16½
320a to 329a	1	1⅝	⅜	1/8	4½	1 3/32	*	2½	22¾	12	8 21/32	5 7/16	9½	11 3/8	13¾	...	2 7/16	14¾
350a to 359a	1	1⅝	⅜	1/8	4½	1 3/32	*	2½	25¾	15	10 3/32	5 7/16	12½	12⅞	16¾	...	3 15/16	17¾
360a to 369a	1	1⅝	⅜	1/8	4½	1 3/32	*	2½	26¾	15	10 31/32	5 7/16	12½	13 3/8	16¾	...	3 15/16	17¾
450a to 459a	1	1⅞	7/16	5/32	5⅝	1 1/16	7/32	4⅛	32 5/16	13 5/8	12 13/16	6 11/16	11¼	16 7/32	4⅛	5⅜	3¼	16 5/8
460a to 469a	1	1⅞	7/16	5/32	5⅝	1 1/16	7/32	4⅛	33 5/16	15 5/8	13 5/16	6 11/16	13¼	16 23/32	4⅛	5⅜	4¼	18 5/8
470a to 479a	1	1⅞	7/16	5/32	5⅝	1 1/16	7/32	4⅛	34 5/16	15 5/8	13 13/16	6 11/16	13¼	17 7/32	4⅛	5⅜	4¼	18 5/8
550a to 559a	1	2⅜	9/16	3/16	6⅞	1¼	9/32	4	37⅛	15	14 9/16	8	12½	18 9/16	4¾	6¼	3⅞	18¾
560a to 569a	1	2⅜	9/16	3/16	6⅞	1¼	9/32	4	38⅛	15	15 1/16	8	12½	19 1/16	4¾	6¼	3⅞	18¾
570a to 579a	1	2⅜	9/16	3/16	6⅞	1¼	9/32	4	39⅛	17	15 9/16	8	14½	19 9/16	4¾	6¼	4⅞	20¾
580a to 589a	1	2⅜	9/16	3/16	6⅞	1¼	9/32	4	40⅛	17	16 1/16	8	14½	20 1/16	4¾	6¼	4⅞	20¾
630a to 639a	2	2⅞	11/16	¼	8¼	1 7/16	9/32	5¾	42⅛	16 5/16	16 5/16	9½	13½	21 1/16	5⅜	7⅛	1⅝	20⅝
640a to 649a	2	2⅞	11/16	¼	8¼	1 7/16	9/32	5¾	44⅛	18½	17 9/16	9½	15½	22 1/16	5⅜	7⅛	2⅜	22⅝

Frame No.	Fig. No.	B†	BA	BB	BC	BD	BE	BF	C	CA	CB	CC	CD	CF	O	OA	OB†
220a to 229a	1	6¼	13 5/16	1 5/16	12⅛	1⅛	3/16	3 7/16	12	11¾	16¾	8⅜	11½	8 9/16	5/8	½	7/16
240a to 249a	1	6¼	13 5/16	1 5/16	12⅛	1⅛	3/16	3 7/16	12	11¾	16¾	8⅜	11½	8 9/16	5/8	½	7/16
320a to 329a		7⅜	17 3/8	1⅜	14⅜	1⅜	3/16	4¾	15	14	20	10⅞	14¾	9 5/8	¾	5/8	7/16
350a to 359a	1	7⅜	17 3/8	1⅜	14⅜	1⅜	3/16	4¾	15	14	20¼	10⅞	14¼	9 5/8	¾	5/8	7/16
360a to 369a	1	7⅜	17 3/8	1⅜	14⅜	1⅜	3/16	4¾	15	14	20¼	10⅞	14¼	9 5/8	¾	5/8	7/16
450a to 459a	1	9	20½	1 7/16	17⅝	1½	¼	6 7/16	18⅛	17¼	26	13⅜	20	11¼	¾	¾	½
460a to 469a	1	9	20½	1 7/16	17⅝	1½	¼	6 7/16	18⅛	17¼	26	13⅜	20	11¼	¾	¾	½
470a to 479a	1	9	20½	1 7/16	17⅝	1½	¼	6 7/16	18⅛	17¼	26	13⅜	20	11¼	¾	¾	½
550a to 559a	1	10¾	24 5/16	1⅝	21⅛	1⅝	5/16	8⅜	20¼	20⅜	31¼	15⅜	24	12 15/16	⅞	⅞	½
560a to 569a	1	10¾	24 5/16	1⅝	21⅛	1⅝	5/16	8⅜	20¼	20⅜	31⅛	15⅜	24	12 15/16	⅞	⅞	½
570a to 579a	1	10¾	24 5/16	1⅝	20 13/16	1⅝	5/16	8⅜	20¼	20⅜	31¼	15⅜	24	12 15/16	⅞	⅞	½
580a to 589a	1	10¾	24 5/16	1⅝	20 13/16	1⅝	5/16	8⅜	20¼	20⅜	31¼	15⅜	24	12 15/16	⅞	⅞	½
630a to 639a	2	13	31¼	1⅞	25⅛	1¾	5/16	6 11/16	26	24¼	38	19	30	16½	1	1	½
640a to 649a	2	13	31¼	1⅞	25⅛	1¾	5/16	6 11/16	26	24¼	38	19	30	16½	1	1	½

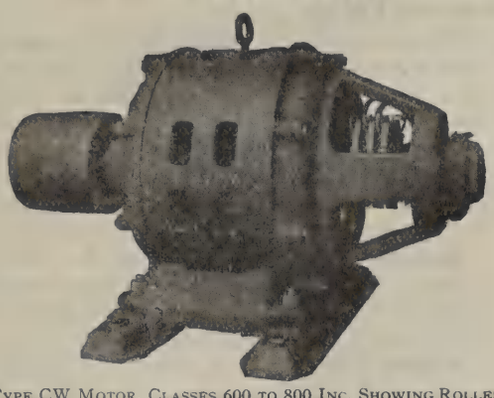
*One Groove in center of frame; see cut.
†May be necessary when motor is used without bedplate or slide rails.
‡This dimension will never be exceeded. When exact dimensions are required liners up to 1/32" may be necessary.
**This dimension to center line of shaft extension.

WOUND-ROTOR INDUCTION MOTORS

TYPE CW FOR CONSTANT AND VARYING-SPEED CONTINUOUS DUTY SERVICE

TYPE CI FOR VARYING-SPEED INTERMITTENT SERVICE

2 AND 3-PHASE **25 AND 60 CYCLES**



TYPE CW MOTOR, CLASSES 600 TO 800 INC. SHOWING ROLLED STEEL FRAME CONSTRUCTION AND ONE-PIECE BRACKETS

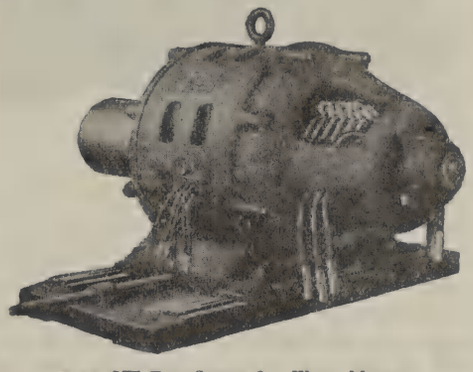
Type CW

Westinghouse type CW wound-rotor induction motors are designed for both constant and varying-speed continuous duty service, and are recommended wherever strong starting effort with small starting current is required. The line is very complete, consisting of all commercial ratings, one-half horsepower and larger.

These motors find extensive application in driving compressors, plunger pumps, positive pressure blowers, hoists requiring a continuous duty motor; in shops where many machines are operated by one motor through long shafting and belts; and wherever it is necessary to bring up to speed loads requiring heavy starting torque on power lines where close voltage regulation is imperative. Every effort is made to reduce the diameter and weight of motors to a minimum, a feature that makes these motors especially adapted for quick starting, stopping, and reversing. Heavy starting torque with low starting current is obtained by inserting resistance in series with the rotor windings when starting the motor. As the motor attains speed, the resistance is gradually cut out of the circuit by means of either a manually operated or an automatic starter furnished with the motor.

For varying-speed service a controller with resistors is furnished to obtain continuous operation on any running point from one-half to full speed for either blower or constant torque service.

In general, the construction of the type CW motors of the larger sizes is the same as that of the type CS, and of the smaller sizes as that of the type CSA.



TYPE CW TWO-SPEED OIL WELL MOTOR

Information relative to installations requiring modifications of type CW motors, such as vertical, back-geared, or conduit-wired motors, or motors with special dust protection or forced ventilation, can be obtained from the Company.

10-HORSEPOWER TYPE CI MOTOR SHOWING FRAME CONSTRUCTION OF SMALLER SIZES

Type CI

The Westinghouse type CI wound-rotor motor is especially designed for heavy duty on cranes, hoists, elevators, drawbridges, roller lift bridges, railway turntables, transfer tables, etc., and is adapted, both mechanically and electrically, to meet the requirements of this severe intermittent, varying-speed, reversing service. It is suitable for heavy duty on all machines where the operation consists of successive periodic cycles requiring high-starting torque.

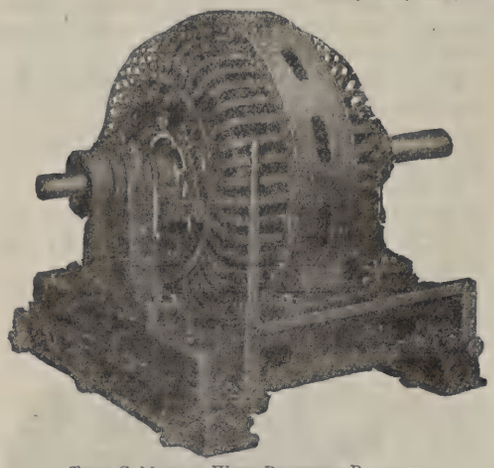
Careful attention has been given to the reduction to a minimum of overall dimensions and weight, making this motor especially suitable for use on cranes where headroom is often the limiting feature and for other applications where space and weight are important considerations. As the rotor is small in diameter the flywheel effect is small, which is essential in motors for this class of service, where quick starting, stopping and reversing are required.

These motors have the same sturdy construction as described for type CS and CW motors, the frame classifications being the same as for the type CW.

SYNCHRONOUS MOTORS

TYPE G—40 TO 350 H.P. 2 AND 3-PHASE 60 CYCLES
220, 440, 550, 1100 AND 2200 VOLTS

TYPE E—90 TO 1500 H.P. 2 AND 3-PHASE 25 AND 60 CYCLES
220, 440, 550, 1100 AND 2200 VOLTS

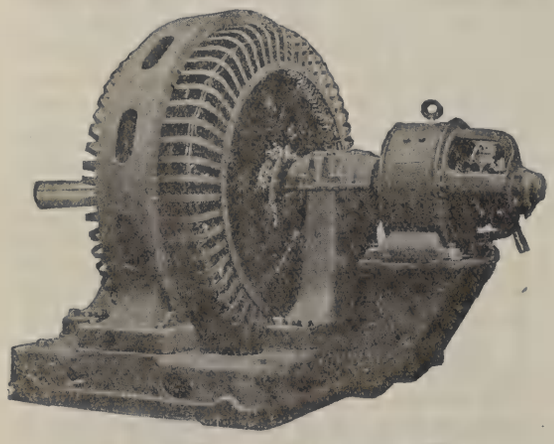


TYPE G MOTORS WITH PEDESTAL BEARING

Type G

Westinghouse type G synchronous motors form a desirable means of driving pumps, fans, compressors and similar machinery, because in addition to driving the mechanical loads these motors can be used to raise the power factor of the circuits on which they operate. Raising the power factor increases the capacity of transformers and transmission lines, gives better voltage regulation and therefore causes lower rates for central station energy.

These motors start as induction motors, auto-starters being used for this purpose. After reaching full speed the motor runs on its synchronous windings, field excitation being furnished by a small direct-current generator either belted to the generator shaft or mounted on it.



TYPE G PEDESTAL BEARING MOTOR WITH DIRECT-CONNECTED EXCITER

The torque developed during starting is approximately 25 per cent of full load and is sufficient to meet light starting conditions, such as usually obtain with centrifugal pumps, reciprocating pumps having by-passes, compressors with unloading devices, etc. Simplicity and ruggedness of construction, economy in operation and maintenance, and moderate first cost are features of these motors.

Excitation—The collector end of the shaft is extended for the exciter pulley. Direct-coupled exciters can be attached to all motors if desired. The standard excitation voltage is 125.

Method of Drive—These motors can be direct-connected, belted, or geared to the driven machine. Each belted motor is provided with a non-binding ratchet device for adjusting the belt tension.

SELF-STARTING SYNCHRONOUS MOTOR

Type E

Type E, self-starting, synchronous motors are extensively used for constant-speed service where starting conditions are moderate, such as for driving compressors, pumps and large blowers. The electrical features of this line are similar to those of the type G.

The type E machines can be made to operate not only as synchronous motors but also as synchronous condensers, that is, they can be operated to improve the power factor of the circuit. A starting panel and a type Q auto-starter switch, or a set of three interlocked switches can be supplied with each motor. Suitable measuring instruments and switches are mounted on the panel.

HEADSTOCK EQUIPMENTS FOR WOOD-WORKING LATHES

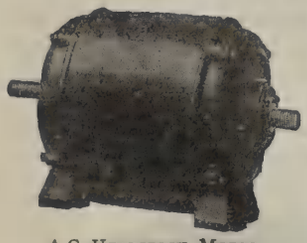
½ H.P.—Alternating Current—Three-Phase, 60 Cycles, 110-220 Volts
½ H.P.—Direct Current—115-230 Volts

D.C. Headstock Motor

The Westinghouse headstock equipments comprise a safe, simple and efficient means of driving wood-working lathes. They replace dangerous and unsightly belts, facilitate control, and increase the efficiency of the machines. These features have brought about the extensive use of the headstock equipments in practically all classes of wood-working plants, such as pattern shops, furniture and piano factories, and wood specialties shops; as well as in shops and manual training departments of schools and colleges.

The quality of the work and production is greatly increased by this method of drive as it enables the operator to use exactly the right speed for the particular piece of work in hand. The tool being under perfect control, there is no fluctuating change in cutting speed due to belt slippage, such as is the case with belt-driven lathes.

No available time is wasted changing belts and adjusting machines to obtain various speeds A small movement of a conveniently situated controller handle gives the proper speed for any depth of cut, or for any diameter of stock up to the capacity of the lathe.



A.C. Headstock Motor

Elimination of belts insures added safety for the workmen, and a better lighted and more sanitary shop.

There is no delicate mechanism requiring frequent attention. Occasional inspection and lubrication will keep the apparatus in good condition almost indefinitely. Construction and design are such that successful operation is assured even with hard usage and unskilled handling.

Each equipment consists of a motor and a controller, specially designed for the service. The operating circuit may be either alternating current or direct current, the apparatus differing to conform to the characteristics of the circuit.

Alternating-Current Equipments

Motor—This is a special, four-speed, ball-bearing motor mounted on the top of the lathe.

Speed Adjustment—Motor speeds approximately 575, 1160, 1750 and 3450 revolutions per minute at full load are given by the four running points of the controller.

The controller is mounted in the leg of the lathe and is operated by a handle which projects through an opening in the leg. A cover held by latches completely protects the control mechanism.

D.C. Controller, Cover Removed

Dynamic braking effect for slow-down is obtained by throwing on the next lower speed. The motor should be brought to the lowest speed before being finally stopped by the handwheel.

Direct-Current Equipments

Motor—An adjustable-speed, commutating-pole shunt-wound motor is supplied for this service. It is mounted in the same manner as the alternating-current motor, and resembles it in general construction. The commutator end bracket is provided with two covers which may be removed for inspecting commutator and brushes.

Speed Adjustment—Adjustable motor speeds are obtained through field control and range from 600 to 3000 revolutions per minute.

The controller is very simple in construction and is designed to be operated successfully by the most inexperienced operator. It is mounted in one leg of the lathe and is completely enclosed by a cover plate furnished by the lathe manufacturer to suit his particular construction.

A.C. Controller Cover Removed

Dynamic braking insures an automatic, quick, and positive stop in all cases as soon as the line circuit is opened.

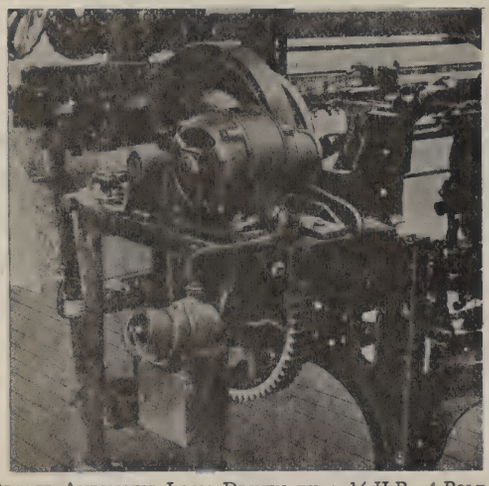
Complete information regarding this equipment furnished on request.

LOOM MOTORS WITH WASTE PACKED BEARINGS

⅓ TO 2 H.P., 1750 AND 1160 R.P.M.

The Westinghouse Loom Motors are specially designed for individual geared loom drive for which ordinary standard motors are not suitable.

These motors operate on alternating current and are of the squirrel-cage induction type, which is particularly suitable for this service because of the simplicity of construction. They are built with low starting torque for continuous running, or with high starting torque to start and stop with the loom.



DRAPER AUTOMATIC LOOM DRIVEN BY A ⅓-H.P., 4-POLE, CONTINUOUSLY RUNNING, OPEN LOOM MOTOR

Frame—The cast iron frame is circular in form with the interior ribbed to hold the primary core. The feet are slotted making it easy to mount the motor. The brackets are open or totally enclosed and are interchangeable. They can be arranged for floor, wall or ceiling mounting.

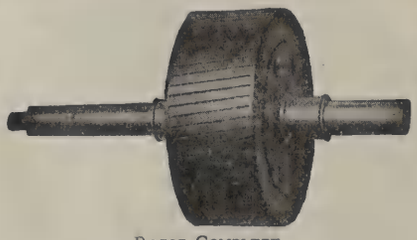
STATOR CORE AND WINDING

Stator—The stator windings are threaded into partially closed slots, insulated with specially treated cloth of high insulating value. After winding, the core is thoroughly dried and impregnated with insulating compound and baked, forming a moisture and stress-resisting unit.

Rotor—The core is made up of iron punchings riveted together under pressure. Each slot contains two conductors of copper strap, swedged over the face of the end plate in opposite directions, insuring a joint with low electrical resistance and of great mechanical strength.

⅓-H.P., 4-POLE LOOM MOTOR

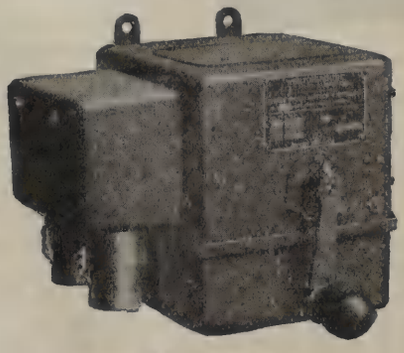
Bearings—Bearings are waste packed. They are large and give ample bearing surface.



ROTOR COMPLETE

Electrical Performance—On both high and low torque motors, the efficiencies are unusually high, particularly in view of the varying amount of power demanded during the cycle of operation of the loom.

Control—The type T-2 starter may be used for all loom motors where an oil switch and a lever operated switch are preferred. The specially enclosed snap switch may be used for motors of one horsepower and smaller where the voltage and phase conditions permit. Type 815 switches are used for starting squirrel-cage induction motors with full line voltage up to and including 10 hp.



10 HORSEPOWER
TYPE 815 QUICK-MAKE AND BREAK STARTING SWITCH

MILL AND CRANE MOTORS

TYPES MCA, MCB, MCOA, MCOB, MA AND K

TYPE MCB ENCLOSED MILL MOTOR

Mill Motors

Types MCA, MCB, MCOA and MCOB—These motors are applicable to intermittent service such as operating steel mill auxiliaries, cranes, contractors' hoists, mine hoists, railway turn-tables, transfer tables, railway lift bridges, draw-bridges, etc.

These motors are of a special and very rugged construction, designed to operate under the most severe service and to withstand the mechanical shocks to which mill motors are subjected, this service is in most cases intermittent. The ideal application for this type of motor is for a cycle of operation in which the motor for a considerable portion of time is accelerating, retarding and standing at rest, and the motor seldom operates for any considerable time at a fixed continuous load.

The applications in steel mills where these types are most desirable are roll tables, side guards, screw-downs, tilting fingers, transfers, lift table mechanism, etc., where the periods of operation are short and high momentary torques are required.

Type MA

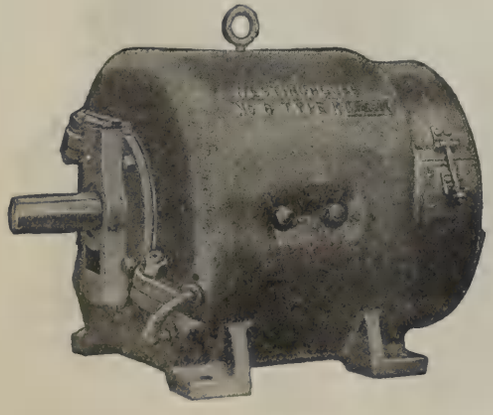
Westinghouse Type MA alternating - current, high-torque, wound-rotor, steel mill motors have been especially designed to withstand the severe service conditions in iron and steel mills, brick plants, cement mills, etc. The general features of construction are based on the results obtained through long and successful experience with the manufacture of direct-current steel mill motors, so that thoroughly satisfactory operation is assured.

Special attention has been given to the production of a motor which is simple in construction, able to withstand the roughest handling, and capable of being repaired in the shortest possible time in case of accident. In order to attain these ends the frame is massive and dust-proof, the insulation is fireproof, the shaft is large, and all parts are accessible.

Crane Motors

Type K—Westinghouse direct-current crane motors are designed for severe, intermittent, varying speed service where high starting torque is required, as for driving cranes, hoists, coke-charging machines, and applications for which rugged series wound motors are best adapted. Many hundred thousand horsepower of these motors are in service and their constantly growing use testifies to their excellence. Their special features are compactness, reliability, simplicity, and ease of inspection and repair. The speed and torque characteristics are those which have been found to be best suited to the service requirements.

TYPE MA MILL MOTOR



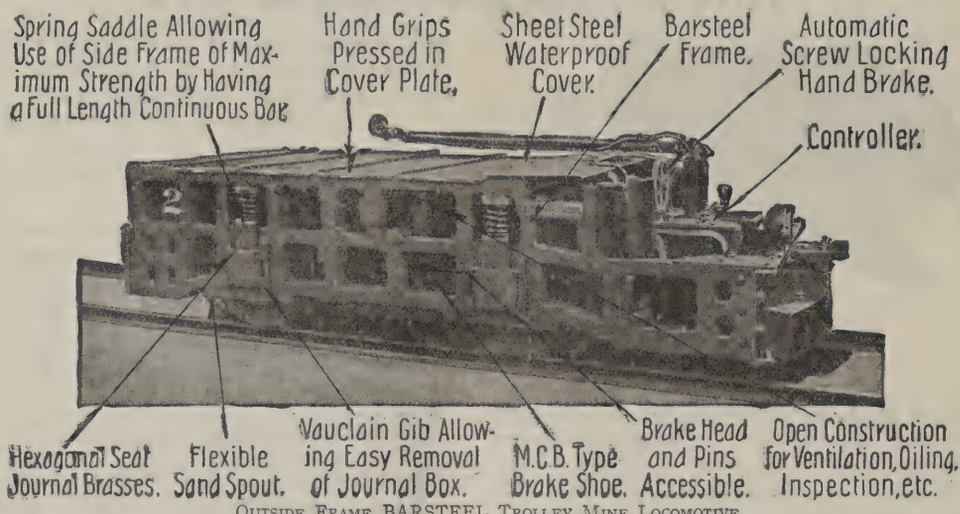
TYPE K CRANE MOTOR

Accessibility is obtained by having a split frame easily opened up. Small over-all dimensions permit it to be installed in cramped spaces and mountings can be made on floor, wall, or ceiling. Uniform heat distribution prevents hot spots.

Where desired electrically-operated brakes can be supplied. These brakes are self-contained and have no exposed moving parts.

Complete description of the motors will be furnished on request.

BALDWIN-WESTINGHOUSE TROLLEY AND STORAGE BATTERY MINE LOCOMOTIVES

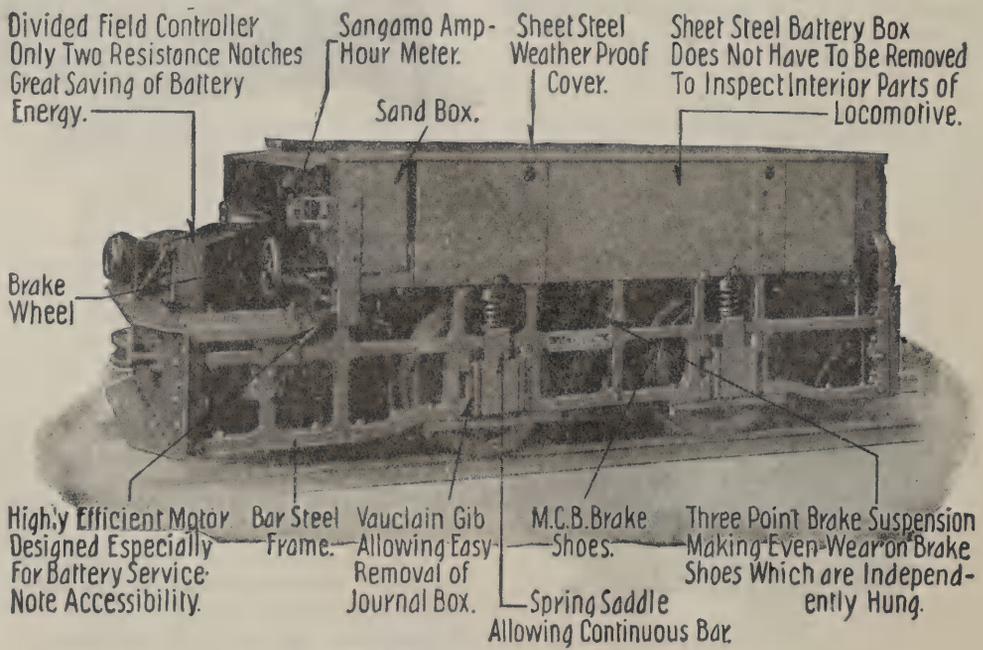

Spring Saddle Allowing Use of Side Frame of Maximum Strength by Having a Full Length Continuous Bar
Hand Grips Pressed in Cover Plate.
Sheet Steel Waterproof Cover.
Barsteel Frame.
Automatic Screw Locking Hand Brake.
Controller.
Hexagonal Seat Journal Brasses.
Flexible Sand Spout.
Vauclain Gib Allowing Easy Removal of Journal Box.
M.C.B. Type Brake Shoe.
Brake Head and Pins Accessible.
Open Construction for Ventilation, Oiling, Inspection, etc.

OUTSIDE FRAME BARSTEEL TROLLEY MINE LOCOMOTIVE

Baldwin-Westinghouse mine locomotives are designed to give continuous service and, therefore, maximum production. The two most important features of these locomotives are the **Barsteel** frame and the commutating-pole motors with oil-and-waste lubricated bronze bearings. Other features include accessibility, simplicity, efficiency of operation and general ruggedness of design.

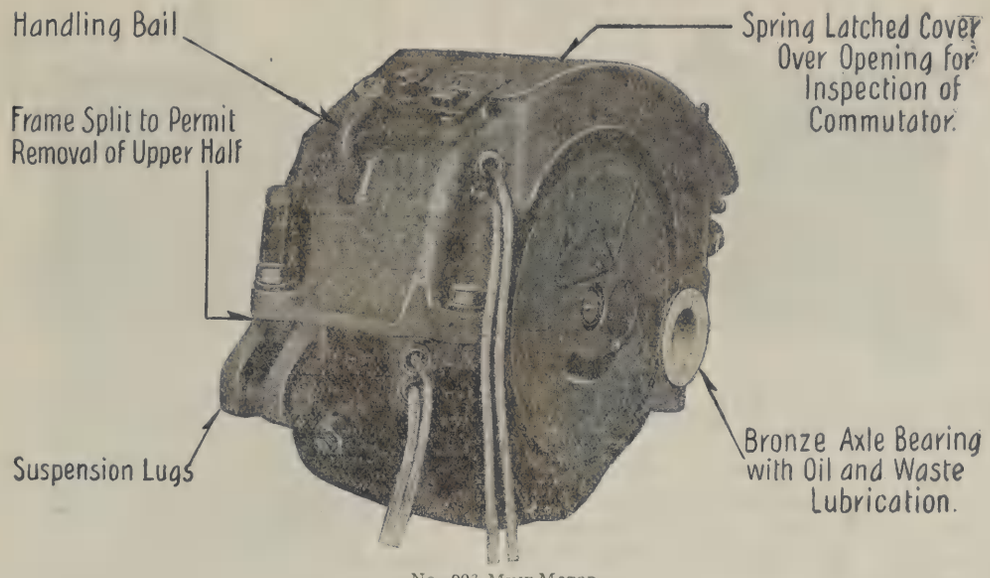
The storage battery locomotive is particularly adaptable to gathering service and underground haulage, where there are difficulties in erecting and maintaining trolley wires and in bonding the rails, or where wooden rails are used. It is also suitable for general work on the surface, by the addition of a cab or canopy. Operating under any of the above conditions, it is entirely reliable and very easily operated. The mining type conforms to the principles established by years of experience in the successful application of mining locomotives of the trolley type and the construction follows that type as closely as possible.

A complete description of these locomotives will be furnished on request.


Divided Field Controller Only Two Resistance Notches Great Saving of Battery Energy.
Sangamo Amp-Hour Meter.
Sand Box.
Sheet Steel Weather Proof Cover.
Sheet Steel Battery Box Does Not Have To Be Removed To Inspect Interior Parts of Locomotive.
Brake Wheel
Highly Efficient Motor Designed Especially For Battery Service Note Accessibility.
Bar Steel Frame.
Vauclain Gib Allowing Easy Removal of Journal Box.
M.C.B. Brake Shoes.
Three Point Brake Suspension Making Even Wear on Brake Shoes Which are Independently Hung.
Spring Saddle Allowing Continuous Bar.

OUTSIDE FRAME BARSTEEL STORAGE BATTERY MINE LOCOMOTIVE

No. 900 MINE MOTORS


Handling Bail
Frame Split to Permit Removal of Upper Half
Suspension Lugs
Spring Latched Cover Over Opening for Inspection of Commutator.
Bronze Axle Bearing with Oil and Waste Lubrication.

No. 903 Mine Motor

Westinghouse commutating-pole mine motors have been built to meet the exacting demands of mine locomotive service. They are the result of long experience in the manufacture of both mine motors and street railway motors, and possess all of the improvements that have been shown to be desirable in motors for service of this nature, while the general proportions are designed specifically for mine locomotives.

The principal features of these motors are excellent commutation due largely to the use of commutating poles, a superior system of lubrication, and a generally improved mechanical design, especially as regards ease and rapidity in installing and overhauling.

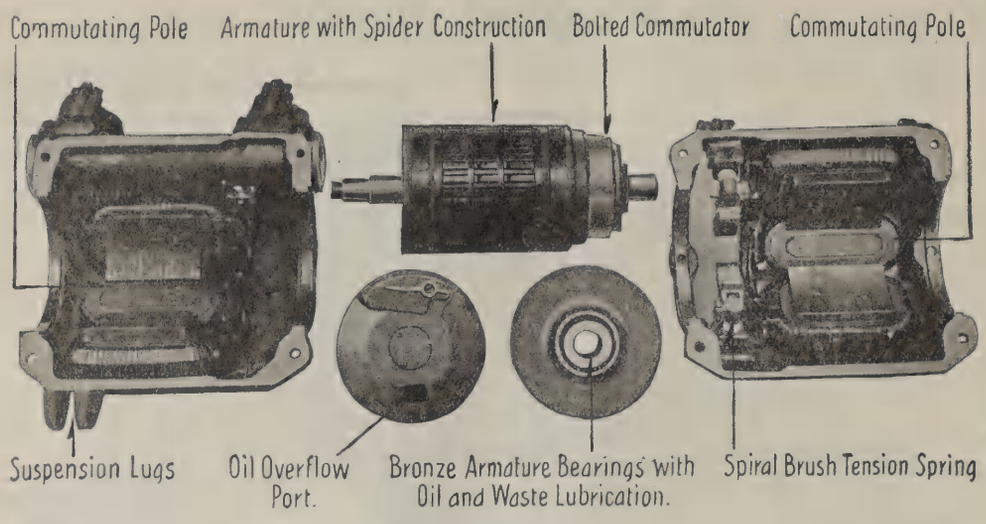
The commutating poles maintain a neutral field under the brushes, resulting in perfect commutation at all loads. Reliable operation and low maintenance cost are thereby insured; the commutator and brushes require very little attention and brush renewals are seldom required. Moreover, the insulation of armature and field coils remains in good condition because of absence of copper and carbon dust.

The 901, 903, 905 and 915 mine motors are built for operating narrow gauge mine locomotives frequently used in metal mining. The minimum gauge for the 901 is 18 inches; 903 is 22 inches; 905 and 915 is 24 inches. The width of these motors is small in proportion to the diameter, but all the special features of the 900 line of motors have been incorporated in their design.

The 902, 904, 906, 907 and 917 mine motors are built for general mine locomotive service. They are built for track gauges of 36 inches and wider.

They have relatively small over-all diameters,

No. 907 Mine Motor



permitting the locomotives to be built low in height. The heights vary from 35 inches for the 902 with cast iron wheels to 43 inches for the 907 or 917 with steel tired wheels.

The 909, 919 and 910 mine motors are built for industrial and heavy mine locomotive service. The 909 and 919 are built for a minimum gauge of 36 inches and the 910 for a minimum gauge of 42 inches.

The No. 908 mine motor can be furnished with or without openings in the housings to admit air for cooling the motor. The ventilated type is used with locomotives operating on very long and severe grades. This insures cool operation and at the same time prevents over-motoring the locomotive.

Compactness and ruggedness are salient features, while provision is made for easy and rapid installation and overhauling.

Sparkless commutation is secured by means of commutating poles, even during the accelerating period or on grades, thus protecting the motors from commutation trouble and excessive wear on the brushes and commutator.

Thorough circulation of air within the motor and through the armature insures uniform heat distribution and dissipation. This guards against hot spots and consequent burnouts during overloads.

Armature—The armature coils are form wound; insulated by several layers of tape, and made moisture proof by impregnating. They are securely held in place by sunken band wires.

Commutator—The commutator bars and mica segments are assembled under heavy pressure and are clamped between steel V-rings by bolts. This construction permits the clamping pressure to be made uniform at every point, so that it is impossible for bars to work loose.

Brushholders—The brushholder boxes are carried by steel rods which are clamped to machined seats on the frame. The brushholders are therefore rigidly held in place and cannot turn; they are however easily adjusted radially for wear of the commutator.

Armature Core—The laminations are keyed to the spider and clamped between a shoulder on the spider and a heavy end ring. Large openings in the spider and through the core permit thorough ventilation.

Bearings—The armature and the axle bearings are bronze. Oil and waste lubrication is used. A large pocket is provided for the waste which comes in contact with the shaft through openings in the housing and the bearings. The oil is poured into a separate reservoir and is soaked upwards by the waste. An overflow opening in the armature oil-well prevents flooding the bearing.

DIRECT-CURRENT CONTROLLERS

TYPE S DRUM-CONTACTOR CONTROLLER

Controllers for Mine Locomotives

The controllers for mine locomotives are of the two general types for storage battery and trolley type locomotives. The storage battery type differs from the trolley type in that the number of notches is less, the insulation less for the lower potentials used, and in most cases field control is employed as well as arrangements for commutating the battery and when both commutating of battery and field control are used, usually only two resistor steps are employed. In the controllers for trolley type locomotives the series and parallel method of control are used. This is primarily for the reason of providing a controller of minimum height, as the series and parallel controller requires less over all height than the series-parallel control. With the series and parallel control the difference from the series-parallel control lies in the use of a separate selector drum to obtain the combination of motors series and motors parallel.

Type S Drum-Contactor Controllers are used for starting and adjusting the speed of shunt, series and compound-wound direct-current motors by adjusting the resistance in series and parallel with the motor armature. They are applicable to cranes, hoists, crushers, floor chargers, roll and transfer tables, punches, and practically all applications employing this system of control.

The outstanding advantages of these controllers are:

Easy to operate—contacts actuated by cams and rollers which have little friction.

No sticking nor freezing of contacts.

Longer contact life than obtained with any manually-operated controller of equal capacity.

Circuit closed and opened by snappy positive action: almost too quick for the eye to follow; no severe arcing.

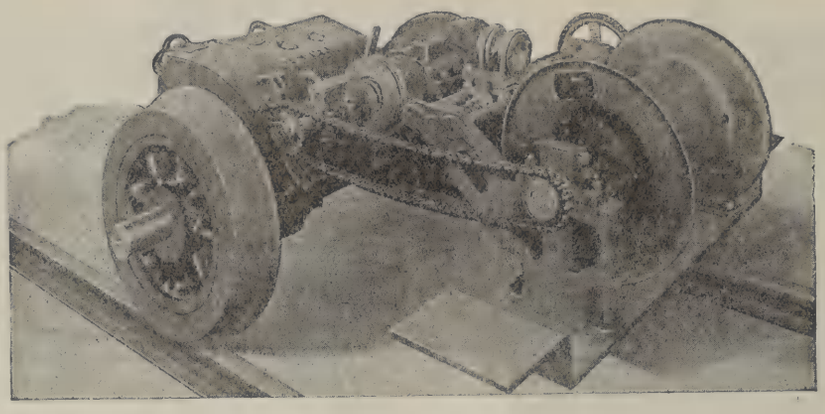
The controllers for trolley locomotives as generally used the types R-86-G, R-109-G, R-112-C, R-113-D and R-114-C. The use of any one of these controllers depends upon the capacity of and number of motors to be controlled. The R-86-G is suitable for use with two 60 H.P. motors at 500 volts. The R-109-G is suitable for two 110 H.P. motors at 500 volts. The R-112-C is suitable for two 170 H.P. motors at 500 volts. The R-113-D and R-114-C are for special locomotive equipments having a total capacity of three 120 H.P. and four 86 H.P. motors at 500 volts respectively. The R-114 has its application in the majority of cases to two 2-motor locomotives operated in tandem. The ratings are given here for the maximum voltage service. If, as in most cases, the voltage is 250 volts, the horse power capacity is half the value given for 500 volts. All of these controllers except the R-86-G have individual blowout coils for the main drum fingers and provide efficient blowout of arcs between fingers and drum contacts. The R-86-G controller is equipped with a single blowout coil and with the arrangement of magnetic circuits in the arc barriers sufficient blowout is afforded for breaking the circuits between the fingers and drum segments. In general the R-109-G, R-112-C, R-113-D and R-114-C embody the same design features.

TYPE R CONTROLLER

3000-11A

CONDUCTOR-CABLE REELS

MECHANICALLY OPERATED



MECHANICALLY-OPERATED CONDUCTOR-CABLE REEL

Gathering Locomotives

The distinguishing feature of gathering locomotives is, of course, the reel with which they are generally equipped.

There are two types of reels supplied on Baldwin-Westinghouse gathering locomotives.

1. Conductor cable reels, by means of which the locomotive can be operated over tracks along which the trolley wire has not been extended, being limited only by length of cable carried on the drum. In this way the empty as well as the loaded cars can be handled by the locomotive. Conductor-cable reels can be subdivided into two classes.

(A) Mechanically driven from locomotive running gear.

(B) Motor driven reels.

2. Traction rope reels by which cars may be pulled from any point towards the locomotive, within the limits of the length of steel rope carried on the drum. The locomotive cannot travel beyond the limits of the trolley wire nor can empty cars be pushed to the working places.

Conductor-Cable Reels—Mechanically Operated

The method of drive is by means of a countershaft supported on two bearings of the bracket which is bolted to the field frame of the back motor on the locomotive as shown in illustration. The driven gear which is keyed to the gear spindle, meshes with the locomotive axle gear through an opening provided in the gear case.

The drive is through a multiple disc friction clutch contained in the enlarged end of the gear spindle and composed of alternate brass and steel discs attached respectively to the gear spindle and drive shaft. The sprocket is keyed to the end of shaft and connected by roller bearing chain with sprocket keyed to shaft of reel drum, thus rotating the reel. In order that the cable may be wound on the reel drum at the same speed at which the locomotive travels and at a uniform tension, an adjustment is provided for the pressure exerted by the spring against the friction plates. This is made by means of a castle nut provided at the end of the shaft which extends beyond the gear spindle.

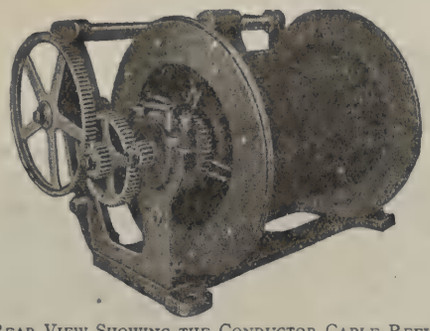
When pulling out the cable the pressure on the friction discs is relieved by a compressing spring through a clutch collar actuated by the clutch arm, this being connected through operating rods to a hand wheel placed convenient to the operator. When this collar is thrown to the left facing, it comes in contact with a brake disc which provides a slight tension in the cable to prevent it unwinding faster than the locomotive travels and to avoid excessive strain on the trolley wire, hook or cable.

Conductor-Cable Reels—Motor Driven

The YR2 reel is entirely self-contained. The motor is mounted inside of the reel drum and is of the shunt wound type connected to the line through a canopy switch, snap switch, fuse and a permanent resistance.

The resistance is so connected and of such capacity that the reel may be left across the line, and will maintain approximately a constant pull on the cable for reeling in or reeling out. The permanent resistance is divided in two sections. One section is in series with the armature. It should be noted that as long as the reel is connected to the line, power is consumed, and for this reason it is advisable to open the circuit by use of the snap switch when the reel is not required.

MOTOR DRIVEN



REAR VIEW SHOWING THE CONDUCTOR CABLE REEL

The reel drum is mounted in a horizontal position on the reel frame which is mounted on the locomotive. The drum is made of sheet steel of ample strength and insulated with wooden strips around the entire periphery. These wooden strips protect the cable and also the drum.

The spooling device or spooling bracket as it is called consists of a casting which travels on the top guide bar and the lead screw at the bottom. The lead screw limits and reverses automatically the travel of the spooling bracket so that the cable is wound on the drum in even layers. The spooling bracket is driven by a tongue which travels in the grooves of the double square threaded shaft called the lead screw. The rotary motion of the lead screw is produced by gearing so arranged to feed either the single or double conductor cable by suitable gears. The gears supplied are designed for the particular size of cable furnished with the reel, and if the size of cable is changed it will be necessary to change the one pinion and the one gear on the second reduction operating the spooling device. A porcelain block is bolted into the spooling bracket casting having a bell shape opening in same through which the cable is guided on the reel drum. The porcelain guide block is a standard on all reels although the spooling bracket casting is so designed that a wooden guide block can be applied in case customer so desires.

The reel is so designed that all parts are readily accessible and the armature can be removed without dismantling the reel.

When single conductor cable is used one end is connected to the trolley wire hook and the other end is led through a hole in the barrel of the reel drum to terminal on collector ring which revolves with the drum. The single conductor cable is used when the track in the rooms is made of steel and the joints so bonded that they afford a return circuit.

When double concentric cable is used the inside strand of the cable on one end is connected to trolley wire hook, while outside strand is connected to the rail hook. The other end of cable is led through a hole in the barrel of reel drum and the inside strand is connected to the terminal on collector ring, which revolves with the reel drum. The outside strand is connected to the reel frame which is part of the return circuit through the locomotive frame from the locomotive main motors.

In either case where the single or double conductor cable is used the current for the main motors is taken from the collector ring by a brush and holder, then carried through leads to controller and locomotive motors.

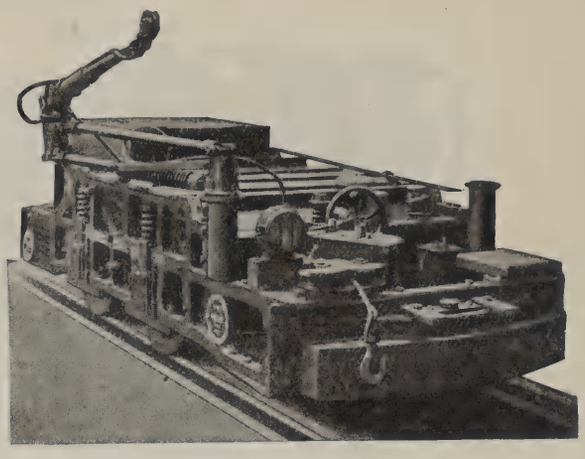
Style	**279317**	YR2	Single	Con.	Cable	250 Volts
Style	**237319**	YR2	Double	Con.	Cable	250 Volts
Style	**270318**	YR2	Single	Con.	Cable	500 Volts
Style	**279320**	YR2	Double	Con.	Cable	500 Volts

FRONT VIEW SHOWING THE INSULATED CABLE GUIDE

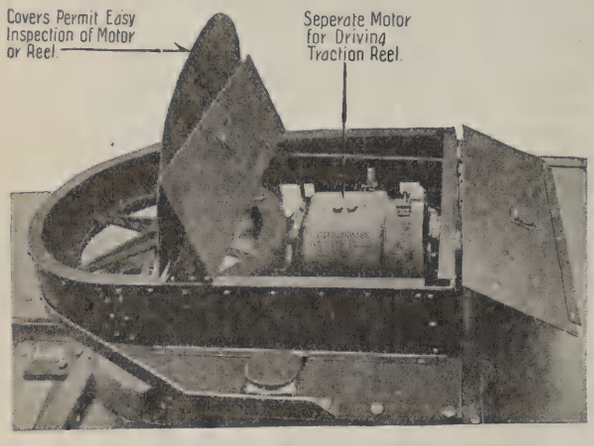
TRACTION REEL LOCOMOTIVES

The Baldwin-Westinghouse traction-reel locomotive is constructed with a bar steel frame which is very strong, yet open in construction and permits the weight of the locomotive to be distributed so that the shocks and strains encountered in mining service are withstood without damage.

The traction-reel locomotive has a motor driven reel on which is wound a steel cable. The locomotive is stationed on the cross entry track with the brakes set and the cable is run into the room by a switchman who hooks the cable to a loaded car. The reel motor is then started and the car drawn out on the cross-entry track.



FRONT VIEW OF TRACTION-REEL LOCOMOTIVE



SHOWING MOTOR OF TRACTION-REEL

This type of locomotive can be used where the headroom is too low for the conductor-cable-reel locomotive, and where the track in the room is so light or poorly laid that nothing heavier than loaded cars can be supported. It can haul loaded cars up very steep grades and is useful in handling flat cars that are loaded with rails or props or that for any reason cannot be coupled to other types of locomotives.

The Baldwin-Westinghouse traction reel is vertical and is driven by a motor through single reduction bevel gearing. It is very simple in construction, there being no clutch or other complications in the mechanism. The motor is of a type which has been giving satisfaction for years in the severest kind of service. It is operated through a speed-regulating controller mounted on the locomotive.

Traction reels can be arranged to pay cable out over the front or back end of locomotive as desired.

REAR VIEW TRACTION-REEL LOCOMOTIVE

MINE AND INDUSTRIAL HAULAGE TROLLEYS—DRIVING JOURNAL BOX

Form D-20 Trolley

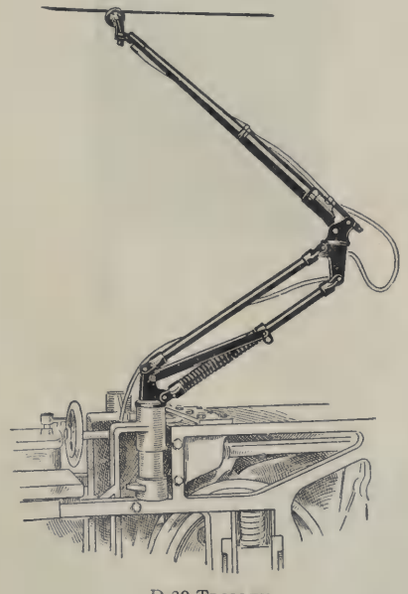
For haulage with comparatively low head room and high cars, and for narrow haulage roads where a long pole cannot be conveniently turned around, the D-20 trolley has been developed. This consists of two members as shown in the illustration, the upper member is in reality a short independent trolley pole which is carried on the upper end of the lower member. The latter can be swung both horizontally and vertically and locked in any position. This trolley can be turned in narrow passages, can be adjusted for wide variations in the height of the trolley wire, and does not interfere with high-trailing cars when the trolley is low.

Form D-21 Mine Trolley

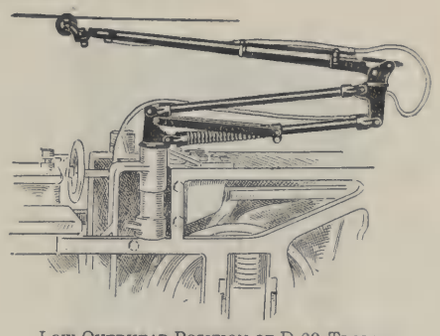
The general design of the Form D-21 is based upon the known conditions of mine operations that this type of trolley will be used under.

Since conditions cause a slight varying of the nature of the service rendered it has been found expedient to deviate in a few instances from the design of the standard D-21.

To supply these needs, seven variations, Forms D-21-A, B, C, E, E-1 and F are manufactured and



D-20 Trolley



Low Overhead Position of D-20 Trolley

give successful service. These variations give any demanded pole length, wheel pressure, etc.

The materials used in their construction are seasoned white ash poles, phosphor-bronze wheels and harps, cast and wrought iron parts and cold rolled pins—all selected because of durability proven by actual service test.

Driving Box-Thrust Type

The driving journal box for outside frame locomotives is so designed that the lateral thrust of the axle is taken on a renewable wearing plate in the box lid, thereby relieving the wear between the wheel hub and the inside of the driving box. With steel tired wheels, this permits many renewals of tires without the wheel hub being torn down.

Easily removable protecting gibs of sturdy angle iron section are provided, one located on each side of the driving box. This gib is so arranged as to permit easy removal of the journal box, and also to protect the box and box lid, and particularly the nuts holding the lid.

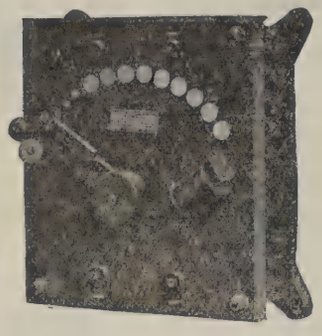
An oil hole with a threaded plug is provided in the lid so that the journals may be lubricated without removing the lid.

The journal brasses are cylindrical in form, having lugs to prevent their turning in the journal box. These brasses are so designed that they may be quickly removed by simply releasing the weight of the locomotive from the brass, and drawing the brass out from the end of the box.

For inside frame locomotives, the driving box has a steel or bronze wearing plate to take the lateral thrust of the axle, this reducing the wear upon the wheel hubs.

DIRECT-CURRENT RHEOSTATS AND CONTROLLERS

TYPES D, DM, DS, H, DA AND I



TYPE D RHEOSTAT WITH BAR RESISTOR

Type D Starting Rheostats are used for starting shunt, compound and series wound direct-current motors. These starters are characterized by strong compact, fire-proof construction and have the approval of the National Board of Fire Underwriters. They are self-contained, consisting of a faceplate with renewable segments, low voltage release mechanism and self-contained resistance. In the smaller sizes tube and bar resistors are employed while in the larger ratings the grid type resistor is used. Each part is readily accessible for inspection and all wearing parts can be easily and cheaply renewed.

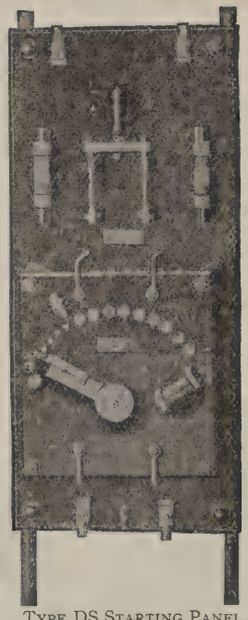
Type DM Rheostats are designed for use in mines and other places where the apparatus is subjected to dampness. In type DM rheostats the current carrying parts are thoroughly protected against injury from the presence of moisture or acid.

Type DS Starting Panels consist of a type D starter and a line switch with fuses mounted on a slate base. The panels may be mounted either on the wall by means of brackets or on pipe frame supports bolted to the floor.

Type H Rheostats are used for starting and regulating the speed of direct current motors in non-reversing service where speed adjustment by field control is desired. The apparatus is so arranged that the motor is always started with full field strength. In case of failure of the voltage the field control resistance is automatically short-circuited and the motor is disconnected from the line. The rheostats are self-contained, consisting of a face-plate with renewable segments, low voltage release mechanism and self-contained field and starting resistance. Each part is readily accessible for inspection and all wearing parts can be easily and cheaply renewed.

TYPE H STARTING AND SPEED ADJUSTING RHEOSTAT

Type DA Rheostats are used for reducing the speed of shunt, compound and series wound direct-current motors by armature control. They consist of a face-plate with renewal segments, low-voltage release mechanism and self-contained resistors. Each part is readily accessible for inspection and all wearing parts can be easily and cheaply renewed. There are two classes of non-reversing service for which these rheostats are suitable—namely, varying torque and constant torque. Fans, blowers, centrifugal pumps, etc., come under the first heading, in this service the torque decreases with the speed but remains constant at any given speed. Machine tool, job printing presses, plunger pumps and similar applications are in the second class; in this service the torque is independent of the speed. Constant speed with varying torque cannot be obtained with these rheostats.



TYPE DS STARTING PANEL

Type I Rheostats are similar to type DA rheostats but in addition provide for speeds higher than normal by field control. The applications are the same as those of type DA rheostats, except that type I rheostats cannot be used with series and heavily compounded motors.

Complete descriptions of these controllers will be furnished on request.

DIRECT-CURRENT CONTROLLERS

TYPE S DRUM-CONTACTOR CONTROLLER
TYPES V-5, V-4, 245 AND 246 DRUM CONTROLLERS

TYPE S DRUM-CONTACTOR CONTROLLER

Type S Drum-Contactor Controllers are used for starting and adjusting the speed of shunt, series and compound-wound direct-current motors by adjusting the resistance in series and parallel with the motor armature. They are applicable to cranes, hoists, crushers, floor chargers, roll and transfer tables, punches, and practically all applications employing this system of control.

The outstanding advantages of these controllers are:

Contacts actuated by cams and rollers which have little friction.

No sticking nor freezing of contacts.

Longer contact life than obtained with any manually-operated controller of equal capacity.

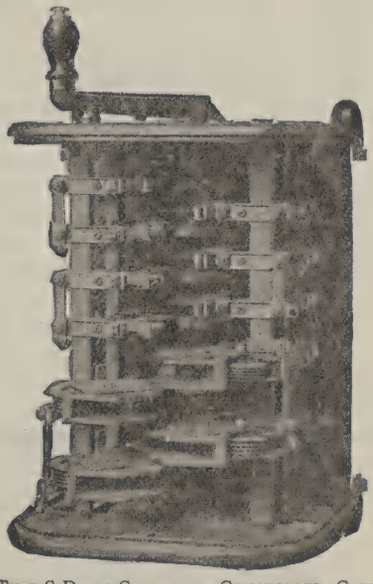
Circuit closed and opened by snappy positive action: almost too quick for the eye to follow: no severe arcing.

Contact pressure always uniform.

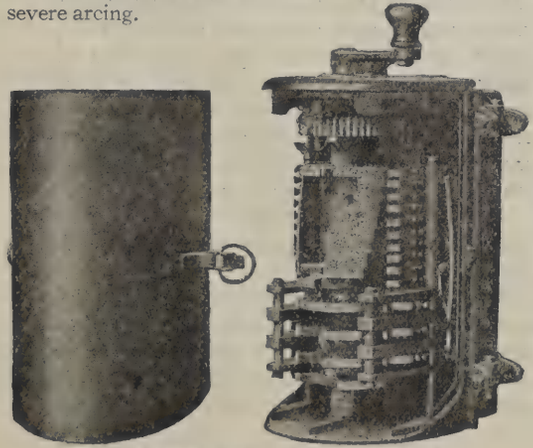
Contacts can be renewed in shorter time and at less expense than those on existing drum controllers.

In operation these controllers employ the same principles as magnetic contactor controllers except the contactors are operated by cams mounted on the controller shaft. Normal movement of the controller handle causes the contactors to open or close with a quick positive action. This reduces the arcing, which is further controlled by a rolling motion. The line contactors are protected by magnetic blow-outs, that limit the arcing and burning to the contact tips. Consequently, there is no pitting, roughing, nor burning of contacts where the load current is carried.

Controllers embody all safety-first features, such as conduit wiring, enclosed current-carrying parts, protection against controller being locked in running position, and prevention of accidental starting or reversing.



TYPE S DRUM-CONTACTOR CONTROLLER, COVER AND BARRIERS REMOVED



TYPE V-5 CONTROLLER FOR ADJUSTABLE-SPEED MOTORS IN MACHINE-TOOL SERVICE

Type S controllers are supplied both with and without dynamic braking.

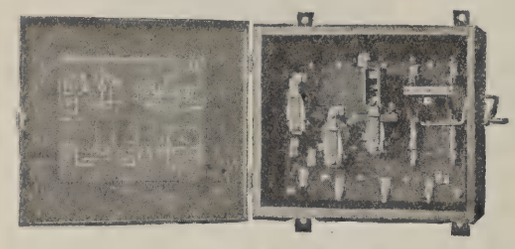
Machine Tool Controllers, including types V-5, V-4, 245 and 246, are designed for use with shunt and compound-wound direct-current motors in machine tool and similar reversing service, requiring speed adjustment by field control. Sturdy construction insures long life and the design is such that the operation is extremely easy and accurate. The movement of a single handle starts the motor in either direction of rotation and brings it to the desired speed. All parts are readily accessible for inspection and all wear is confined to substantial pieces which can be quickly and inexpensively renewed.

DIRECT-CURRENT CONTROLLERS—Continued

The following table shows the standard machine tool controllers.

Type of Controller	H. P. Ratings			No. of Points			Max. Speed Range	Resistors	Starting	Running
	110 to 125 Volts	220 to 250 Volts	500 to 550 Volts	Starting Each Direction	Running Forward	Running Reverse				
V-5	1 to 5	1 to 7½	.....	3	17	17	1 to 4	Self Con.	Drum	Drum
245	7½ to 10	7½ to 15	7½ to 15	2	16	6	1 to 4	Separate	Drum	Dial
246	12½ to 25	20 to 35	20 to 35	3	16	6	1 to 4	Separate	Drum	Dial
V-4	30	40 to 50	40 to 50	3	8	4	1 to 2	Separate	Drum	Drum

TYPE C DIRECT-CURRENT CONTROL AND AUXILIARIES



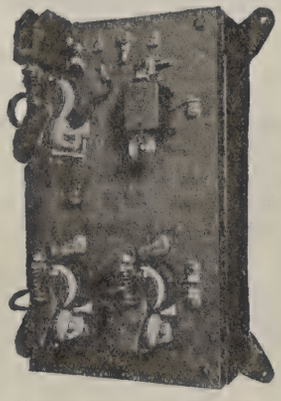
TYPE C AUTOMATIC STARTER

Westinghouse type C automatic starters constitute the ideal form of starting for direct-current motors, giving them perfect protection from excessive current during the starting period and eliminating the uncertainty and inefficiency of hand operated starters.

The personal factor of the operator loses its influence when the motors are started with automatic starters; there is no loss of time through overcautiousness, nor burned-out motors from the impatience of the operator. He simply closes the switch and the motor is started with the maximum speed consistent with safety. The starters are so simple that wrong operation is impossible.

These starters are used with motors driving machine tools, wood-working machines, pumps, compressors, blowers, etc., and all are supplied for two general classes of service as follows:

With low-voltage release. If the power fails, the motor is stopped automatically, but starts again when the power returns. This arrangement is very desirable for operating pumps, compressors, etc.



TYPE C AUTOMATIC STARTER

With low-voltage protection. For this class of service the motor stops when the power fails and can only be started again by the operator closing the starting switch. Hence there is no danger to operator or expensive machinery from the unexpected starting of the machine. Starters for machine tools and wood-working machines are equipped with low-voltage protection.

These starters are furnished in a large variety of forms to suit different applications.

FORM L STARTER FOR USE WITH SEPARATELY MOUNTED RHEOSTAT—THREE POINTS ACCELERATION

All starters automatically accelerate the motor at the proper rate. The rate of acceleration depends upon the speed of the motor, that is, the lighter the load the less time required for the motor to accelerate to full speed. Overload protection may be provided either by an inverse time element, overload relay, or by knife switch and fuses mounted on the control panel.

Reversing may be obtained by the use of a standard non-reversing automatic starter and a drum reverse switch.

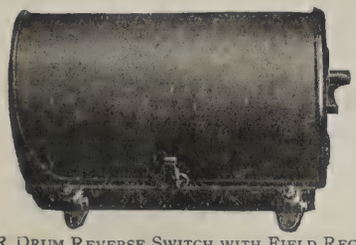
Speed Control may be obtained by the use of an automatic starter and a separately mounted field rheostat or reversing and speed control may be obtained by using a drum reverse switch in the field control circuit with Rheostat.

Auxiliaries

Drum Reverse Switches, 5 to 35 horsepower, may be used with non-reversing automatic starters to obtain reversing, dynamic braking and drift

TYPE 810 DRUM REVERSE SWITCH

Drum Reverse Switches with Field Regulation. 5 to 35 horsepower are used in conjunction with non-reversing constant-speed automatic starters to provide reversing, dynamic braking, and drift. By the use of these switches the complete control of the motor can be obtained from one handle or the spline shaft of the driven machine.



TYPE 817-R DRUM REVERSE SWITCH WITH FIELD REGULATION

DIAPHRAGM PRESSURE REGULATOR

Float Switches are used in supplying open tanks or draining sumps. In the former case, the motor is started when the level falls to a certain point and is stopped at the desired upper level. For sump service the motor is started at the maximum level and stopped at the minimum.

Gauge Type Pressure Regulators are used in connection with compressors or pumps emptying into a closed pressure system. One of these regulators makes connections to start the motor, when the pressure falls to a predetermined point and stops it when the desired maximum is reached.

A Diaphragm Type Pressure Regulator may be furnished for use in systems in which the fluid or gas is not injurious to the rubber diaphragm.

Type C Push-Button Stations are used in connection with alternating and direct-current automatic starters and controllers to control their various functions. They act as a master controller and allow the operator to start, slow down, speed up, stop or reverse the motor providing the controller is arranged for the particular operations

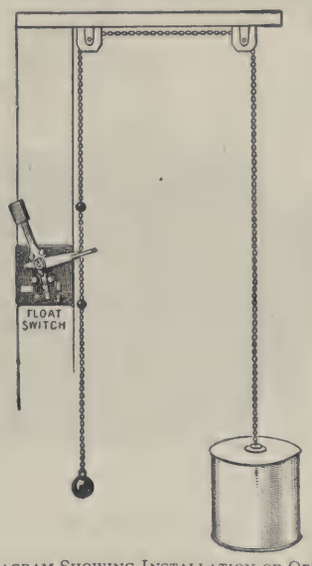
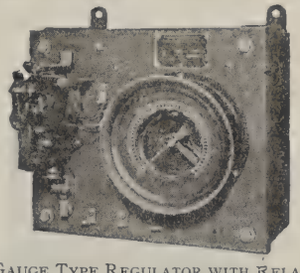


DIAGRAM SHOWING INSTALLATION OF OPEN TYPE FLOAT SWITCH

desired. Any number of stations may be employed and they may be mounted on the driven machine or any other convenient place. All stations are



GAUGE TYPE REGULATOR WITH RELAY

arranged for conduit wiring. Accidental operation is practically impossible (except foot-operated buttons) as the buttons must be pressed past a projecting rim on the enclosing cover surrounding the button before it will operate.

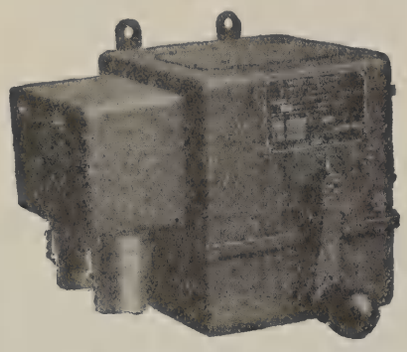
Complete description of this apparatus will be furnished on request.

PUSH BUTTON STATION "FORWARD", "REVERSE", "STOP"

PUSH BUTTON STATION "START", "STOP"

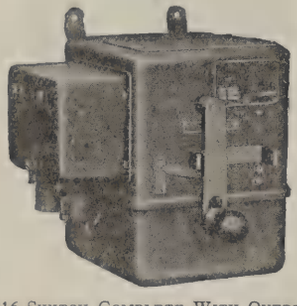
STARTERS FOR SQUIRREL-CAGE INDUCTION MOTORS

TYPES 815, 816, T-2 AND 810 SWITCHES TYPE A AUTO-STARTER



TYPES T-2 STARTER FOR LOOM MOTOR

Types 815 and 816 Quick-Make and Quick-Break Starting Switches, 1 to 25 horsepower, 110 to 550 volts, 2 and 3 phase, 25, 40, 50, and 60 cycles are especially suitable for starting squirrel-cage induction motors in textile mills, flour mills, woodworking establishments, etc., where inflammable dust, gases or explosive materials are present. They furnish complete protection to workman and machinery,



TYPE 816 SWITCH COMPLETE WITH OVERLOAD AND LOW-VOLTAGE PROTECTION

and eliminate the use of fuses with the consequent danger and loss of time in replacing them.

The fire hazard is reduced by the use of asbestos barriers which permit the elimination of oil. When explosive gases are present and explosion hazard outweighs fire hazard, contacts can be immersed in oil.

Instructions for operating and a wiring diagram are permanently posted inside of cover.

These switches may also be used as line switches for wound-rotor induction motors or other services where the features of this switch are desirable.

They can be furnished with or without overload and low-voltage release, and are suitable for either hand or shipper-rod operation.

Type T-2 Starters are of the oil-immersed drum type and are designed for starting squirrel-cage induction motors 1 to 3 horsepower. They may be used for either reversing or non-reversing service.

Type 810 Drum Reverse Switches, 1 to 35 horsepower, are particularly suited to the operation of motors in machine tool, wood-working and similar services in which reversing is required.

These switches are made for alternating-current or direct-current circuits. They connect the motor directly across the line.

Type A Auto-Starters as listed are self-contained, consisting of an oil-immersed switch, auto-transformer, low-voltage protective device and overload relay, all mounted in a steel enclosing case. The auto-transformers are provided with two taps, giving 65 and 80 per cent of the line voltage for starting;

TYPE 810 DRUM REVERSE SWITCH

the 80 per cent tap is regularly connected when starters are shipped. The starter handle has three positions—start, off, and run, each position plainly marked on the starter case. The handle will remain in the off and run positions but will not remain in the start position unless held, returning promptly to the off position if released. This eliminates any possibility of the motor operating on a low-voltage tap should the operator fail to move the handle from the start to the run position. The handle cannot be moved from the off to the run position without first going through the start position.

TYPE A AUTO-STARTER

TYPES RF AND FA ALTERNATING-CURRENT DRUM CONTROLLERS

TYPE RF—225-AMPERE SINGLE-DRUM CONTROLLER

RF CONTROLLERS

RF Controllers are used for starting and regulating the speed of wound-rotor induction motors and are suited to all non-reversing applications where a drum type controller is desirable. They are simple in construction, reliable in operation, and all wearing parts can be quickly and easily repaired. The stationary and moving contacts are heavy copper pieces. The fingers are pressed against the drum contacts by adjustable springs which are protected from the current by copper shunts. These controllers make the secondary connections only and do not open the secondary circuit. They must have a separate primary switch circuit-breaker or knife switch to control the motor primary. Also starting or speed regulating resistors must be added to make a complete control unit.

These controllers start and control the speed of the motor by cutting out resistance connected in the motor secondary and may be used with either two or three phase motors providing the motor has a three phase secondary winding. They are provided with a horizontal handle and the various speed points are indicated on the face of the top casting.

Reset Contact may be provided in the "off" position for operating in the low voltage circuit of a primary contactor to insure starting with all resistance in the motor secondary.

FA CONTROLLERS

FA Controllers are used for starting, reversing and regulating the speed of wound-rotor induction motors and are suitable for all applications where a drum controller is desirable. These controllers control both the primary and secondary circuits, and an extra primary switch is desirable only for furnishing overload and low-voltage protection. Starting or speed regulating resistors must be added to make a complete control unit.

These controllers start and control the speed of the motor by cutting out resistance connected in the motor secondary and may be used with either two or three phase motors providing the motor has a three-phase secondary winding. The off, forward, reverse and various speed points are indicated on the face of the top drum casting. A latch is provided in the off position which prevents inadvertent starting.

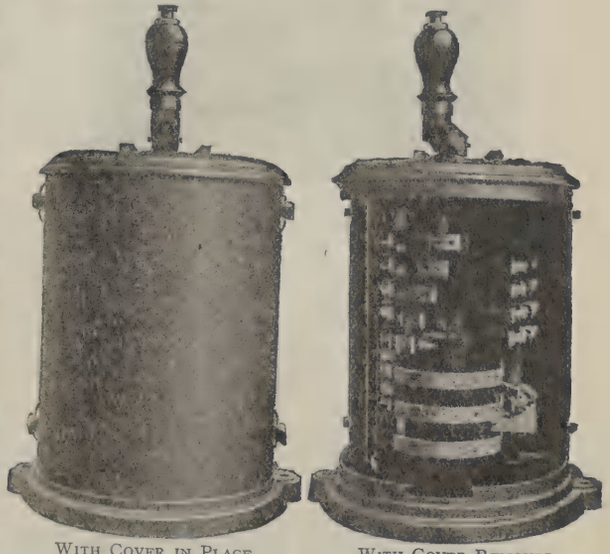
Reset Contact may be provided in the "off" position of several of these controllers. This contact is connected in the low voltage circuit of a primary contactor to interlock the two devices.

RESISTORS

The **resistors** used with these controllers may be either of the grid or tubular type, or a combination of grids and tubes depending on the size and characteristics of the motor. The three-point suspension iron grids are strong and durable and will withstand very heavy overloads for short periods of time without injury.

Resistors consisting of tubular units assembled in frames of the same overall dimensions as the grid resistors, are used where high resistance is required and the current is low. Combinations of grids and tubes are advantageously included in the same general assembly. These tubular units have high heat-radiating qualities and are so mounted as to be unaffected by ordinary vibration; they will successfully withstand severe service conditions.

Complete description of these controllers will be furnished on request.



WITH COVER IN PLACE WITH COVER REMOVED

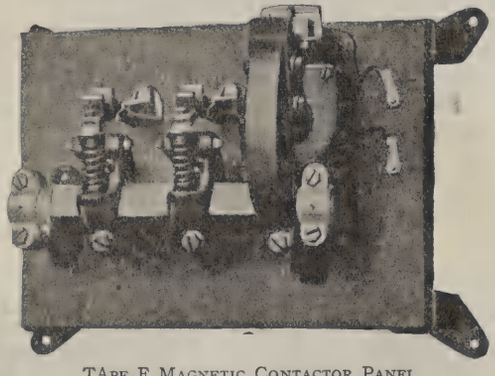
TYPE FA 50-AMPERE REVERSING CONTROLLER

TYPE F ALTERNATING-CURRENT CONTROL AND AUXILIARIES

STARTER FOR WOUND-ROTOR MOTOR

Type F Automatic Starters are used with alternating-current motors in nearly all industrial applications when automatic starting or acceleration is desired or where it is desired to control the motors from a remote point. They safeguard both operator and machine against improper starting or acceleration.

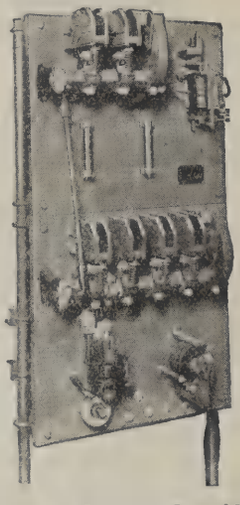
Reliability, durability, and simplicity are features of these starters. There are few parts and these are rugged in construction and easily accessible. All connections are made by type F magnetic contactors which are positive in action and never stick, as they are opened by a strong spring and gravity. The starters are easily operated from a remote point and the proper connections are made automatically and in the correct sequence.



TAPE F MAGNETIC CONTACTOR PANEL

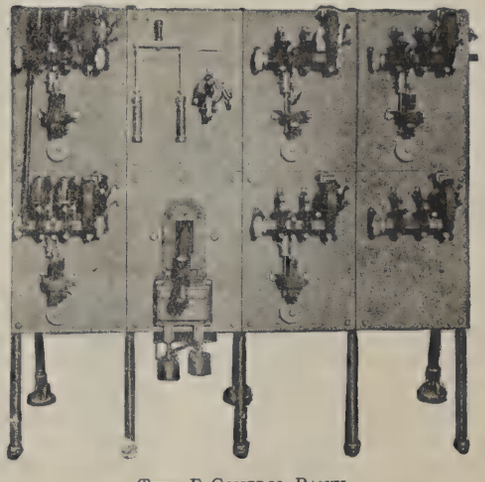
In the case of wound-rotor motors the starting current is limited and the time required for acceleration is automatically varied according to the load on the motor. The machinery is protected against too slow or too rapid acceleration and time is saved by bringing the motor to full speed at the most rapid permissible rate. The line contactor closes first with the maximum resistance in the rotor circuit. When the current falls to a predetermined value, a relay closes a magnetic contractor which cuts out a part of the resistance in the rotor circuit Each contactor operates in this manner, cutting out its portion of the resistance at the proper time. The last contactor short-circuits all the resistance and, after it has closed, an electrical interlock allows the accelerating contactors to open.

To start the motor it is simply necessary to press a button, close a snap or knife switch, or operate a master switch or some similar device. The controller does the rest. In some applications even the operation of pressing a button is unnecessary, as this feature is automatically taken care of by a float switch or pressure gauge.



STARTER FOR SQUIRREL-CAGE MOTOR

Low-Voltage Release starters will automatically restart the motor upon the return of power without the supervision of the operator after the motor stops due to the failure of power. This arrangement is desirable for such services as pumps, fans and blowers.

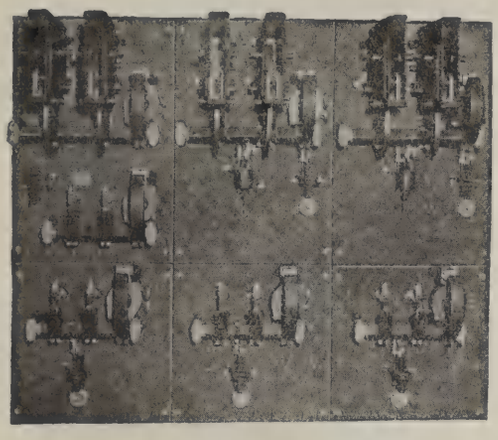


TYPE F CONTROL PANEL

3600-7

TYPE F ALTERNATING-CURRENT CONTROL AND AUXILIARIES—Continued

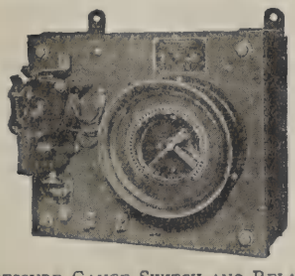
Low-Voltage Protection starters will not restart the motor upon the return of power after a shut-down from any cause unless the push button or master switch is operated. This arrangement is desirable for starters when used in connection with woodworking machines, machine tools and similar applications where the operator, machinery or work may be damaged by the unexpected starting of the machine.



TYPE F CONTROL PANEL

Drum Reverse Switches, 5 to 35 horsepower, may be used with non-reversing automatic starters to obtain reversing.

Drum Reverse Switches with Field Regulation, 5 to 35 horsepower are used in conjunction with non-reversing constant-speed automatic starters to provide reversing. By the use of these switches the complete control of the motor can be obtained from one handle or the spline shaft of the driven machine.



PRESSURE GAUGE SWITCH AND RELAY

Float Switches are used in supplying open tanks or draining pumps. In the former case, the motor is started when the level falls to a certain point and is stopped at the desired upper level. For pump service the motor is started at the maximum level and stopped at the minimum.

Gauge Type Pressure Regulators are used in connection with compressors or pumps emptying into a closed pressure system. One of these regulators make connections to start the motor, when the pressure falls to a predetermined point and stops it when the desired maximum is reached.

A Diaphragm Type Pressure Regulator may be furnished for use in systems in which the fluid or gas is not injurious to the rubber diaphragm.

DIAPHRAGM PRESSURE REGULATOR

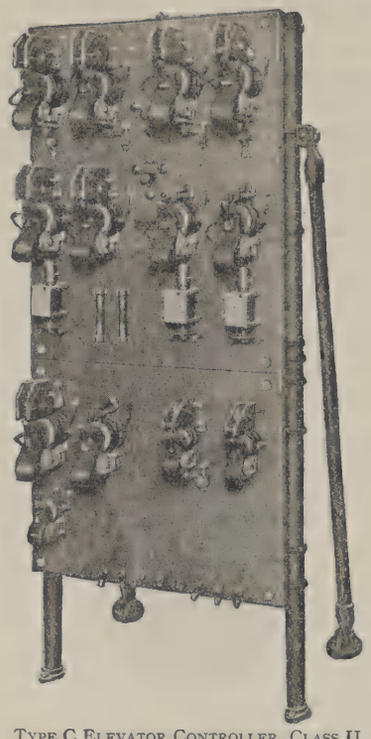
Type C Push-Button Stations are used in connection with alternating and direct-current automatic starters and controllers to control their various functions. They act as a master controller and allow the operator to start, slow down, speed up, stop or reverse the motor providing the controller is arranged for the particular operations desired. Any number of stations may be employed and they may be mounted on the driven machine or any other convenient place. All stations are arranged for conduit wiring. Accidental operation is practically impossible (except foot-operated buttons) as the buttons must be pressed past a projecting rim on the enclosing cover surrounding the button before it will operate.

Complete description of this apparatus will be furnished on request.

PUSH-BUTTON STATIONS

3600-8A

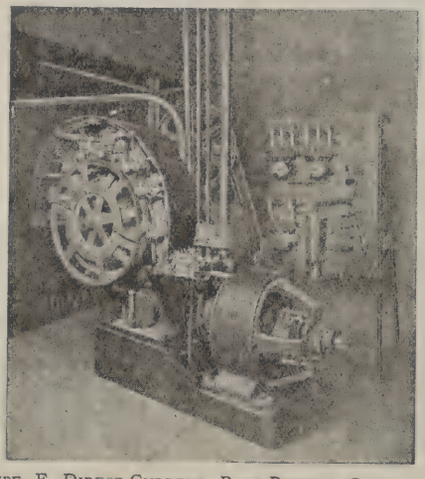
ELEVATOR CONTROL



TYPE C ELEVATOR CONTROLLER, CLASS II

Type E Controllers—These controllers are designed for single speed freight and passenger service where speeds do not exceed 150 feet per minute. Their operation is quiet, simple, and absolutely reliable. The car is always under complete control yet both passengers and equipment are protected from careless or ignorant operation.

Push-Button Control—A complete equipment for direct-current operation consists of a floor-mounting control panel for starting and controlling the speed, a floorstop device (not required for two landings), a call button for each landing, a bank of operating buttons for the elevator car, and a combination doorlock and switch for each landing.

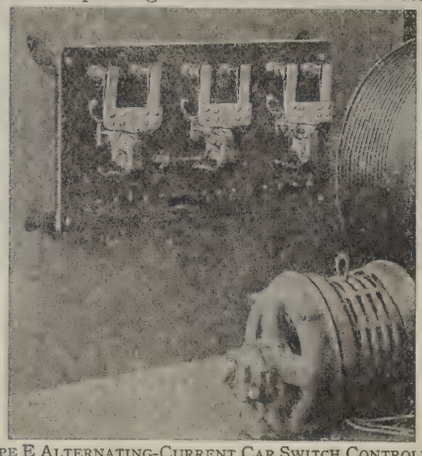


TYPE E DIRECT-CURRENT PUSH-BUTTON CONTROLLER

The alternating-current equipment differs from the above in having a wall-mounting control panel and a type E brake magnet with a "non-interference" device to prevent the car being "stolen." Protection against phase failure is provided, as well as hatchway limit switches and other safety devices when desired.

Car-Switch Control—The apparatus is very simple, consisting of a control panel, a car switch, and such elevator safety devices as may be desired.

Type C Controllers—Direct-current type C magnetic controllers fulfill the demands for safe and efficient elevator controls. They are applicable to freight and passenger elevators in all service.



TYPE E ALTERNATING-CURRENT CAR SWITCH CONTROLLER

Class I controllers are for passenger elevators running at speeds up to 400 feet per minute and are operated by direct-current motors having a 2 to 1 or 3 to 1 speed range by shunt field control.

Class II controllers are for passenger and freight elevators running at speeds up to 250 feet per minute, operated by single-speed compound-wound motors.

Class III controllers are for passenger and freight elevators running at speeds up to 150 feet per minute, operated by compound-wound motors.

Class IV controllers are semi-magnetic and are designed for freight and slow-speed passenger service with speeds less than 150 feet per minute. They are operated from the car by means of a hand rope or wheel.

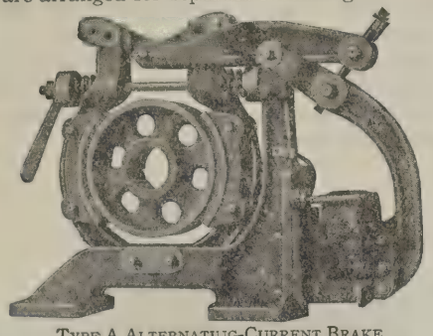
Accessories—The safety devices most commonly used are the emergency switch to be used by the operator in case of accident to the car switch; machine-limit and hatchway-limit switches, which operate automatically to prevent accidents from over-travel should the operator for any reason fail to release the car switch; and door interlocks, which prevent the starting of the car until the door is properly closed.

Complete description of these controllers will be furnished on request.

MAGNET-OPERATED BRAKES

TYPE A—220, 440 AND 550 VOLTS—25, 50 AND 60 CYCLES
TYPE B—115, 230 AND 550 VOLTS—SERIES AND SHUNT OPERATING COILS

Types A and B magnet-operated brakes are used for stopping motors quickly without jar or shock and for holding their connected loads. They are designed primarily for use with mill, crane and hoist motors where frequent stops and reversals are made and are arranged for separate mounting.



TYPE A ALTERNATING-CURRENT BRAKE

The brakes are simple, rugged and accessible, each consisting essentially of a clapper type magnet, strong compression springs, series of levers, brake shoes, brake wheel and supporting frame.

The following are a few of the many important features incorporated in these brakes:

1. They are applicable to any horizontal motor within their range and can be arranged for floor, wall or ceiling mounting, and with the magnet on either the right or left side of motor.
2. The use of the clapper type magnet eliminates all moving parts within the coil and the consequent wear, sticking or damage of insulation.
3. The armature is the only moving part of the magnet.
4. The simplicity and accessibility of the few parts render these brakes easy to install, operate and maintain.
5. The shoes are accessible and can be removed easily and without disturbing brake mounting.
6. Smooth retardation and dependable operation is insured by strong compression springs.
7. Equal clearance between both shoes and brake wheel when brake is released.
8. Self-aligning brake shoes.
9. No danger of load slipping due to brake not operating as brake sets if adjustment for shoe wear is neglected.

Type B

Series brakes are used on crane hoists, bucket hoists and similar services employing dynamic braking on lowering and a majority of steel mill applications. In general, brakes should be equipped with series coils wherever possible as the inductance of a shunt coil tends to make the brake sluggish in operation. Brakes series with series coils will release the shoes at 40% of the rated motor current with springs set for torque given in the table. Torques for one hour and continuous cycles may be increased up to the half-hour value with an increase of the 40% releasing current. For example, a brake used on a one-hour cycle will require approximately 50% of the one hour rated current of the motor to release if the springs are set to hold the torque corresponding to the half-hour rating.

Shunt brakes are required under the following conditions:

(a) Where a drift point is required, as on lift bridges, trolley motion on ore bridges and similar applications.

(b) Where the motor current passes through a low value at some point in the cycle.

(c) Where resistance is used in shunt with the armature to obtain slow-down, as on skip hoists, bell hoists and car dumpers.

All shunt coils are wound for low-voltage and are equipped with an adjustable series resistance and shunt discharge resistance.

Selection of Brakes

In order to select the proper brake for use with a motor other than of Westinghouse manufacture, or for a Westinghouse motor with which a brake is not listed, proceed as follows:

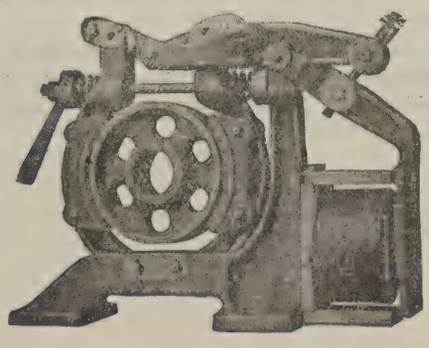
(a) If a Westinghouse motor, select a brake from the table corresponding to the frame number of the motor.

(b) Check torque of motor using the formula:

$$\text{Torque in pounds at one foot radius equals } \frac{5250 \times \text{Horsepower}}{\text{Motor speed in r. p. m. at full load}}$$

The brake should be selected for the same heating cycle as that of the motor with which it is used. The brake torque should be equal to or greater than the full load torque of the motor when used on cranes, hoists, lift bridges, copper converters and other services where the brake must hold the load or bring the apparatus to rest very quickly. In such services as bucket conveyors, printing presses, planers and other services where several seconds can be allowed to stop the motor, a brake may be selected with a torque as low as one-half that of the motor.

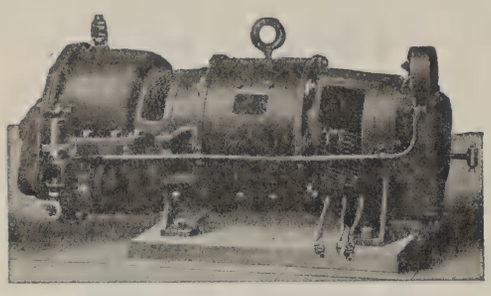
(c) Check the speed and horsepower of the motor.



TYPE B DIRECT-CURRENT BRAKE

SMALL TURBINES FOR ALL NEEDS

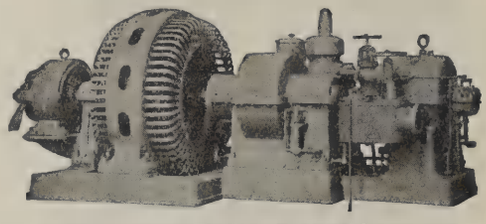
The Westinghouse Electric & Manufacturing Company holds a pre-eminent position in the small turbine field, due to their ability to furnish small turbines for all classes of service.



SMALL DIRECT CURRENT NON-CONDENSING TURBINE GENERATOR UNIT

Illustrating small direct connected turbine generator units, built in capacities from 5 to 15-kilowatts. A very compact lighting set for boats, dredges, steam shovels, small industrial plants and for furnishing electricity to electric magnets on locomotive cranes.

Built in capacities of 25 to 1000-kilowatts. Very economical. In small sizes used as exciters and as the main unit in large manufacturing plants where exhaust steam is needed for heating purposes.

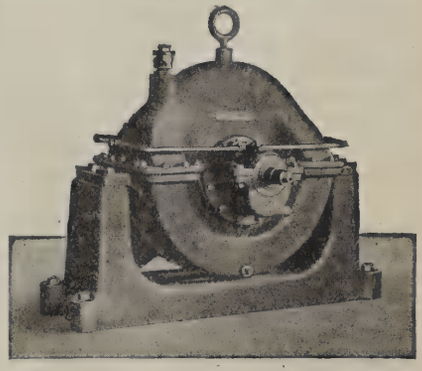


NON-CONDENSING GEARED TURBINE GENERATOR UNIT FOR HIGH ECONOMY

CONDENSING TYPE TURBINE GENERATOR UNIT FOR CENTRAL STATIONS

Fills the need for small and moderate capacity turbine generating units in power houses and central stations, requiring 100-kilowatts and upwards. These units are of condensing design.

A line of small turbines for driving centrifugal pumps and fans. Can be arranged for either direct connection to driven apparatus or through the medium of a gear.

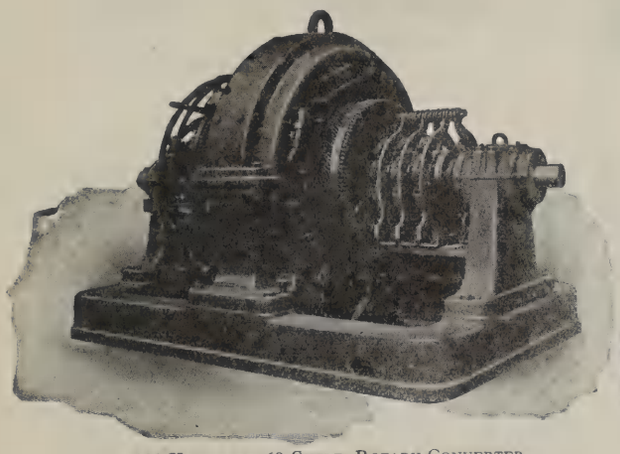


STEAM TURBINE FOR DRIVING PUMPS AND BLOWERS

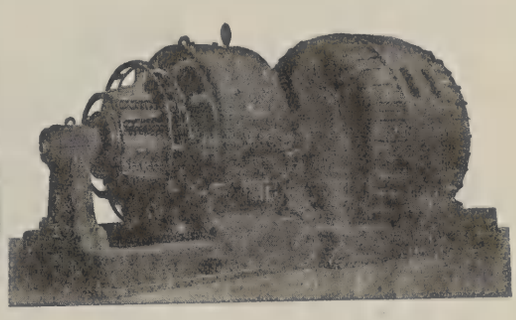
SYNCHRONOUS CONVERTERS AND SYNCHRONOUS MOTOR-GENERATORS

EFFICIENT RUGGED RELIABLE

For All Classes of Service



1000 KILOWATT, 60 CYCLE, ROTARY CONVERTER



1000 KILOWATT, 60 CYCLE, MOTOR GENERATOR

Synchronous Converters

Kilowatts—100 to 4000
D. C. Volts—250, 275, 600
Cycles—25 and 60

Application—Westinghouse commutating-pole converters, shunt or compound wound are applicable to railway, and the various kinds of industrial service not requiring minute direct-current voltage adjustment, in which cases the booster converter for larger capacities or an induction regulator with synchronous converter in the small capacities is applicable.

Standard converters can be arranged for either alternating- or direct-current, self-starting, or for both, although alternating-current, self-starting is usually preferred.

Synchronous Motor Generators

Kilowatts—¼ to 1500
D. C. Volts—125, 250, 275, 600
Cycles—25 and 60

Application—Westinghouse synchronous motor-generators are applicable for converting alternating to direct current except where alternating-current line conditions are such that it is inadvisable to use synchronous apparatus, in which cases, the induction motor-generator is applicable. The rapid development in the last five years of very economical alternating-current generation and transmission apparatus makes a careful study of conditions and types of converting apparatus imperative, if the same relative efficiency is to be maintained.

STOKERS

UNDERFEED STOKER

Westinghouse Underfeed Stoker

The Underfeed Stoker is of the multiple retort type. The field for this stoker is in plants that require a wide range of economical operation, or where peak loads and sudden increases in steam demands must be met.

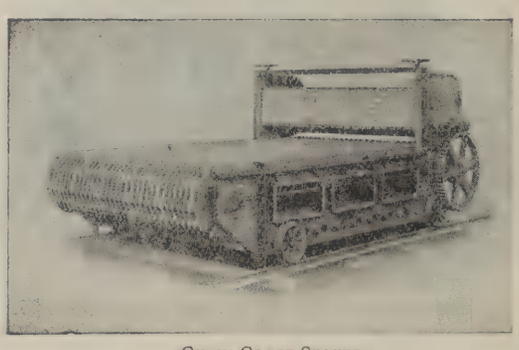
Where maximum reserve capacity of 250, 300 or 400 per cent of rating is required, this type of stoker should be used.

Forced draft is required for this type of stoker, air being obtained from forced draft fans.

Westinghouse Chain Grate Stoker

The Chain Grate Stoker is of the traveling grate type.

This stoker gives very satisfactory results for uniform loads, but should not be used for applications exceeding 200 per cent of boiler rating for maximum reserve capacity.



CHAIN GRATE STOKER

RONEY STOKER

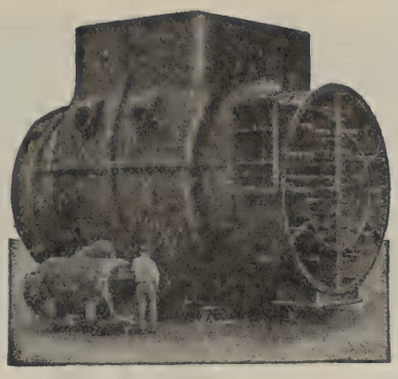
Westinghouse Roney Stoker

The Roney Stoker is of the overfeed type and used universally in different sections of the country.

Where maximum reserve capacity is not over 200 per cent rating, and with proper draft and furnace design, this type of stoker gives very satisfactory results.

It is particularly adapted to tubular boiler applications and to boilers generally found in the moderate sized plant.

CONDENSING EQUIPMENT



LARGE SURFACE CONDENSER

Because of their exceptional performance Westinghouse Condensers have become generally known throughout this country and abroad as High Vacuua Condensers.

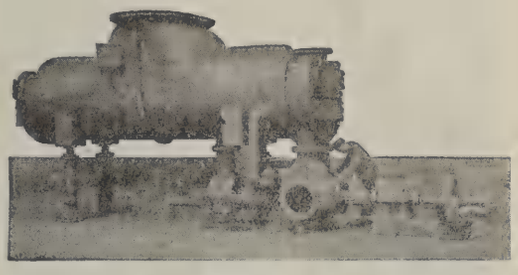
They are operating successfully in many parts of the world, Peru, Russia, Brazil, Porto Rico, Manchuria, Cuba, New Foundland, Japan, Hawaii, Mexico, British West Indies, Alaska, Siberia and other foreign lands. Only condensers of undisputed reliability could have become so widely known and used.

Surface Condensers

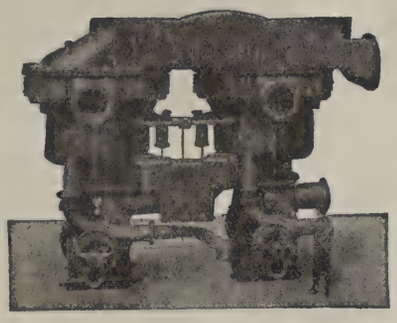
Serving turbines up to 100,000 horsepower capacity.

All Westinghouse surface condensers are designed to get the maximum temperature of condensate and a minimum drop in pressure through the condenser tube bank.

The smaller condensers have a very compact arrangement of pumps that permits all to be connected to one drive, eliminates complicated interconnecting piping, and utilizes the minimum space.



UNIT TYPE SURFACE CONDENSER



TWIN JET CONDENSER

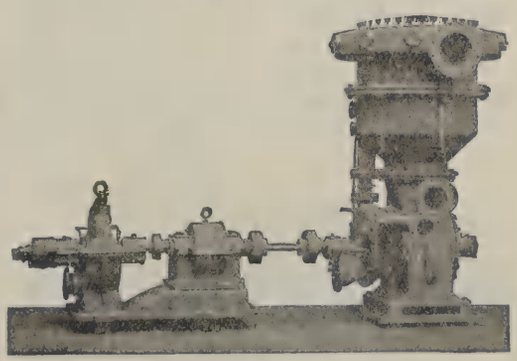
Jet Condensers

Now serving turbines up to 65,000 horsepower capacity.

Jet condensers, either low level, or high level, are desirable for some installations. Large low level jets are frequently built as twin units, not because the limit in size of a single condenser is reached, but because of the greater flexibility and saving in head room. High level jet or barometric condensers can be used when the elevations are such that the cooling water can be allowed to flow away from the condenser head by gravity.

All these condensers are equipped with the Westinghouse LeBlanc air pump, the most efficient air scavenger for high vacuua on the market. This pump has the peculiar advantage of increasing in efficiency at the time highest efficiency is most needed, when the **Vacuum** is **Highest.**

Westinghouse Condensers are unexcelled in ability to maintain a high vacuum, simplicity of construction, reliability and compactness.

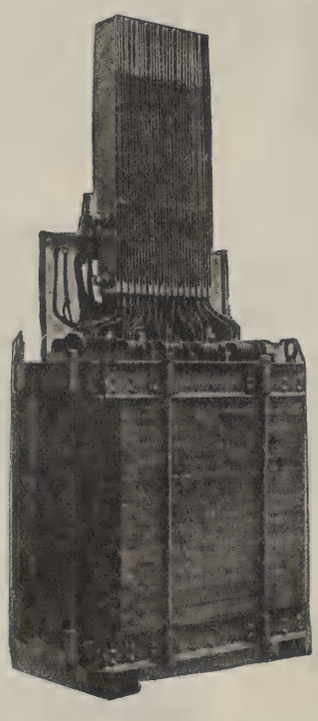


SMALL LOW LEVEL JET CONDENSER

POWER TRANSFORMERS

Transformers, making possible the use of distant sources of power by stepping up the voltage at the source and stepping it down where wanted, are supplied by this Company in any size, any voltage, either single or three-phase, to meet any specific requirements. Three general types are recognized, the classification being made on the way in which the heat resulting from their electrical losses is removed—Self Cooled, Water Cooled and Air Blast.

A 14,000 Kva. Water-Cooled Transformer for 150,000 Volt Service, Single Phase, 60 Cycles



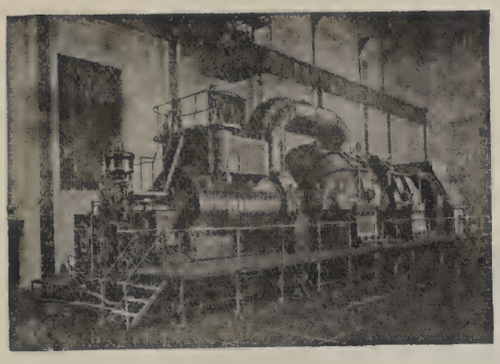
The Core and Coils of a Large Transformer Used for Supplying 36,000 Amperes for an Electric Furnace in Making Calcium Carbide

A Self-Cooling Transformer of 2,000 Kva. Capacity, 66,000 Volts

On all large high voltage transformers the greatest attention is paid to Insulation, Ventilation and Mechanical Strength, as these factors mean Reliability and Ability to meet operating conditions.

The successful operation of a power transformer depends on a number of factors, chief of which is the correctness of its design. Westinghouse power transformers embody fundamentally correct principles of design which have been arrived at through painstaking study during many years of successful transformer manufacture. In Westinghouse transformer construction the factors are carefully balanced which guarantee long life, efficient performance, and security against breakdown.

LARGE STEAM TURBINE GENERATOR UNITS

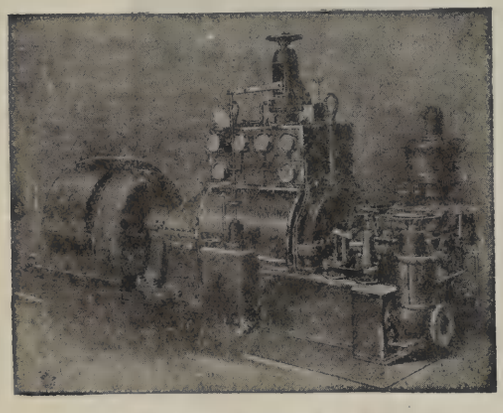


30,000 KILOWATT UNIT

Westinghouse Steam Turbines are of the reaction or Parsons type or a combination of the impulse and reaction principles depending upon the particular problems to be met. **Economy** and **Reliability** are the factors governing the type of construction used.

Units in which the complete expansion of the steam is carried out in a single cylinder are built in capacities up to 30,000 kilowatts. To obtain the most reliable machine possible, units from 30,000 kilowatts to 70,000 kilowatts are built in two or more cylinders. The excellent performance of Westinghouse Steam Turbines shows the correctness of these designs.

TWO 20,000 KILOWATT UNITS



500 KILOWATT BLEEDER TYPE UNIT

Westinghouse Steam Turbines are designed and built for both condensing and non-condensing service, and are also furnished in low pressure or exhaust steam, and mixed pressure types. Where exhaust steam is desired for heating or manufacturing purposes, the bleeder or extraction type turbine is furnished.

Westinghouse Reduction Gears are of the flexible pinion frame type. By an ingenious construction, the pinion is always kept in perfect alignment with the gear. This combined with the most accurate workmanship possible—insures **noiseless operation** and **high efficiency.** Westinghouse gears are **unexcelled** for any application of the steam turbine driving slow speed machinery.

3750 KILOWATT D. C. GEARED UNIT

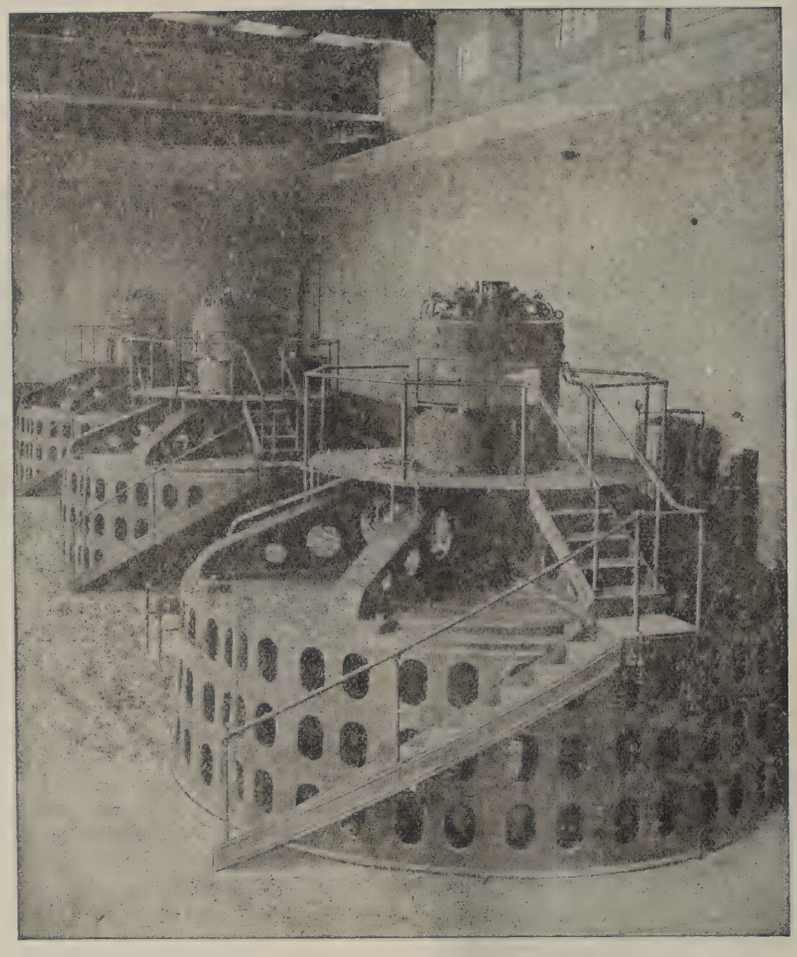
ALTERNATING-CURRENT GENERATORS

The Westinghouse Company builds A. C. Generators for any service condition.

A standard line of small belted units, capacities 17 kilovolt-amperes and upward, permits the selection of the machine best fitted to match in capacity that of the prime mover.

Standard engine type generators are available for direct connection to steam, gas, and oil engines.

Generators for water wheel drive, in both horizontal and vertical types, are built in sizes as small as 30 kilovolt-amperes and as high as 30,000 kilovolt-amperes or more.

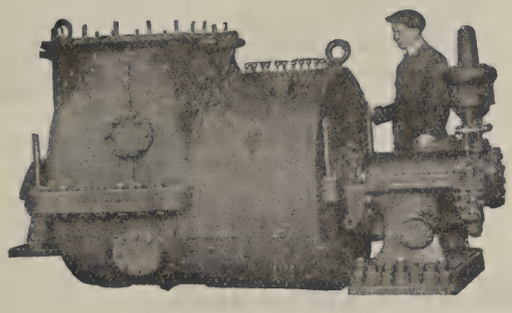


THREE 6,250 KILOVOLT-AMPERE VERTICAL A.C. GENERATORS—WATERWHEEL DRIVE
GENERATOR VOLTAGE, 6600—TRANSMISSION VOLTAGE, 140,000

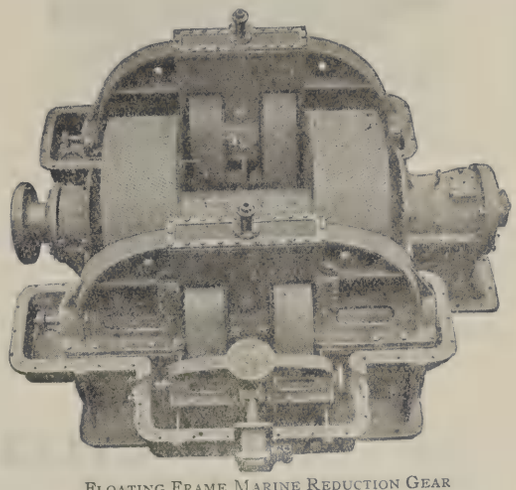
Prices, on the machine best suited for your particular conditions, upon application.

WESTINGHOUSE MARINE PROPELLING MACHINERY

Being among the pioneers in the field of geared turbine propelling machinery, the Westinghouse Company has furnished and is equipped to supply turbines, gears, condensers, and auxiliaries, such as air ejectors, condensate pumps, circulating pumps, etc., for vessels requiring from 90 to 90,000 horsepower.



HIGH PRESSURE MARINE TURBINE



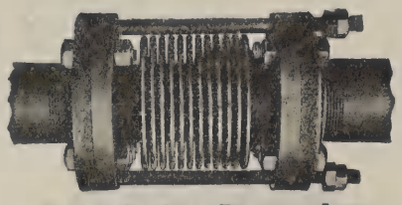
FLOATING FRAME MARINE REDUCTION GEAR

By employing rotary machinery in ship propulsion, considerable economy is effected in regard to weight of equipment and space occupied by steam consumption and maintenance. All machinery is of rugged construction and ample precautions are taken to obtain safety and reliability of operation. In employing geared turbine propelling equipment, a much higher over-all efficiency is obtained, due to the fact that both the turbine and the propeller can run at speeds conducive of a higher efficiency. Reduction gears are built to maintain pinion alignment under all conditions of load. The thrust bearing employed is the well-known Kingsbury thrust bearing which is a considerable improvement over the usual type of marine thrust bearings. The condensing equipment contains special features which effect considerable economy with respect to steam consumption, weight, and space occupied.

For details apply to the nearest district office.

NUTTALL EXPANSION JOINTS

NUTTALL ONE-PIECE EXPANSION JOINT



NUTTALL ONE-PIECE EXPANSION JOINT

As the name implies, this joint is made in one piece, machined to extremely close dimensions from a solid hammer-forged steel blank.

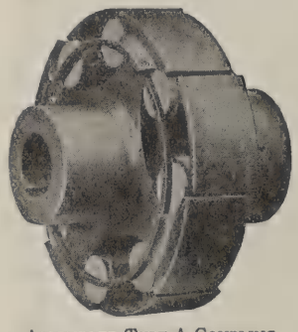
The compact construction of this joint makes it much more desirable than the awkward loops and U-bends; the one-piece construction completely eliminates the use of packing which is absolutely necessary for the successful operation of other types of joints, which require constant care and frequent renewing to keep them tight.

The carefully machined walls allow action by the same method as a bellows. Breakage is uncommon, not only because of the natural strength of the steel, which has been reinforced by oil tempering, but also by a sliding sleeve inserted on the inside, which helps support internal strain. Limiting bolts, equipped with sleeves on the outside, further guard against extreme expansion or contraction.

This joint can be had for any standard size pipe, for both high and low pressure lines, allowing a total movement of 2 inches on the high pressure and $\frac{5}{8}$ inch in the low pressure.

This joint has absolutely no chance of leakage, and is readily responsive to the slightest pressure of the line.

NUTTALL FLEXIBLE COUPLINGS



ASSEMBLED TYPE A COUPLING

Type "A" Coupling—is equipped with rubber buffers and is made in sizes to care for any load from 9 to 1340 horsepower.

The illustration shows how the cast iron arms, assisted by rings, hold in place the rubber cylinders that absorb the shocks and jars.

The simplicity of construction, which is a quality of all Nuttall couplings, reaches its highest development in this type. The ease of replacing the buffers, and their low cost, make it advantageous to install this type of coupling.

Type "B" Coupling—This coupling is designed for heavy duty service and is constructed in various sizes to transmit any horsepower from 98 to 4875.

The substantial construction of this type makes it more economical than most other types because of the infrequency of repairs caused by breakage.

Type "C" Coupling—This has been named the "safety first" coupling because of its construction. It is perfectly cylindrical, and has no projecting parts to catch the clothing of workmen and cause injury in case of accidental contact.

It is the most complicated of the Nuttall couplings, yet is very simple in construction.

The tempered steel springs are enclosed in the smoothly machined steel case, one side of which can be removed, the springs taken out, and the driving or driven machine operated separately. In diameter it ranges from $6\frac{1}{2}$ to 52 inches, and is made to care for ratings from 83 to 2680 horsepower.

ASSEMBLED TYPE B COUPLING

STANDARD RAILWAY MOTORS

The Westinghouse standard line of railway motors embodies all of the very latest improvements and is up to the minute in every detail. There are nine sizes, ranging from 25 to 190 horse-power at the 600-volt rating, which are so graded that there is a standard motor to meet any requirement ordinarily encountered in electric traction application.

The thirty years experience of the Westinghouse Electric and Manufactruing Company as railway motor builders, combined with the co-operation of many competent operators, has brought about numerous improvements and refinements in railway motor design and construction. This, together with the use of the commutating field, high grade cast steel motor frames, and parallel system of self-ventilation, has produced a great reduction in motor weight per unit of power output. Realizing the extreme value of these improvements, many railway companies have been systematically retiring obsolete motors of all makes, thus availing themselves of the great saving in both maintenance cost and operating expense.

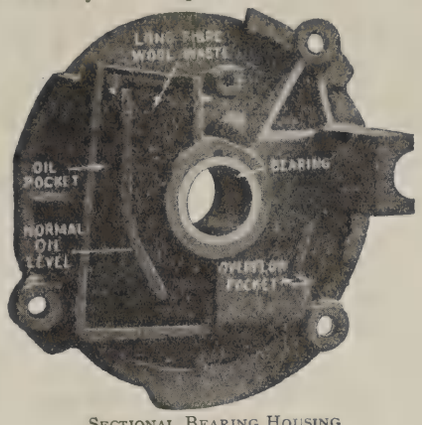
Satisfaction has been rendered by each of these motors in service, under every operating condition. They have proved economical and durable by severest test, with the result that they are now the established standards of many railway properties.

Never before have railway requirements been covered by so complete and yet so few varying motor designs. This condition, combined with the large demand for each of these standards, gives the railways the advantage of the lower prices resulting from quantity production.

Every effort has been made to arrange all motor details and wearing parts to give the longest possible life with the very minimum expenditure for replacements. A few of the improvements intended for this purpose are described below.

MOTOR FRAME COMPLETE, WITH ARMATURE BEARING HOUSINGS REMOVED

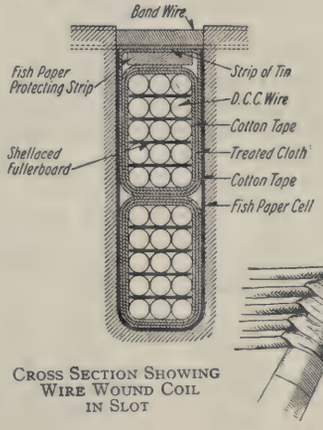
The split between the axle cap and frame is at such an angle that the weight of the motor is largely taken off the axle-cap bolts. Through axle-cap bolts are used. The housing fits in a circular opening in the frame. It has a machined flange resting against a machined seat on the end of the frame held by axial tap bolts.



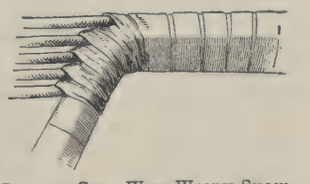
SECTIONAL BEARING HOUSING

Bearings and Lubrication

The bronze motor bearings are in dust proof housings on the shaft. Axle bearings are furnished of either bronze or babbitted malleable iron. Oil and waste lubrication for both armature and axle bearings needs no further introduction, since the reliability and economy of this design has been proved many times.



CROSS SECTION SHOWING WIRE WOUND COIL IN SLOT

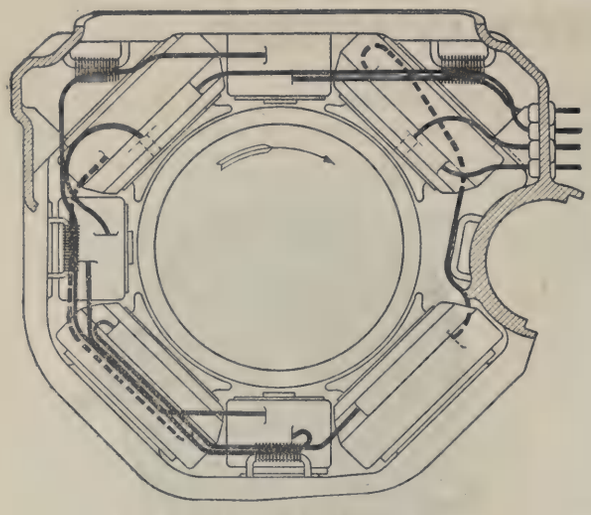


PART OF COIL, WIRE WOUND SHOWING TAPING BETWEEN LEADS. PREVENTS SHORT CIRCUITS

Armature Coils

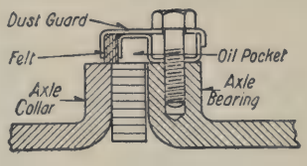
The armature coils are so wound that there are no sharp cross-overs. They are thoroughly insulated and treated and, being further protected by means of U-shaped pieces in the ends of the armature core slots, secure a construction that will ensure reliable service. The taping between leads where they emerge from the coil provides against short circuits and keeps the leads securely in place.

STANDARD RAILWAY MOTORS—Continued



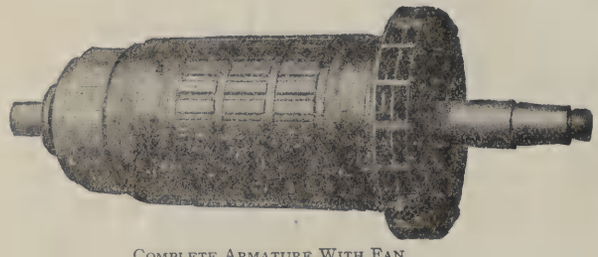
Wiring Around Frame

Note the substantial manner in which the wiring is held by staples preventing vibration and breakdown.



Dust Guard

The improved, light-weight, pressed steel guard prevents entrance of dirt and grit between the flanges of axle collar and commutator-end axle bearing, resulting in increased life of the bearings.



COMPLETE ARMATURE WITH FAN

Armature Banding

To insure reliability, a strip of tin is placed around the periphery of the armature, over this the steel wire band is wound while armature is hot then soldered together, forming a solid hoop.

Axle Dust Shield

An axle dust shield made of sheet-steel completely encases the axle between the bearings; two windows permit inspection of axle bearings without removing casing.

Standard Ratings and Weights

Motor Type	H.P. at 600 Volts	Weight Complete Lbs.	Wheel Diameter Inches	Descriptive *Leaflet
506-A	25	900	24–26	3901-A
506-C	25	1000	30–33	
514-A	40	1650	24–26	2022
514-C	40	1770	30–33	
532-A	50	2300	26–28	3763-B
532-B	50	2325	30–33	
306-CV	65	2700	33–36	3834-A
548	100	3175	33–36	3836-A
333-V	125	3850	33–36	3837-B
557	140	4050	33–36	3838-A
567	165	4900	33–36	2031
577	190	5650	36	.....

Here are Motors for Every Service

Safety cars.
Double-truck city cars.
Light urban and interurban cars.

Haul Freight

Heavy interurban cars.
Freight and express cars.
Elevated and subway cars.

Retire Obsolete Equipment

Write for Descriptive Leaflets. They give full information.

TYPE HL CONTROL

About ten years ago, the Westinghouse Electric and Manufacturing Company designed and introduced type HL Control, after many years of experience in the successful manufacture of pneumatically operated forms of control equipment for heavy multiple unit train service on subways, elevated, and interurban roads. Because of the great need for a universal form of multiple unit control for train operation the HL Control immediately won a home in the railway field throughout the entire country. Today, over 200 roads in the United States and Canada have adopted it for their standard.

Although many refinements have since been incorporated in HL Control, no change has been made which affects an interchangeability of parts with the original equipments. All modifications and improvements have been made to further simplicity, lengthen life of wearing parts, and to add to the many valuable features by which it gained its early recognition and prominence.

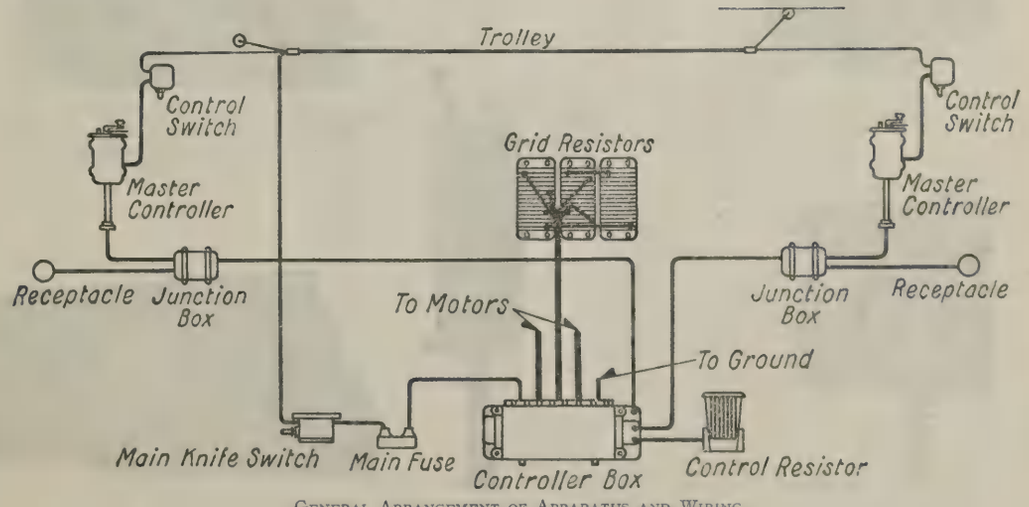
Simplicity, accessibility, ruggedness, and positive action are the fundamental principles upon which the design of the entire line of HL Control has been based. The principle that a railway equipment should consist of but the fewest and simplest parts possible, has been rigidly adhered to. Delicate automatic devices have been entirely eliminated as well as all features which tended to complicate former equipments. A general idea of characterizing features of HL Control may be obtained from the illustrations shown on next page.

Type HL control is arranged to handle two-motor and four-motor equipments of all capacities from small city cars up to, and including, freight locomotives. Throughout the entire range of sizes the same design and construction are employed. The varying conditions in the wide range of standard railway applications have been covered by combinations in which the interchangeability of parts of each type is not disturbed, and the number of wearing parts is kept at the minimum. These types are given below:

1. The type 275 unit switch is designed for low-floor, 26-inch wheel cars, up to, and including capacities of 200 H. P.
2. The type 264 unit switch is designed for all cars having not less than 30-inch wheel clearances and this unit switch will handle all capacities encountered in standard city and interurban 600 volt traction service.
3. Both the type 275 and the type 264 switch units for capacities up to, and including, a total of 500 H.P. per car are assembled in groups of eight, with the reverser located on one end, forming what is termed the "Controller Box", or "One Piece Control".
4. For equipments between 340 H.P. and 500 H.P. capacity per car, ten type 264 unit switches, total, are required. The two additional switches are assembled in a separate two-switch box, known as the "Line Switch".

In excess of 500 H.P. requirements, and for locomotives, the standard type 264 switch units can be grouped together in sufficient numbers to cover the conducting capacity for the heavier currents encountered.

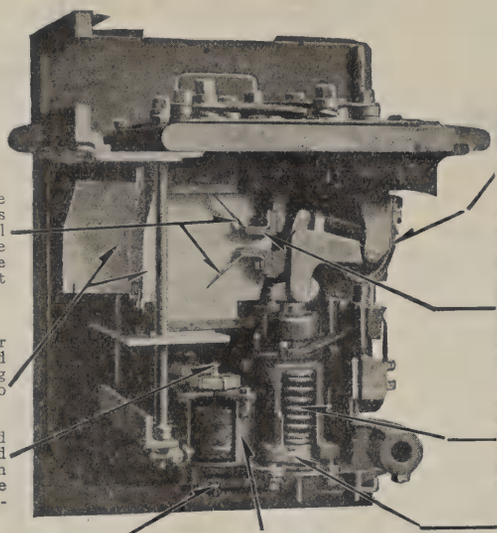
Besides the controller box, there are certain details required to complete a car control equipment. These are master controllers, control switches, control resistance, junction boxes and train line receptacles and jumpers. Ask for Leaflet 3865A. It gives a full description of HL control.



General Arrangement of Apparatus and Wiring

5001—1

TYPE HL CONTROL—Continued



Bronze arcing tips carry the arc out from the butt contacts under the impetus of powerful magnetic blowout coils. The arc traveling outward on the tips is so effectively cooled that little burning takes place.

Reversible asbestos lumber arc shute sides easily removed by pressing aside a small spring retainer, confine the arc to limited space.

Pins, which when depressed admit air to the cylinder and operate the switch mechanism permit inspectors to test the movement of each switch without any current on the car.

Heavy flexible shunts of braided copper insure large current carrying capacity and relieve all bearings and pins of current carrying duty.

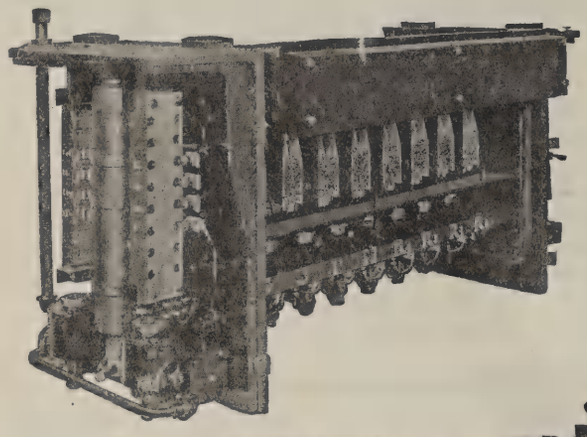
Heavy copper butt contacts comprise the switch jaws. They are self-cleaning by virtue of a "wiping" action which takes place during opening or closing of the switch. Their tremendous current carrying capacity is made possible by the 100 pounds resultant contact pressure secured by the use of compressed air.

This heavy coiled spring constantly exerts 100 pounds pressure against the piston. Upon release of air from the cylinder the switch-jaws are quickly separated by its powerful, positive action.

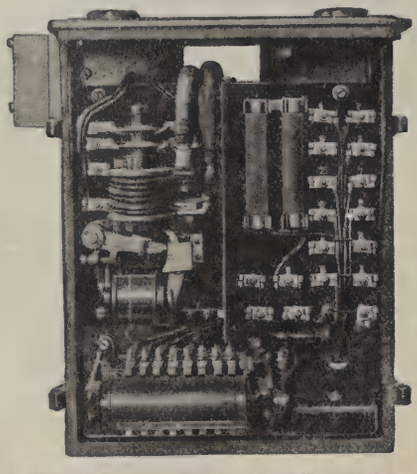
The piston which forces the movable contact upward is made of triple-ply carefully treated leathers reinforced with metal retainers.

Here is the valve mechanism which under the action of an electro-magnet energized by the master controller, permits the entrance or exit of the compressed air which operates the switch.

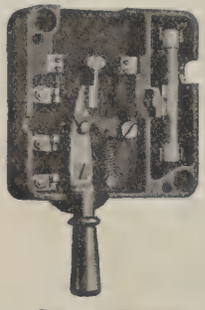
No insulation trouble here. The valve actuating magnet is enclosed within weatherproof cast iron shells. The coils are thoroughly impregnated with "Bakelite", one of the best known insulators.



CONTROLLER BOX WITH COVERS REMOVED, SHOWING REVERSER MOUNTED ON THE END PLATE AND THE FRONT SIDE SWITCH GROUP



END OF CONTROLLER BOX WITH COVERS REMOVED SHOWING THE OVERLOAD RELAY, CONTROL CIRCUIT TERMINAL BOARD AND THE MOTOR CUT-OUT SWITCH



CONTROL SWITCH

MASTER CONTROLLER

CONTROL RESISTOR

BALDWIN-WESTINGHOUSE ELECTRIC LOCOMOTIVES

One of the early results of the efforts to secure reliability in Baldwin-Westinghouse Electric Locomotives was the practice of producing them, not by a special assembly of miscellaneous parts, but by carefully designing each of the fundamental elements for the purpose it was to fulfill.

The mechanical parts are built at the Baldwin Locomotive Works in accordance with designs developed jointly by the engineers of the two Companies. The underframe, which transmits the draw-bar pull and forms the backbone of the entire structure, is made with longitudinal members of rolled-steel channel and end sills or bumpers of forged steel or cast iron. The sills are fastened together by heavy knees and an exceedingly substantial structure secured. This method of construction is based on that which has been used for years in building the tenders of steam locomotives.

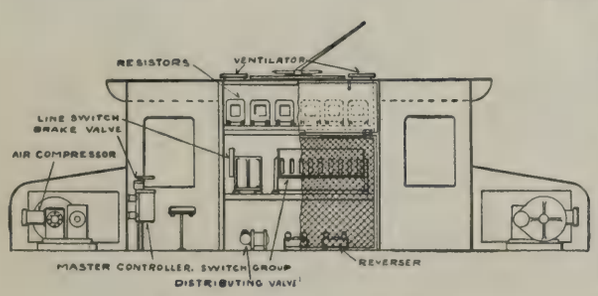
Where differences in weight are required with locomotives of the same class these are secured not merely by the use of idle ballast, but by enlarging the section of the channels and other members, and hence increasing the strength of the locomotive as well as its weight.

VIEW OF STANDARD BALDWIN-WESTINGHOUSE ELECTRIC LOCOMOTIVE FROM NON-OPERATING SIDE, SHOWING ARRANGEMENT OF DOORS, HAND RAILS, STEPS, ETC.

The cab is of the steeple type and thus permits an unobstructed view of the track with either direction of operation. It is made of steel and is thoroughly braced and fastened.

The motors with which Baldwin-Westinghouse locomotives are usually equipped are of a special, slow-speed type designed by the Westinghouse Electric & Manufacturing Company to secure maximum hauling power with minimum current. In the successful handling of carload freight this is of particular importance, since on many roads the amount of power which can be safely drawn from the system is restricted by the limited capacity of sub-stations and feeders.

The effect of these motors on the work which a locomotive can do is best shown by a specific example. A 100-horsepower 600-volt railway motor of the car type, operating with a maximum gear reduction at its one-hour rating of 147 amperes, will run at a speed of about 16.75 miles per hour. A 50-ton locomotive with four such motors at this rating will require a current of 588 amperes, which on many systems is as much as it is desirable to use, and on a 2 per cent grade will haul a load of 140 tons. A 100-horsepower locomotive motor, under similar circumstances will operate at a speed of about 9 m. p. h. instead of 16.75 and the locomotive, if equipped with this type, will haul 310 tons instead of 140 tons, with exactly the same current. Practically, this means that the Baldwin-Westinghouse locomotive, by operating on the 2 per cent grade at a speed of 9 m. p. h. (which usually is ample) instead of 16.75 m. p. h., can haul seven 45-ton freight cars instead of only three. Further economy in the use of power is obtained, where circumstances warrant, by arranging the motors for field control and when service conditions require, increased capacity is secured by forced ventilation from motor-driven blowers.



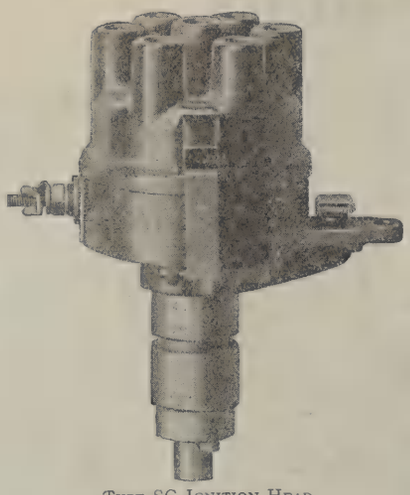
CENTRALIZATION OF EQUIPMENT

The control apparatus, upon which more than any other single element the reliability of a locomotive depends, is of the well-known HL type, which has established such excellent records in handling severe service in all parts of the country. Good equipment deserves reasonable care, and to insure this for the control apparatus, the various parts are located in the center of the cab where light is available and convenient access from all sides may be had.

The apparatus compartment is normally enclosed by heavy expanded metal screens which prevent accidental contact with live parts while still affording a complete view. These screens are easily removable and can be quickly set aside when the apparatus requires inspection or repair. The grid resistance is not included with the other apparatus, but is located in a fully enclosed compartment just above, to which suitable doors afford access and from which ventilators in the roof carry off the heat.

Every other detail of the individual parts and their assembly embodies in a similar way, the results of careful thought and years of experience and the apparently remarkable results obtained in service with Baldwin-Westinghouse Electric locomotives are but a logical outcome of this intelligent work.

AUTOMOTIVE ELECTRIC EQUIPMENT



TYPE SC IGNITION HEAD

Type SC Ignition

A hot spark at all car speeds and practically no attention required—that describes the Westinghouse system of battery ignition, designated as type SC. It is not merely an ordinary outfit, altered in a few minor details, but is the result of a thorough investigation of the entire ignition problem on the part of the Westinghouse automotive engineers, and represents an advance in ignition practice from both an electrical and a mechanical stantpoint.

Among the special features of this ignition are the following:

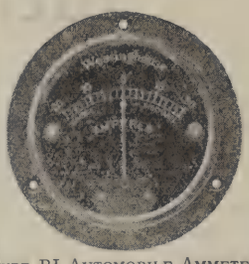
It consists of a few rugged parts, easily understood and adjusted.

The coil and the condenser are highly efficient and are so balanced in functioning that a hot spark is produced by a small primary current. This, together with the breaker's positive action at all speeds, insures perfect ignition at all times, with an especially intense spark at starting. Moreover, since the primary current handled by the breaker contacts is small and since the condenser almost entirely suppresses sparking at this point, there is little burning of the contacts and their life is long.

The breaker cam is moulded from material developed by the Westinghouse laboratories. It is self-lubricating and requires no attention whatever.

The breaker contacts are made of pure tungsten, a hard, durable metal. They open and close with a wiping action, so that the surfaces are kept clean and free from pitting. Ajustments are generally unnecessary under 10,000 miles or more, and renewals are not needed except in case of accident.

The condenser and the coil are so designed and protected that they are practically indestructible under ordinary service conditions.



TYPE BI AUTOMOBILE AMMETER

Meters

Ruggedness and reliability are built right into Westinghouse Automobile Meters. Their attractive appearance will add to the effect of any automotive equipment. The name "Westinghouse" on the dial is a sufficient guarantee of quality.

Type BI ammeter has a 2-inch dial, either black or white nickel, as desired. It operates on the polarized vane principal and has no springs or moving coil.

Type EW and AW ammeter and voltmeters have 3-inch dials. They are operated on the D'Arsonval principal, which has a permanent magnet and a moving coil mounted in pivot and jewel bearings.

Type BX instruments are of the highest grade and are the only D'Arsonval meters with two-inch dials.

Full details of these meters may be found in Section 3-B of this catalogue.

Starting and Lighting Equipment

In addition to its ignition system, the Westinghouse Company supplies a complete line of steel-pipe-frame starting motors and lighting generators suitable for use on any type or size of automotive apparatus. The motors are supplied with either screw-pinion or magnetic gear shifts. The generators comprise third-brush, and voltage regulator types. This equipment has gained an enviable reputation for efficiency and reliablity during the many years it has been on the market and is now being used by more manufacturers of passenger cars and trucks, and on more high grade cars, than any other make of electric automotive apparatus.

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2000—5

STYLE NUMBER INDEX

Style No.	Page
12	1113
301	113
601	1113
602	1113
603	1113
603A	1113
653	1113
653A	1113
1810	10
1811	10
K1807 to K1811	180
2002	407
2003	407
2023	407
2024	407
2026	407
2027	407
2029	407
2030	407
2032	408
2033	408
2035	408
2036	408
3038	408
2039	408
2041	408
2059	413
2060	413
2062	413
2063	413
2065	413
2066	413
2073	436
2076	436
2079	436
2082	436
2085	436
2088	436
2091	432
2094	432
2097	432
2100	432
2103	432
2127	441
2130	441
2133	441
2136	441
2139	441
2145	437
2148	437
2151	437
2154	437
2157	437
2160	437
2163 to 2172	439
2173 to 2182	428
2189	419
2192	419
2195	419
2198	419
2287	426
2290	426
2294	426
2297	426
2300	426
2321	426
2322	437
2323	437
2324	426, 437
2325	437
3326	437
2327	426
2330	426
2333	426
2412	437
2414	426
2445	437
2517	426
2518	426
K2681 to K2690	200
K2741 to K2749	200
K2795 to 2800	180
K2815 to K2820	180
K2940	166
K2951	166
K2952	166
K2955	166
K2956	166
K2988	166
K2992	166
K2999	166
W30857	122
W30859	122
W30860	122
W30862 to W30869	122
W30871	122
W30873 to W30881	122
W30883 to W30889	122
W30891 to W30898	122
W30900 to W30908	122
3379	621
3380	621
3794	1078
4753	21
4772	239
4944	239
5136	236
5225A	1082
5262	237
5263	237
5306	238
5307	238
5590	237
5591	237
5624	1078
5793A	1082
5796	239
K6007	195, 199
K6011 to K6014	199, 195
K6017	199, 195
K6041	198
K6047	198
K6051	198
K6057	198
K6061	195
K6062	195
K6063	195
K6065	199, 195
K6141	199
K6561	195
K6562	195
K6565	195
K6641	199
K6042	199
K6643	199
K7098	198
K7001	195, 198, 199
K7002	195, 198, 199
K7004	195, 198, 199
K70011 to K7014	195, 198 199
K7021	195, 198, 199
7034	239
K7057	195, 198 ,199
7249	556
7250B	556
7299A	605
7227	220
7530	220
7532	220
7533	220
7534	220
7543	605
7544A	605
7545A	605
7546A	605
7547	605
7549	605
7550	605
W20532	1145
7655	121
7655A	121
8689	604
8824	605
9428	571
9587	17
9992 to 9995	739
10004	739
10281	739
10333	739
10334	739
10335	739
10344	739
10347	739
10349	739
10351 to 10356	739
10358	739
10359	739
10368 to 10375	739
10441	739
10449 to 10453	739
11557	121
11559	121
12951A	605
12973	605
15185B	556
15309A	605
15803 to 15806	656
16598	19
16599	19
16600	19
16602	19
18775	393
10454	739
19655	690
W20399	1160, 1161
W20400	1160, 1161
W20401	1160, 1161
W20413	1168
W20415	1168
W20480	1144
W20481	1144
W20487 to 20490	1144
W20618 to W20627	1162
W20628 to W20645	1163
W20680 to W20697	1164
W20698 to W20703	1162
W20746	1170
W20747	1170
W20763	1166
W20768	1166
W20769	1166
W20770	1166
W20773	1166
W20778	1166
W20779	1166
W20780	1166
W20784	1167
W20786	1167
W20788	1167
W20294	1167
W20704 to W20709	1165
W20782	1167
W20796	1167
W20802	1167
W20804	1167
W20810	1167
W20811	1167
W20813	1167
W20814	1167
W20816	1168
W20817	1168
W20818	1168
W20826 to W20829	1168
W20836	1169
W20839	1169
W20841	1169
W20844	1169
W20852	1169
W20853	1169
W20863 W20864	
W20868 to W20877	1170
W20883	1171
W20884	1171
W20887	1171
W20888	1171
W20892	1171
W20894	1171
W20896	1171
W20938	1203
W20942	1203
W21105 to W21109	1200
W21117 to W21121	1201
W21122 to W21125	1198
W21180 to W21187	1205
W21190 to W21197	1205
W21218 to W21229	1207
W21245	1204
W21246	1204
W21247	1204
W21248	1204
W21281	1165
W21282	1165
W21283	1165
W21290 to W21295	1193
W21297	1193
W21298	1193
W21300	1193
W21362	1145
W21363	1145
W21364	1145
W21365	1180
W21368	1193
W21369	1193
W21398	1193
W21399	1193
W21408	1193
W21409	1193
W21430	1193
W21434	1144
W21438	1180
W21439	1145
W21440	1145
W21441	1145
W21443	1180
W21451	1144
W21462	1144
W21470	1166
W21471	1166
W21472	1166
W21484	1144
W21485	1144
W21486	1144
W21487 to W21495	1145
W21487 to W21493	1180
W21713	1144
W21791	1202,1204
W21817 to W21821	1202
W21825	1202,1203
W21826 to W21831	1202
W21830	1198,1204
W21831	1198,1203 1204
W21835	1204
W21836	1204
W21837	1204
W21838	1204
W21839	1204
W21840	1204
W21841	198, 1204
W21842	198, 1202 1204
W22057	1199
W22060	1199
W22113	1196
W22114	1196
W22115	1196
W22116	1197
W22117	1197
W22118	1197
W22125 to W22130	1192
W22133 to W22138	1192
W22151	1199
W22153	1199
W22158	1199
W22161	1199
W22166	1196,1197
W22167	1196
W22168	1196
W22169	1197
W22170	1197
W22171	1197
W22172	1196
W22173	1196,1197
W22175	1196
W22176	1197
W22262 to W22275	1189
W22276 to W22287	1190
W22288 to W22299	1191
W22340 to W22344	1171
W22361	1198
W22372	1197
W22401	1198
W22452	1203
W22453	1198,1204
W22454	1198,1204
W22472	1202
W22473	1202
W22487	1198
W22488	1198
W22489 to W22493	1198, 1203
W22544 to W22550	1203
W22556	1196,1203
W22557	1197,1198 1202,1204
W22558	1197,1203
W22559	1197
W22560	1203
W22602 to W22607	1199
W22869 to W22879	1197
W22889	615
W22890	615
W22926	1196
W22928 to W22940	1196
W22941 to W22947	1197
W22949	1197
W22950	1196
23138	38
W23156A	1198
W23156B	1198
W23171	1198
2	1198
W23500 to W23504	1201
W23692 to W23696	1200
W23697	1198
W23698	1198
W23775 to W23779	1208
W23796 to W23807	129
W23904 to W23920	129
24051	558
24139	856
24140	856
W24196 to W24202	1187
W24203 to W24211	1188
W24212 to W24218	1187
W24219 to W24227	1188
24836 to 24843	370
25019	219, 220
25028	19
25029	19
25376	238
26666	121
27000	1203
27001	1203
27003 to 27007	1203
W27209	1166
27034	1173
27035	1173
W27050 to W27057	1144
W27055	1142
W27101 to W27110	1134
W27111 to W27120	1135
W27121 to W27126	1138
W27126 to W27130	1139
W27131 to W27135	1140
W27136 to W27140	1141
W27141	1134, 1135 1138, 1139 1140, 1141 1142
W27142	1134, 1135 1142
W27143	1134, 1135 1138, 1139 1140, 1141 1142, 1147 1148, 1149 1152, 1153 1156, 1157 1158, 1159 1160, 1161
W27144	1135 1139, 1141 1142, 1149 1153, 1157 1159, 1161
W27145	1135 1139, 1141 1142, 1149 1153, 1157 1159, 1161
W27146	1134, 1138 1140, 1142 1148, 1152 1158, 1160 1161
W27147	1136, 1138 1154, 1161
W27148	1136, 1138 1154
W27149	1136, 1154
W27150	1136, 1154
W27151	1137
W27152 to W27155	1155
W27156	1155, 1156
W27157	1137
W27158	1137, 1155
W27159	1137
W27160	1137, 1155
W27161	1138 1140, 1143
W27162	1134, 1138 1142, 1147 1148, 1152 1156, 1158 1160, 1161

STYLE NUMBER INDEX—Continued

Style No.	Page
W27163	1143
W27164	1140,1141 1158,1159 1161
W27165	1143,1169
W27166	1138
W27166 W27167 W27168	1134 1140 1142 1147 1148 1152 1156 1158 1160 1161 1135 1139 1141
W27169 W27170 W27171 W27172	1142 1149 1153 1157 1159 1161
W27173 to W27176	1136 1154
W27177	1137,1155
W27178	1137
W27179	1136
W27180	1136 1145,1154
W27181	1136,1154
W27182	1143
W27183	1142
W27184	1142
W27185	1142
W27186	1143,1145
W27187 to W27193	1143
W27194	1142
W27195	1144
W27196	1144
W27197	1142,1145
W27198	1137,1145
W27200 to W27208	1163
W27210 to W27218	1163
W27219	1166
W27229	1166
W27230 to W27238	1164
W27240	1165
W27241	1165
W27242	1165
W27243 to W27247	1167
W27248	1169
W27249	1169
W27250	1169
W27256	1169
W27257	1169
W27258	1169
W27500 to W27504	1152
W27505 to W27509	1153
W27510 to W27515	1155
W27516 to W27520	1156
W27521 to W27525	1157
W27526 to W27530	1158
W27531 to W27535	1159
W27536	1152,1156 1158,1160 1161
W27537	1153,1157 1159,1161
W27538	1156,1157 1161
W27539	1145,1158 1159,1161
W27540	1161
W27541 to W27545	1160
W27546	1155
W27547	1160
W27548	1155
W27549	1155
27659	571
W27701 to W27710	1147
W27711 to W27719	1148
W27720	1148,1164
W27721 to W27728	1149 1164
W27729	1149
W27730	1149
W27731	1147
W27732	1148
W27733	1149
W27734	1147
W27735	1148
W27736	1149
27736	322
27741	322
27746	322
27751	322
27756	322
27761	322
27766	322
27771	322
27781	322
27786	322
27791	322
29763	220
29865	67
29897 to 29900	657
30053	739
30054	739, 788
30055 to 30058	739
30059 to 30063	1113
W30452	1180
W30453	1180
W30456	1180
W30468	1208
W30469	1208
W30518	1180
W30519	1180
30549	67
30550	67
W30650	1175
W30651	1175
W30652	1175
W30627	1182
W30628	1182
W30631	1182
W30638	1182
W30639	1182
W30642	1182
W30643	1182
W30646 to W30650	1178
W30657 to W30667	1178
30668 to 30672	1183
W30668 to W30683	1174
30674 to 30678	1183
W30688	1180
W30689	1180
W30690	1180
30688	1183
W30691	1183
W30692	1183
W30695 to W30699	1180
W30700ANB	1185
W30702ANS	1185
W30703AWB	1185
W30705AWS	1185
W30706CNB	1185
W30708CNS	1185
W30709CWB	1185
W30711CWS	1185
W30712	1185
W30713	1185
W30714AN	1185
W30715AW	1185
W30716CN	1185
W30718	1185
W30719 W30721 to W30724	1185
W30731MNB	1185
W30732MNS	1185
W30733MWB	1185
W30735RNB	1185
W30736RNS	1185
W30737RWB	1185
W30738RWS	1185
W30739	1185
W30740	1185
W30741MN	1185
W30742MW	1185
W30743RN	1185
W30744RW	1185
W30746	1185
W30767 to W30771	1180
W30774 to W30800	1179
30780	237
30901	739
30902	739
W30909 to W30926	1179
W30927 to W30940	1183
30933A	62
W30946	1183
W30948 to W30979	1174
W30982 to W30987	1175
W31001 to W31056	1181
W31057 to W31078	1182
32304 to 32316	61
32481	65
32482	65
32485	65
32486	65
32488	65
32489	65
32492	65
32493	65
32495	65
32496	65
32497	65
32499	65
32500	65
33112	393
33151	392
35152 to 35161	220, 225
35233 to 35241	698
35242	697
35243	697
35244	697
35248	698
35249 to 35253	698
35286	1113
35287A	1113
35289	1113
35290A	1113
35299	221
35373	121
35373A	721
35403	221
35586 to 35589	656
35591	743
36001	1113
36002	1113
36003	1113
36006	1113
36007	1113
36045 to 36050	1113
36053	1113
36054	1113
36451	219
36457	220
37153 to 37184	60
37157	117
37158	118
37159	118
37159	117, 118
37160	117, 118
37161	117
37162 to 37165	117, 118
37166	117, 118
37167	117, 118
37168	117, 118
37169	117
37170	117, 118
37172	117
37173	117
37174	117
37175	117
37176	117, 118
37177	118
37178	117
37182	118
37185 to 37216	61
37186	118
37187	117, 118
37188	118
37189	117, 118 1085
37190	117
37191 to 37194	117, 118 1085
37195	117, 118
37196	117, 118
37197	117
37198	117
37199	117
37200 to 37203	117
37207	117
37209	117
37210 to 37216	1079
37218 to 37232	62
37281	743
K37501 to K37508	153
K37511 to K37518	153
K37521 to K37528	153
K37531 to K37538	153
K37541 to K37545	153
W37541 to W37572	128
K37551 to K37555	153
K37561 to K37565	153
K37571 to K37575	153
K37581 to K37588	153
K37591 to K37598	153
K37601 to K37608	153
K37611 to K37618	153
37935	61
37936	61
37944	61
37945	61
37958 to 37961	61
37962	1113
K38222 to K38236	164
K38238 to K38252	164
K38254 to K38268	162
K38270 to K38284	162
K38286 to K38300	164
K38302 to K38316	162
K38318 to K38332	164
K38334 to K38348	164
K38350 to K38364	162
K38366 to K38380	162
K38382 to K38396	164
K38398 to K38412	162
K38446 to K38460	162
K38462 to K38476	162
K38494 to K38508	162
K38510 to K38524	165
K38526 to K38540	165
K38542 to K38556	163
K38558 to K38572	163
K38574 to K38588	165
K38590 to K38604	163
K38606 to K38620	165
K38622 to K38636	165
K38638 to K38652	163
K38654 to K38668	163
K38670 to K38684	165
K38686 to K38700	163
K38710	162
K38711	162
K38712	162
K38734 to K38748	163
K38750 to K38764	163
K38759	203
K38782 to K38796	163
K38798 to K38812	182
K38814 to K38828	182
K38830 to K38844	182
K38846 to K38860	182
K38862 to K38876	182
K38878 to K38892	182
K38894 to K38898	182
K38910 to K38924	182
39919	1113
K38942 to K38956	183
K38958 to K38972	183
K38974 to K38988	183
K38990 to K39104	183
K39106 to K39120	183
K39122 to K39136	183
K39138 to K39152	183
K39154 to K39168	183
K39170 to K39184	183
K39186 to K39200	184
K39202 to K39216	184
K39218 to K39232	184
K39234 to K39248	184
K39250 to K39264	183
K39262 to K39265	185
K39266 to K39276	184, 18
K39277 to K39280	184
K39282 to K39296	184
K39298 to K39312	185

STYLE NUMBER INDEX—Continued

Style No.	Page
K39314 to K39328	185
K39330 to K39344	185
K39346 to K39360	185
K39378 to K39392	185
K39394 to K39408	185
K39410 to K39424	185
K39426 to K39440	186
K39442 to K39456	186
K39458 to K39472	186
K39474 to K39488	186
K39490 to K39504	186
K39506 to K39520	186
K39522 to K39536	186
K39538 to K39552	186
K39554 to K39568	187
K39570 to K39584	187
K39586 to K39600	187
K39602 to K39616	187
K39618 to K39634	187
K39650 to K39664	187
K39666 to K39680	187
40649	1113
41595	121
41728	121
42300 to 42318	61
42320	65
42321	65
42322	65
42970 to 42975	62
43105	121
43107	121
K43435 to K43449	169
K43451 to K43465	169
K43467 to K43481	169
K43680	856
K43499 to K43513	168
K43515 to K43529	168
K43531 to K43545	168
K43563 to K43577	169
K43579 to K43593	169
K43595 to K43609	169
K43627 to K43641	168
K43643 to K43657	168
K43659 to K43673	168
43670 to 43673	287
44887D	1074
46185	21
46868	605
47417	6
47608	324, 371
47609	324
47889	121
47893	872
47931	879
47941	121
47941A	121
47969	371
48231	13
48645 to 48650	874
48653	882
48814	22
49363	874
49372	881
49373	881
49372	921
49373	921
49374	920, 921
49375	921
49394 to 49398	939
50337	1079
50382	219, 222
50383	222
50384	222
50403A to 50406A	1113
50885	879
52073 to 52088	153
K52231 to K52320	171
K52327 to K52349	173
K52351 to K52353	196
K52354 to K52364	197
K52366	197
K52518 to K52521	155
52557	856
52559	856
52560	857
52562	857
52563	857
52565	857
52566	857
52568	857
52569	859
52571	589, 855
52572	589
52574	859
52596	863
52602	865
52604	865
K53000	150
K53001	150
54924	865
54928	886
54930	886
54934	867
54936	867
54937	867
54939	867
54943	867
54944	867
54950	868
54956	865, 868
54972	698
54973	698
55382	203
55383	203
56359	201
56364	238
56365	238
56822	238
56823	238
57513 to 57519	887
57930	324
57965	65
57968	1116
58070	203
58496	1079
58650	322
58651	322
58651	1076
59083	676
59084	677
59086	677
59523	1113
59570	607
59571	607
59601	677
59932	324, 371
60010	324, 371
60179	697
60180	697
61045 to 61048	220, 225
61047	220
61048	220
61057	62
61058	62
61059	62
61062	62
61063	62
61064	62
61720	1096
61721	1096
62133	10, 13
63718	677
63719	677
63720	677
64421	1088
64767	676
65608	1096
65609	1096
65610	1096
65747 to 65761	326
65766	676
65768	676
65769	676
65942	260
65943	260
65944	260
65952	260
65953	260
65954	260
65962	260
65963	260
65964	260
66042	677
66095	1114
66131	918
66276 to 66292	677
66294	677
66295	677
66298 to 66313	676
66319	677
66371	698
67192	220
67193	225
67764	225
67765	225
68221	920, 1069
69902	677
69903	677
70555	1096
71664 to 71669	672
72312	670
72313	670
72321 to 72338	672
72449	677
72458	652
72749	608
72750	608
72751	608
72752	607
73853	1094
73854	1094
74508	604
74509	604
74598	604
74599	604
74600	604
74645	1113
74646	1113
76823	236
76824	236
76825	237
76826	237
76827	237
80126	33
80205	219, 200
81133 to 81138	203
81552 to 81560	203
81599	847
81600	847
81607	847
81608	847
81798	848, 849
82617	868
82629	868
82633	858
82636	858
82639	858
82642	858
82645	858
82648	886
82661	886
82667	867
82671	880
82672	880
82689	868
82701	868
82711 to 82719	893
82720	872
82735	883
82738	878
82742	867
82747	857
82773	886
82776	886
82779	867
82787	877
82789	877
82791	877
82793	877
82797	874
82798	874
82799	876
82801	876
82803	876
82805	876
82873	874
82874	874
83121	869
83123	869
83125	869
83129	612
83355	848, 849 850
83356	848, 849 850 850
83393	848 849 850, 958
83347	851
83348	851
83805	1083
84143 to 83184	939
84600 to 84608	677
84636 to 84661	677
84663 to 84686	677
84687	676
84688	676
84689	676
84691	676
84692	676
84693	676
84715 to 84756	676
84799	677
84817	677
85329	874
85330	874
85332	874
85334	874
85416 to 85419	877
85421	877
85422	877
85756	1113
85784	1113
87637	1096
87643 to 87663	213
87664	847, 849
87665	847, 849
87666	848, 849
88497	677
88498	677
88703	865
88823 to 88826	287
88921	920
91071A	600
91073B	600
91074A	600
91075A	600
91193	119
91219	932
91244	677
91245	677
91246	677
91266	918
91331	677
91350	1076
91351	1076
91354	1076
91355	1076
91383	121
91466	918, 1026
91703	548
91704	548
92113	918
92132	849
92133	849
92141	930
92146	940
92147	940
92149	939
92210	918
92232	887
92233	887
92234	887
92248 to 92251A	1113
92510 to 92513	920
92721	1110
92790B	556
93510 to 93524	561
93527 to 93534	561
93590	22
93596	1096
97456	237
97457	237
97466	851
97467	851
97474	849
97475	849
97512	940
97513	940
97519 to 97523	210
97527 to 97531	210
97604	739
97605	739
97870	1096
97878	1096
98798	677
98801	677
99008	1096
99038	121
99080	237
99081	237
99082	237
99342	1114
99402	877
99404	877
99553	1116
99596	1116
99708	677
99709	677
99710	677
99712	677
99713	677
99714	677
99829	261
99830	261
99839	676
99840	676
99895	660
100416	847, 848 849, 850
100417	847, 848 849, 850
100418	849, 850
100419	849, 850
100420	847, 849 857
100421	847, 849 857
100422	849,851
100423	849, 851
100424	851
100425	851
100426	849, 850
100427	849
100443	1345
100727	17, 21
101292 to 101299	287
101473	260
101474	260
101941	276
101942	941
101954	847
101953 to 101958	960
102113 to 102117	999
102121	976
102125	976
102143 to 102148	959
102146	932
102147	932
102192	1002
102193	1002
102247 to 102250	994
102259	956
102260	956
102261	956
102273	956
102274	956
102275	956
102287	956
102288	956
102746	1261
102747	1261
103414	219
103689	1113
103691	1113
104162	1116
104167	677
104391	120
104392C	120
104789	1113
104790	1113
105696	396
106568	1116

STYLE NUMBER INDEX—Continued

Style No.	Page
106697 to 106708	1111
106711	1111
106712	1111
106802	1345
107150 to 107212	671
107482	671
107483	671
107493	794
107494	794
107495 to 107504	795
107505 to 107512	804
107513	805
107514	805
107516	1108
108058	677
108059	677
108060	677
108064 to 108067	677
108078	573, 574
108079	573, 574
108099	317
108100	317
108101	317
108142	869
108143 to 108152	743
108201	677
108380	119
108474	677
108989 to 108996	561
109008	608
109009	608
109010	608
109712	1120, 1122
109713	1120, 1122
109733	1122
109340	879
109341	882
110354 to 110360	676
110756	652
110757	652
111125	1225
111126	1225
111424	68
112127	121
112323	210
112535	260
112536	260
112537	120
112538	120
112740	995
112878	613
112882 to 112885	651
W113020	1180
W113040	1180
W113060	1180
W113075	1180
W113150	1180
113495	1093
113496	1093
114102	1093
114840-1-2	676
114847	1228
115122	261
115123	261
115124	261
115725	1238
115727	1238
115729	1238
116800	880
117375	201
118768	219
118948	849
118951	849
118960	850
118963	850
118984	848, 849
118987	848
118990	848
118996	848
119014	848
119017	849
119020	849
119043	849
119046	849
119049	849
119052	850
119079	852
119080	852
119081	852
119083	37
119157 to 119160	676
119312 to 119315	904
119317	899
119326	642
119357	995
119371	317
119655	676
119656	676
119657	676
119658	920
119659	920
119890	888
119891	888
119914 to 119917	877
119919	940
119921	940
120076	848, 849
120079	848, 849
120082	848, 850
120085	850
120193	677
120438 to 120446	677
120448 to 120455	677
120456 to 120463	676
120467 to 120471	676
120475 to 120482	676
120483	879
120484	881
120485	881
120563	880
120830	8
120867	940
120869	940
120961	1083
120962	1083
121128	676
121129	676
121130	676
121358	1335
121364	1335
121370	1335
121561	888
121562	888
121602	872
121602	921
121603	921
121610	80
121665	1384
121666	1384
121667	1384
121727	56
121734	937
121738 to 121741	937
122323	930
122429	677
122430	677
122481	1335
122487	1335
122493	1335
122499	1335
122505	1335
122511	1335
122517	1335
122609	876
122611	876
122650A	121
123242	317
123243	317
123359	937
123360	937
123692	121
124389	65
124390	65
124391	65
124393	65
124395 to 124400	65
124401	206
124402	206
124403 to 124406	65
124413	206
124414	206
124586	217
124755	893
124756	893
124757	893
124760	876
124762	876
124967	1227
124968	1227
125000 to 125018	726
125019 to 125035	728
125053 to 125072	732
125077 to 125080	734
125085 to 125096	734
125185	1228
125186	1228
125235	1088
125247	882
125412	8, 37
125527	936
125529	936
125531	936
125533	936
125535	936
125537	936
125539	937
125541	937
125543	937
125547	882
125552 to 125555	877
125604 to 125629	725
125632	904
125680	642
125724	878
125725	882
125726	882
125727	882
125729	882
125731 to 125735	882
125737	882
125739	879
125740	879
125741	879
125743	879
125745	879
125746	879
125747	880
125748	880
125750	880
125752 to 125755	880
125756 to 125759	883
125760	904
125761	904
125762	904
125763	869
125766	704
125778	877
125779	877
125781	877
125782	877
125783	877
125785	877
125787	1384
125788	877
125789	877
125794	888
125795	888
125815	1384
125909 to 125914	893
125916	893
125918	893
125920	893
125922	893
125924	893
125926	893
125927 to 125931	894
126035	937
126199	1109, 1114
126199A	1109, 1114
126200	1109, 1114
126200A	1109, 1114
126269	883
126270	883
126271	883
126387	888
126496	940
126498	940
126500	940
126524	940
126526	940
126528	940
126529	677
126561B	1076
126629	995
126962	890
126963	890
126966	890
126967	890
126970	890
126971	890
126976	876
126977	876
126978	876
126980	876
127059	868
127061	941
127101	994
127124	937
127205 to 127208	894
127267	869
127355 to 127358	904
127520	393
127529	393
127768	610
127776	610
127800	617
127806	599
127909	1110
127932	617
127933	617
128426	995
128476	996
128597	612
129224	288
129229 to 129232	288
129384	757, 758, 759, 760, 761, 762, 763, 764, 765, 766, 773
129806 to 129809	998
130582	960
130583	960
130623	677
133407 to 133410	288
133411	1114
133629	1332
133632	1332
133738 to 133742	288
133829	677
133892	288
133893	288
133973	261
133974	261
133975	261
134218	1088
134250	1114
134251	1114
134613	1381
134769	1068
134770	1068
135073	994
135074	994
135082 to 135086	994
135087 to 135100	890
135957	791
136104	852
136105	852
136468	119
136817	958
136818	958
136849 to 136852	957
136858 to 136864	957
136866	957
136867	957
136868	957
136872 to 136876	957
136878 to 136884	957
136898	958
137231 to 137252	957
137266	957
137268	957
137270	957
137272	957
137273	957
137275	957
137276	957
137277	957
137294	958
137295	958
137296	958
137300 to 137307	958
137309	958
137331	959
137333	959
137335	959
137336	959
137338	959
137360	959
137362	959
137364	959
137365	959
137366	959
137367	959
137368	959
137372 to 137377	959
137378	995
137379	995
137380 to 137383	996
137389 to 137400	996
137401 to 137405	997
137406	1000
137630 to 137633	997
137637 to 137642	997
137649	998
137650	998
137651	998
137653	998
137654	998
137657	998
137659	998
137660	998
137661 to 137669	990
137671	999
137672	999
137673	999
137674	1000
137675	1000
137678 to 137693	1000
137694 to 137701	1002
137702 to 137722	1003
137723 to 137728	1001
137729	869
138141	1111
138186	677
138214 to 138228	1001
138229 to 138234	1002
13825 to 138246	1001
138247	1002
138248	1002
138249	1002
138253	1002
138254	1002
138255	1002
138260	941
138262	941
138264	941
138266	941
138268	941
138270	941
138271	1068
138272	1068
138273	1068
138837	791
138839	791
138840	791
138842 to 138845	791
138877	1096
138885	1096
139100 to 139107	847
139281	1093
139589	1381
139618 to 139625	688
139742	876
139743	876
139745	876
139747	876
139794	37
139962	677
140086	677
140183	887
140577	1333
140581	1333
140606	1330
140609	1330
140689 to 140693	873
140695	873
140697 to 140701	873
141037	637
141145	887
141426	1096
141527	260
141529 to 141532	260
141539	8
141620	869
141621	869
141622	869
142021 to 142024	847
142080	571
142081	1114
142399	53
142400	53
142760	1114

STYLE NUMBER INDEX—Continued

Style No.	Page
143162	903
143681	810
143684	810
143686	810
143688	809
143690	809
143692	809
143697	809
144047	859
144048	859
144265	571
144341	904
144342	904
144830 to 144834	903
145121	65
145122	65
145368	1110
145578 to 145585	1221
145973 to 145976	890
145977 to 145980	903
146065 to 146068	863
146284	1263
146356	891
146357	891
146360	891
146361	891
146366	891
146367	891
146370	891
146371	891
146632	869
146648	1110
146649	1110
146865D	1326
147190	67
147233 to 147240	671
147946	671
148137	993
148138	993
148169	993
148907	388
148908	388
148909	388
149139	208
149140	208
149141	208
149786 to 149790	924
149802 to 149807	924
151072-3	208
151102	1334
151104	1334
151106	1334
151111	888
151186	788
151190	788
151223	15
151224	15
151225	15
151466	1253
151686	788
151808	637
151810	637
151811	637
151812	637
151813	637
151814	637
151815	637
151818	637
151819	637
151820	637
151821	637
152526	1227,1296
152937	881
152938	881
152999	1223,1226
153706	677
154072	898
154225	566
154226	566
154227	566
154297	6, 12
154609	1222
154610	1222
154611	1223
154611A	1226
154713 to 154716	287
154794 to 154797	888
155805	260
156096	566
156145	566
156291	647
156293 to 156296	647
156298 to 156320	647
156572	650
156610 to 156621	651
156763	1345
156764	1345
156767A	1345
156768A	1345
156944	68
156988	651
156989	651
156993	651
156994	651
156998	651
156999	651
157024	651
157025	651
157029	651
157030	651
157034	651
157035	651
157151	898
157152	898
157169 to 157174	123
157228	652
157229	652
157244	655
157245	655
157246	653
157247	653
157275	1093
157645	937
157649	121
157916	681
157957	1228
158118	938
158628 to 158661	923
158665 to 158698	923
158837 to 158867	926
158872 to 158902	926
159091 to 159101	213
159464 to 159475	893
159493	891
159494	891
159495	891
159497	891
159498	891
159499	891
159520	121
159532	213
159907	1326
159908	1326
160451B	1326
160452D	1326
160905	882
161363	627
161364	627
161367	627
161368	627
161373	627
161374	627
161377	627
161378	627
162123	1263
162322 to 162329	660
162386	891
162387	891
162388	891
162390	891
162391	891
162392	891
162416	890
162497	1190
162498	1190
162497A	1114
162498A	1114
162510	612
162512	612
162513	611
162514	611
162515	611
162517	612
162548 to 162576	636
162591	1086
162620	1235
162622	1235
162624	1235
162626	1235
162628	1235
162631	1235
162637	1235
162639	1235
162658	677
W163020	1188
W163040	1188
W163060	1188
W163075	1188
163088	651
163089	651
163090	651
163093	651
160094	651
163134	677
W163150	1180
163320	788
163446	208
163447	208
163537	1235
163540	1235
163663	899
163664	899
163665	899
163667	899
163668	899
163669	899
163687	899
163688	899
163689	899
163691	899
163692	899
163693	899
163699	657
164226	1384
164227	1384
164228 to 164232	1381
164233	1384
164253 to 164260	596
164272 to 164275	600
164295 to 164298	599
164300	1238
164353	805
164354	805
164463	56
164673	121
164844	1265
164846	1265
164848	1265
164851	1265
164853	1265
164854	1265
164856	1265
164860	1265
164862	1265
164864	1265
164867	1265
164968	604
164969	604
164970	619
164987	611
164988	611
164989	611
165047	8
165093	937
165174	921
165220	388
165402 to 165416	685
165477	68, 71, 1080
165487	687
165488	687
166071	208
166072	208
166770	660
166955	1074
166956	1074
166963	921
166964	921
167502	219, 221
167508	859
167510	891
167512	891
167514	891
167516	891
167524 to 167529	890
167527	932
167529	932
167530 to 167540	476
167552	476
167562	476
167607 to 167638	456
167639 to 167670	457
167587 to 167597	688
167671 to 167703	459
167704 to 167735	460
167736 to 167757	461
167815	918
167816	918
167817	681
167835 to 167839	507
167845 to 167849	507
167865 to 167869	507
167875 to 167879	507
167895 to 167899	506
167905 to 167909	506
167925 to 167939	506
167944 to 167947	507
167952 to 167955	507
167960 to 167963	508
167968 to 167971	508
167972 to 167979	507
167980 to 167987	508
168004 to 168019	457
168020 to 168039	458
168049	201
168093	688
168094	688
168095	688
168154	1345
168165	932
168170	685
168171	685
168246 to 168299	251
168300 to 168326	252
168327 to 168335	253
168336 to 168353	252
168354 to 168371	255
168372 to 168395	256
168616 to 168636	513
168367 to 168357	514
168658 to 168665	513
168666 to 168670	510
168667	506
168668	506
168669	506
168707	513
168708	513
168824	619
168995 to 168998	255
169235C	1076
	1077
169257A	1114
169258	1114
169338A	1114
169465A	1114
169490	788
169510 to 169517	695
169518	690
169519	690
169520	690
169581	1114
169764	1098
169768 to 169771	866
169873	866
170051	918
170052	918
170224	688
170643	49
170664	571
170780	627
170781	627
170782	627
170784	627
170785	627
170786	627
170787	627
170789	627
170792	627
170794	627
170795	627
170796	627
170797	627
170799	627
170818	627
170820	627
170821	627
170823	627
170824	627
170826	627
170827	627
170829	627
170909	809
170910	809
170911	809
170917	809
170918	809
170919	809
170955	809
170956	809
170957	809
170961	809
170962	809
170963	809
171086	859
171088	859
171187	677
171188	677
171538	1076
171653	883
172193	650
171897	1067
172877 to 172886	810
172852 to 172856	810
172569	696
172571	696
172793	...
172928	918
172929	918
173047 to 173052	647
173158	1114
173204 to 173207	680
173209	681
173210	681
173211	681
173295	219
173296	219
173297	219
173295	222
173296	222
173297	222
173489	1076
173517	810
173804	677
173861	1076
174005	681
174088	1245
174332	1245
174397 to 174403	651
174415 to 174418	681
174889	1076
175443	1345
175509 to 175516	811
175521	1076
175758C	1076
175805 to 175835	924
175836 to 175866	923
175867 to 175897	925
175910 to 175929	924
175930	931
175932	866
175933	932
175934	932
175935	932
176930 to 176937	929
176459 to 176489	923
176883 to 176913	927
176970	1087
176972	1087
176973	1087

STYLE NUMBER INDEX—Continued

Style No.	Page
177034	690
177035	690
177036	690
177039	690
177054	651
177103	1235
177105	1235
177109	1235
177321	899
177512	607
177513	620
178263 to 178271	251
178272 to 178280	253
178554	692
178647	811
178766	811
178843	801
178928	629
178929	629
178930	629
178932	629
178933	629
178934	629
179001	647
179002	647
179003	647
179063	788
179098	1235
179100	1235
179339	788
179347A	1345
179348A	1345
179359 to 179364	478
179371	478
179376	478
179383 to 179418	480
179419 to 179439	481
179475 to 179479	935
179481 to 179485	936
179488 to 179491	935
179555 to 179561	680
179758	606
179908	732
179914	16
179968	788
179975	788
179981 to 179990	866
179992	866
179994	866
179995	866
179996	866
180199	681
180201	681
180202	681
180281A	1082
180316	1076
180317	1076
180318	900, 932
180417	884
180418	884
180642	726
180643	726
180644	726
180646	728
180647	728
180648	728
180794	681
181534 to 181545	897
181552 to 181563	897
181570 to 181581	897
181588 to 181599	897
181627 to 181635	898
181642 to 181653	898
181856	1067
181857	1067
181860	994
181863	859
181878	859
182005	859
182006	859
182007	859
182037	867
182039	867
182041	867
182045	867
182354	863
182360	863
182756 to 182774	730
182776 to 182794	730
182796 to 182815	728
182908	37
182945	115
182963	690
182971	692
182972 to 182977	690
183081	681
183148 to 183153	891
183508 to 183518	53
183580	1114
183583 to 183586	1114
183589A	1114
183615	656
183616	656
183630 to 183633	472
183728	627
183729	627
183730	627
183732	627
183736	627
183738 to 183742	627
183744	627
183748	627
183750	627
183751	627
183752	627
183753	627
183754	627
183756	627
183760	627
183762 to 183765	627
183767	627
183771	627
183773 to 183777	627
183779	627
183783	627
183785 to 183789	627
183791	627
183797	627
183954	627
183955	627
183957	627
183958	627
183960	627
183961	627
183963	627
183964	627
183968	651
183969	651
184002 to 184007	683
184008 to 184011	682
184012 to 184015	683
184086	952
184110	117, 118
184110 to 184122	60
184111	117
184112	117
184113	118
184114	117
184116	117
184117	117, 118
184118	117
184119	118
184123 to 184137	61
184125 to 184128	117
184130	117
184131	117
184200	899, 932
184511	1384
184549	1384
184554	1384
185138 to 185141	1114
185143	1255
185312 to 185315	206
185370	899
185371	899
185372	899
185388 to 185395	644
185397	644
185407	644
185530	932
185535	932
185536	932
185537	932
185550	932
185592 to 185597	932
185697A	1114
185772	856
185773	856
185775	856
185906	999
185907	999
185918 to 185921	1114
186025 to 186033	1242
186049 to 186052	1225
186208A	1326
186234	355
186235	355
186236	355
186240	355
186241	355
186242	355
186246	355
186247	355
186248	355
186252	355
186253	355
186254	355
186258 to 186261	357
186266 to 186269	357
186274 to 186277	357
186282 to 186285	357
186294	999
186317	994
186318	994
186320A to 186323A	1114
186367	859
186381 to 186386	647
186465	260, 566
186467	260
186469	260
186470	288
186473	566
186474	260
186784	918
186814	219
186838	896
186839	896
186840	896
186871	683
187115	993
187299	1116
187345 to 187352	1371
187353 to 187360	1371
187638 to 187648	904
187785	393
187788 to 187801	733
187802 to 187812	513
187813 to 187833	514
187876 to 187896	515
187897 to 187917	516
187918 to 187923	515
187924 to 187935	516
188052	517
188053	517
188081 to 188094	517
188115	677
188323	896
188324	896
188325	896
188335 to 188346	896
188424 to 188430	894
188425	932
188426	932
188501	1384
188502	1384
188588 to 188591	1371
188693	651
188706	681
188737	960
188738	960
188740 to 188749	960
188857	954
188897	933
188913	1379
189020A	1114
189025A	1114
189198	1255
189204	1255
189628A	1114
189629A	1114
189696 to 189702	651
189800 to 189815	102
189816 to 189823	103
189824 to 189831	102
189832 to 189839	103
189840 to 189847	102
189848 to 189855	103
189872 to 189879	102
189880 to 189887	103
189888 to 189895	102
189896 to 189903	103
189913	219, 220
189914	220
189920	220
189923	219
189977 to 189980	1384
190003A	1114
190159	22
190212	219, 220
190294 to 190297	1114
190318	933
190336	632
190337	632
190338	632
190340 to 190343	632
190345	632
190379 to 190386	680
190639	219, 220
190640	220
190644	220
190668 to 190671	548
190798	744
191010 to 191047	552
191048	1081
191103A	1114
191395 to 191398	766
191714 to 191723	487
191760 to 191771	491
191772 to 191785	492
191786 to 191797	494
191880	219
191881	219
191989 to 192010	493
192151 to 192154	104
192159 to 192166	104
192171 to 192178	104
192183 to 192186	104
192187 to 192190	104
192195 to 192198	104
192199 to 192202	104
192207 to 192210	104
192211 to 192214	104
192219 to 192222	104
192223 to 192226	104
192231 to 192234	104
192235 to 192238	104
192243 to 192246	104
192247 to 192250	104
192255 to 192258	104
192259 to 192262	104
192267 to 192270	104
192271 to 192274	104
192279 to 192282	104
192283 to 192286	105
192291 to 192294	105
192295 to 192298	105
192303 to 192306	105
192307 to 192310	105
192315 to 192318	105
192319 to 192322	105
192327 to 192334	105
192339 to 192346	105
192351 to 192358	105
192363 to 192370	105
192375 to 192382	105
192387 to 192394	105
192399 to 192406	105
192411 to 192414	105
192486	1085
192544 to 192574	561
192683 to 192690	106

STYLE NUMBER INDEX—Continued

Style No.	Page
192691 to 192698	107
192699 to 192706	106
192707 to 192714	107
192715 to 192722	106
192723 to 192730	107
192747 to 192754	106
192755 to 192762	107
192763 to 192770	106
192771 to 192778	107
192779 to 192782	108
192787 to 192794	108
192799 to 192806	108
192811 to 192818	108
192823 to 192830	108
192835 to 192842	108
192847 to 192854	108
192859 to 192866	108
192871 to 192878	108
192883 to 192890	108
192895 to 192902	108
192907 to 192910	108
192927	681
192929	617
192930	617
193317 to 193328	356
193333 to 193344	356
193349 to 193356	356
193384 to 193387	356
193392 to 193403	356
193579 to 193594	370
193603 to 193609	355
193611 to 193613	355
193619 to 193625	355
193627 to 193633	355
193635 to 193641	355
193643 to 193649	355
193673A	1124
193947	918
193963 to 193995	925
193996	929
194050 to 194082	925
194084	929
194338	220,227
194339	220, 227
194340	220
194341	220
194342	220,227
194349 to 194358	651
194389 to 194394	324
194453	360
194454	360
194455	360
194459 to 194464	360
195138	1023
195141	1023
195143	1024
195146	1024
195148	1025
195149	1025
195150	1026
195153	1025
195156	1027
195159	1027
195160	1028
195161	1027
195162	1025
195163	1029
195164	1028
195165	1028
195166	1057
195167	1054
195168	1031
195169	1057
195171	1036
195176	1038
195177	1057
195179	1041
195180	1043
195186	1050
195187	1058
195190	1053
195191	1055
195194 to 195198	1069
195205	1070
195206	1070
195207	1070
195227	627
195228	627
195229	627
195231	627
195248 to 195267	1071
195268 to 195299	1072
195313 to 195316	105
195321 to 195324	105
195391 to 195394	627
195399	627
195401 to 195405	627
195407	627
195411	627
195413 to 195417	627
195419	627
195463	627
195464	627
195465	627
195467	627
195475	627
195476	627
195477	627
195521	627
195522	627
195523	627
195525	627
195533	627
195534	627
195549 to 195551	627
195553	627
195561	627
195562	627
195570	627
195571	627
195572	627
195574	627
195582	627
195583	627
195584	627
195586	627
195643	1087
195807A	1114
195893 to 195896	108
195901 to 195904	108
195916A	1114
195973	566
195974	566
195979	651
195980	651
196019 to 196022	255
196081 to 196085	956
196122	1238
196158	1251
196202	604
196206	604
196220	962
196222	976
196223	976
196303	602
196305	602, 603
196307	602
196309	602, 603
196311	602, 603
196313	602, 603
196315	966
196323	966
196342	966
196343	966
196344	966
196394	603
196395	603
196403	603
196637 to 196646	957
196665	683
196679	671
196713 to 196716	957
196717 to 196724	958
196725	960
196802 to 196828	958
197027	677
197040	683
197144	933
197145	933
197526	632
197527	632
197528	632
197530	632
197533 to 197535	632
197537	632
197558 to 197565	933
197590	37
197821	632
197822	632
197823	632
197825	632
197829	632
197830	632
197831	632
197833	632
197922	683
197923	683
198049	810
198050	810
198429	220, 226
198495 to 198498	270
198550	1345
198551	1345
198561	220, 226
198605	220, 226
198630	220, 226
198631	220, 226
198699	121
198714	220, 226
198715 to 198724	680
198734	1114
198735	1114
198740	360
198741	360
198742	360
198746 to 198751	360
198766 to 198774	360
198778 to 198783	360
198796 to 198799	357
198804 to 198807	357
198816 to 198839	357
198846 to 198857	357
199096	680
199097	680
199098	680
199099 to 199105	681
199123	392
199124	392
199125	392
199175 to 199186	900
199210	681
199211	681
199263	903
199335	651
199336	651
199341	637
199342	637
199346	637
199362	1088
199363	681
199416 to 199442	326
199651 to 199658	601
200522	1114
200599	1119
200602	1119
200605	1119
200608	1119
200611	1119
200643	1080
200873	220
200874	396
201397	273, 388
201480	274
201482	388
201555 to 201559	8
201597	19
201598	19
201599	19
201601	19
201603	19
201604 to 201608	37
201614	1119
201658	677
201673	16
201782A	1345
201783A	1345
201858	1114
201868 to 201872	211
202036	946
202066	938
202748	1108
202749	1108
202750 to 202761	654
202877	1114
202879	1114
203428 to 203439	322
204780	568
204781	568
205192 to 205251	368
205316	536
205318	536
206000 to 206005	323
206012 to 206017	323
206036 to 206041	323
206048 to 206053	323
206582 to 206599	997
206606	966
206607	966
206608	966
206609 to 206618	962
206859	632
206860	632
206861	632
206863	632
206867	632
206868	632
206869	632
206871	632
206875	632
206876	632
206877	632
206879	632
206882	632
206883	632
206884	632
206886	632
206890	632
206891	632
206892	632
206894	632
206898	632
206899	632
206900	632
207064	37
207243	393
207244	393
207313	1096
207314	1096
207352	861
207353	861
207389 to 207392	692
207921 to 207927	470
207928 to 207933	472
208537 to 208540	358
208545 to 208556	358
208561 to 208568	358
208577 to 208580	358
208558 to 208596	358
208601 to 208608	358
208617 to 208620	359
208625 to 208636	359
208641 to 208648	359
206665 to 206676	359
208681 to 208688	359
208777 to 208780	363
208785 to 208792	363
208817 to 208820	363
208825 to 208832	363
208841	364
208847 to 208855	364
208860 to 208864	364
208873 to 208875	364
208879 to 208887	364
208891 to 208896	364
208926	396
208937	364
208938	364
208939	364
208943 to 208951	364
208955 to 208960	364
208969 to 208971	364
208975 to 208983	364
208987 to 208992	364
209277 to 209300	361
209307 to 209354	361
209385 to 209420	362
209427 to 209462	362
209577 to 209588	364
209625 to 209636	365
209641 to 209652	365

STYLE NUMBER INDEX—Continued

Style No.	Page
209657 to 209668	365
209673 to 209684	365
209721 to 209736	366
209832 to 209836	394
209837	394, 677
209914	677
210233	14
210612	1114
210697	617
W211060	1177
W211075	1177
W211150	1177
W211200	1177
211840	394
211846	392
211917 to 211937	326
212029	573
212030	573
212314	810
212315	810
212325	809
212326	809
212328	809
212329	809
W214040	1177
W214060	1177
214068	396
214077 to 214084	387
214121	393
214133	387
214134	387
214135	387
214140	387
214144 to 214151	388
214159	394
214160	394
214165	394
214166	394
214185	703
W214200	1177
214236	712
214237	712
214241	1088
214316	16
214480	685
214514	536
214515	536
214516	536
214518	536
214519	536
214520	536
214582	393
214592	396
214852 to 214855	396
214856	39
214857	39
214858 to 214861	387
214863	396
214903	1251
214935 to 214950	966
214951 to 214957	966
214960	966
214961	966
214962	966
214963	968
214964	968
214978	677
W215040	1177
W215060	1177
215127	394
215128	394
W215150	1177
215183 to 215187	393
215580	571
215795	573
215799 to 215802	558
215975 to 215978	744
215991	960
216063	394
216064	394
216151	870
216171	938
216193	872
216225	326
216389	611
216390	611
216449	616
216450	616
216451	617
216452	617
216453	617
216509A	615
216510A	615
216511A	615
216515	573
216516	573
216718	703
216719	703
216737	609
216738	609
216750 to 216773	608
216824	642
216901 to 216990	370
217020	760
217021	760
217078	760
217079	760
217236	619
217450 to 217458	735
217462	735
217465 to 217473	736
217477	736
217478	736
217479	736
217480 to 217521	338
217588	642
217589	642
217611	609
217636 to 217641	1108, 1114
217680 to 217688	737
217692	737
217693	737
217694	737
217752 to 217767	600
217852	620
217853	620
217855	620
217856	620
217858	620
217859	620
217861 to 217870	620
217881	392
217987	1296
218042	1261
218043 to 218052	1261, 1262
218053	1104
218054	1104
218055	1104
218119	1261, 1262
218725	1345
218726	1345
218894	632
218895	632
218896	632
218898	632
218900 to 218904	632
218906	632
218908 to 218912	632
218914	632
218916 to 218919	632
219024	632
219025	632
219026	632
219028	632
219030 to 219034	632
219036	632
219038 to 219042	632
219044	632
219046 to 219049	632
219079	677
219092 to 219098	787
219131	1120
219132	1120
219133	1120,1122
219134 to 219137	1122
219146	696
219147	696
219153	393
219154	393
219159	705
219302 to 219312	673
219313 to 219316	690
219341	556
219355	685
219430	1108,1114
219431	1108,1114
219533	13
219799	732
219800	732
219943	392, 484
219944	393
219945	393
219946	393
219947	392
219948	392
219956	392
220241 to 220250	1224
220258	1114
220259	1114
220260	1114
220287	884
220619	273
220785	1114
220841 to 220846	1114
221086	1114
221087	1114
221088 to 221089	1108, 1114
221090	1114
221133	1114
221134	1108, 1114
221135	1114
221136	1108, 1114
221271 to 221282	892
221308	884
221491	1237
221493	1237
221495	1237
221497	1237
221499	1237
221738	720
221876	642
221943 to 221950	324
221970	324,370, 371
221971 to 221977	370
221979	396
222108 to 222113	1261
222173	713
222174	713
222305 to 222308	1223, 1226
222323	1228
222324	1228
222452	270
222561 to 222567	755
222569	756
222571	756
222572	756
223217 to 223220	721
223362 to 223367	755, 756
223369	756
223371	756
223372	756
223411	616
223414	616
223579	653
223580	653
223581	653
223582	573, 575
223583	573, 575
223584	573, 575
223586	573, 575
223587	573, 575
223588	573, 575
223667 to 223672	573
223863	1326
W224040	1176
W224060	1176
W224151	1176
W224172 to W224180	59
224185	388
224296 to 224328	628
224326 to 224372	628
224721	677
224762	1037
224763	1042
224769 to 224787	627
224789 to 224811	627
224813 to 224834	627
224845	627
224849 to 224868	627
224879	627
224881 to 224884	627
224894	631
224905 to 224919	1371
W225040	1176
W225060	1176
W225150	1176
225158 to 225163	810
225647	900, 932
225318	861
225351 to 225355	1114
225440	270
225448	270
225452	270
225654	612
225849 to 225852	632
225869 to 225870	632
225883	632
225884	632
225899 to 225902	632
225919 to 225922	632
255933	632
225934	632
226044	866
226046	866
226048	866
226049	866
226050	866
226052	866
226244	943
226323	611
226324	611
226325	611
226332	871
226409	642
226443	616
226444	614
226445	614
226471	613
226473	614
226571 to 226574	811
226674 to 226677	632
226688	632
226689	632
226704 to 226707	632
226727	869
226728	869
226729	869
226731	869
226732	869
226733	869
226859 to 227026	337
227032	860
227037	860
227050 to 227057	725
227058	726
227059	728
W227060	1176
W227075	1176
227138	863
227139	861
227140	860
227142	860
227144	860
227146	860
227148	860
227149	629
227150	629
W227150	1176
227151	629
W227200	1176
227216 to 227237	627
227362	699
227363	699
227364	665
227365	665
227580 to 227583	683
227599	611
227876 to 227879	74
227881 to 227889	74
227891 to 227895	74
227898 to 227902	74
227904 to 227908	74
227911 to 227915	74
227917 to 227921	74
227924 to 227943	75
227946 to 227950	75
227952 to 227956	75
227959 to 227969	75
227972 to 227976	76
227978 to 227984	76
227985	76, 118
227986 to 228003	76
228005	76
228006	76
228007	76
228044 to 228079	77
228080 to 228097	78
228116 to 228133	79
228134 to 228147	80
228149 to 228157	80
228159 to 228167	80
228169 to 228173	80
228174 to 228177	81
228179 to 228187	81
228189 to 228197	81
228199 to 228207	81
228209 to 228213	81
228214 to 228249	82
228286 to 228291	84
228292	83
228293	83
228294	83
228295 to 228300	84
228301	83
228302	83
228303	83
228304 to 228309	84
228310	83
228311	83
228312	83
228313 to 228318	84
228319	83
228320	83
228321	83
228322 to 228339	85

STYLE NUMBER INDEX—Continued

Style No.	Page
228340 to 228357	86
228358 to 228361	87
228362 to 228365	87, 118
228366	87, 117, 118
228367	87, 117, 118
228368	87, 117, 118
228369	87, 117
228370	87, 117, 118
228371	87, 117, 118
228372	87, 117, 118
228373	87, 117
228390 to 228405	88
228406	88, 117, 118
228407	88, 117
228408	88, 117
228410	88, 117, 118
228411	88, 117
228412	88, 117
228422 to 228427	90
228428	90, 91
228429	90, 91
228430	91
228431	91
228432	91
228434 to 228453	91
228454 to 228461	92
228462	92, 117, 118
228463	92, 117
228464	92, 117
228465	92
228478	93
228479	93
228490 to 228513	115
228886	610
228887	610
228888	610
228977 to 229000	479
229096	1068
229104	201
229105	605
229112	605
229113	605, 1081
229114	605
229116	1081
229120	605
229125	1081
229127	221, 605, 1081
229128	219, 605
229129	1081
229133	221, 605
229134	605
229147	8, 36
229148	8, 36
229228 to 229241	65
229280	396
229752 to 229756	809
229773	605
229814	865
230093 to 230096	1376
230110	6, 12
230168	683
230225	50
230226	50
230227	50
230270	713
230271	713
230318	213
230319	213
230477	1247
230478	1247
230486 to 230518	638
230526 to 230565	102
230566 to 230581	103
230715 to 230754	106
230755 to 230770	107
231158	1080
231380	34, 36
231384	35, 38
231386	34, 36, 38
231394	36, 40
231426	34, 40
231428	34, 36, 40
231430	34, 36, 41
231434	34, 36, 41
231530	677
231562	1244
231564	1244
231575	760
231576	760
231577	760
231580	1288
232014	699
232159 to 232194	810
232175	53
232184 to 232194	809
232500	716
233066	274
233067	274
233108	270
233110	270
233112	270
233229	396
233393	219
233394	219
233395	219
233459	605
233472 to 233476	219
233907	1220
233908	1220
234181 to 234204	366
234277 to 234300	366
234373 to 234396	367
234421 to 234334	367
234957	472
234958	472
234973	599
234974	599
235817 to 235834	220, 225
235835	220
235836	220
235877	273
235878	273
235879	273
235881 to 235885	273
235887	273
235904	605
236433	796
236434	796
236435	797
236440 to 236445	50
236446	56
236447	56
236449	56
236450	56
236603 to 236617	52
236621	52
236622	52
236623	52
236633	788
237019	1024
237020	1067
237021	1067
237022	1067
237023	1030
237026 to 237037	1030
237124	724
237204	635
237219	1061
237482 to 237891	587
237496 to 237519	590
237545 to 237568	591
237782 to 237789	50
237792 to 237801	587
237804 to 237827	590
237828 to 237851	591
237852	53
237863	52
237864	52
237865	52
237870	53
237871	53
237880	53
237881	53
237882	53
238110 to 238116	592
238127	677
238128 to 238175	588
238176 to 238207	587
238209	1242
238211	1242
238232 to 238235	712
238396	571
238464 to 238467	598
238470	597
238579	1242
238610	788
238628 to 238635	602
238636 to 238659	592
238660 to 238083	593
238692	1083
238702	615
238703	615
238704	616
238705	616
238706	614
238707	616
238801 to 238812	596
238823 to 238832	589
238838	598
238839	598
238842	598
238843	598
238844 to 238847	600
238887	1245
238888	1245
238937	801
238938	801
238990	620
238991	620
238992	620
238998	614
239000	1086
239021	615
239022	615
239023	610
239024	610
239026	614
239027	614
239178	619
239179	619
239181	903
239182	903
239183	903
239186	17
239225	884
239295	677
239385	599
239386	599
239389	599
239390	599
239393	599
239394	599
239397	599
239398	599
239401 to 239406	598
239612	736
239613	736
239614	736
239615	737
239616	737
239617	737
239784	705
239799	619
240131	611
240171	705
240191 to 240200	597
240201 to 240206	603
240207 to 240210	604
240475 to 240478	391
240485	273
240486	273
240487	273
240488 to 240491	273
240492	274
240493	274
240494	274
240529	621
240530	621
240531	621
240793	1122
240794	1122
240916	14
240947 to 240950	787
241022	894
241167	10
241168 to 241177	274
241190	274
241279	677
241374 to 241384	903
241430 to 142433	274
241435 to 241439	274
241442	275
241443	275
241445	275
241448 to 241453	396
241504	388
241509	67
241510	67
241549	787
241776	732
241777	732
241842	1233
241871 to 241874	932
242000 to 242009	593
242015	1120, 1122
242017	14
242117	726
242118	728
242119	728
242127	1228
242299	730
242300 to 242319	727
242320 to 242339	729
242340 to 242359	731
242360 to 242374	735
242375 to 242384	1126
242385 to 242399	736
242400 to 242414	737
242575	677
242577	733
242578	733
242579	730
242685 to 242690	50
242866	905
243355	642
243461	1035
243608 to 243635	56, 57
243766 to 243775	534
243812 to 243827	534
243864 to 243867	534
243872 to 243875	534
243876 to 243895	635
243916 to 243919	635
243981	605
243982	605
243986	1081
143988	605, 1081
243993	605
244130	606
244133	606
244134	606
244144	606
244257 to 244291	604
244366	1114
244456 to 244465	636
244646	1026
244648	1047
244649	1062
244650	903
245196	642
245209	1348
245210	1348
245213	1348
245214	1348
245217	1348
245218	1348
245221	1348
245222	1348
245227	1348
245233	1348
245235	1348
245241	1348
245243	1348
245249	1348
245251	1348
245482	728
245645 to 245649	1126
245709 to 245716	717
245730	1296
245922 to 245930	472
245939	484
245940	484
245985	872
245987 to 245995	943
246112	943
246232	1277, 1278, 1279
246318 to 246324	1371
246327	1371
246328	1371
246401 to 246406	344
246409	344
246410	344
246413	344
246414	344
246417	344
246418	344
246446	1122
246447	1122
246593	853
246594	853
246629	809
246631	809
246632	809
246700	861
246701 to 246704	862
246705	869
246706	869
246707	869
246708	862
246720 to 246743	895
246815 to 246818	643
246820	643
246822	643
246826	643
246829 to 246836	643
246851	1243
247007	670
247008	670
247009	670
247012	670
247013	670
247017	670
247025	670
247028	670
247029	670
247031	671
247033	671
247090 to 247095	766
247122 to 247125	766
247127	766
247130	766
247149 to 247160	617
247156	681
247208	219
247210	219, 222
247211	219
247212	219
247213 to 247216	219, 224
247217	219, 224, 225
247218	219, 224, 225
247220	219

STYLE NUMBER INDEX—Continued

Style No.	Page
247221	220
247222	220, 226
247223	220, 226
247224	220, 226
247225 to 247234	220, 226
247235	597
247262	903
247263	903
247351	946
247375	677
247562 to 247577	681
247597	1243
247642 to 247647	270
247648	221
247665	1057
247682 to 247715	467
247851	862
247941 to 247949	887
247950	6
248509 to 248512	901
248515	901, 932
248516	901, 932
248525 to 248528	900
248556 to 248586	922
248694 to 248705	787
248931	760
248981	276
248982	276
248983	276
249093	536
249109	975
249110 to 249122	974
249137 to 249150	971
249151 to 249164	972
249204	1076
249205	1076
249219 to 249223	875
249225	875
249226	875
249227	875
249229	875
249303	766
249304	766
249377 to 249388	893
249392	1067
249418	270
249419	270
249423	220
249424	220
249427 to 249435	1126
249436 to 249442	791
249519	719
249520	719
249529	275
249779	1374
250085	918
250122	677
250333	1039
250384	760
250385	760
250386	760
250467	879
250468	879
251200	1289
251202	1289
251208	1289
251254	952
251365	644
251407	1240
251409	1240
251411	1240
251413	1240
251415	1240
251417	1240
251419	1240
251421	1240
251423	1240
251425	1240
251428	1240
251430	1240
251432	1240
251434	1240
251436	1240
251438	1240
251440	1240
251442	1240
251444	1240
251446	1240
251643	869
251670	1026
251711	889
251712	869
251972 to 251977	763
251979	763
252100	76
252112	76
252212	1114
252248	724
252400	1374
252424	766
252425	766
252512	1371
252513	1371
252592	677
252668	1331
252678	677
252694 to 252699	1225
252725	718
252740	956
252741	956
252743	960
252769 to 252774	966
252775 to 252786	968
252787 to 252797	965
252800 to 252813	970
252828 to 252849	971
252864 to 252885	972
252886 to 252907	973
252908 to 252916	974
252930	975
252931	975
252932	974
252933	974
252940 to 252946	975
253015 to 253020	919
253035	976
253037 to 253045	976
253048 to 253058	968
253102	621
253120	621
253362 to 253367	603
253584 to 253591	602
253704	1296
254706	1023
253707	1024
253708	1027
253709	1028
253710	1046
253971 to 253977	37
254200	535
254300 to 254305	573
254306 to 254311	573, 575
254372 to 254375	85
254376 to 254379	86
254380 to 254383	85
254384 to 254387	87
254388 to 254391	85
254392 to 254395	86
254396 to 254403	85
254404 to 254407	86
254409	91
254411 to 254427	91
254432 to 254435	91
254439 to 254447	91
254448 to 254451	87
254456 to 254459	88
254460 to 254463	87
254468 to 254471	88
254472 to 254475	87
254480 to 254483	88
254484	89
254485	89
254488	90
254489	90
254490	89
254491	89
254494 to 254495	90
254496	89
254497	89
254500	90
254501	90
254502	89
254503	89
254506	90
254507	90
254508 to 254511	89
254516 to 254519	90
254520 to 254523	89
254528 to 254531	90
254532 to 254535	89
254540	90
254541 to 254543	90
254544 to 254547	89
254552	90
254575	90
254576	90
254577	90
254580 to 254583	93
254587 to 254590	92
254595 to 254598	93
254599 to 254602	92
254607 to 254610	93
254611 to 254614	93
254619	93
254622	93
254623 to 254626	92
254631 to 254634	93
254635	92
254637	93
254648	115
254649	115
254679 to 254683	1096
254688	1094
254745	1068
254746	1066
254747	1066
255144	82
255145	82
255146	82
255147	82
255152 to 255155	83
255156 to 255159	82
255164 to 255167	83
255168 to 255171	82
255176 to 255179	83
255180 to 255183	78
255188 to 255191	79
255192 to 255195	78
255200 to 255203	79
255204 to 255207	78
255212 to 255215	79
255216 to 255219	78
255224 to 255227	79
255228 to 255231	78
255236 to 255239	79
255240 to 255243	78
255248	79
255249 to 255251	79
255252	78
255253	78
255256	79
255257	79
255258	78
255259	78
255262	79
255263	79
255264	78
255265	78
255268	79
255269	79
255270	78
255271	78
255274	79
255275	79
255276	78
255276	78
255280	79
255281	79
255282	78
255283	78
255286	79
255287	79
255288 to 255291	74
255292 to 255295	75
255296 to 255299	74
255300 to 255303	75
255304 to 255307	74
255308 to 255311	75
255312 to 255315	74
255316 to 255319	75
255320 to 255323	74
255324 to 255327	75
255344 to 255347	80
255348 to 255351	81
255352	80
255353	80
255355	80
255356 to 255359	81
255360 to 255363	80
255364 to 255367	81
255368 to 255371	76
255376 to 255379	77
255380 to 255383	76
255388 to 255391	77
255392 to 255395	76
255400 to 255403	77
255404 to 255407	76
255412 to 255415	77
255416	76
255417 to 255419	76
255424 to 255427	77
255845	993
255867 to 255884	255
255973	1063
255992	1296
256162	871
256261	903
256262	903
256263	903
256265	869
256266	869
256306	869
256332	635
256368	7
256369	7
256371	7
256372	7
256780	1074
256781	1074
256782	1074
256814	1331
256817	1331
256857	388
256858	388
256859	388
257191 to 257194	74
257195 to 257198	98
257199	74
257200	74
257201	75
257202	75
257236	535
257665	1345
257666	1345
257694	324
257742	324
257772	213
257773	213
257774	213
257775 to 257780	639
257788	14
258097 to 258123	635
258369 to 258377	635
258417	1257
258418	1257
258592	71
258593 to 258596	221, 229
258597	221, 228
258598	221, 228
258600	221, 228
258601	221, 228
258604 to 258612	221, 228
258614	221, 228
258615	221, 229
258616	221, 228
258633	221, 229
258635	221, 229
258650	221, 229
258657	221, 229
258661	221, 228
258665	1114
258721	791
258722	791
258723	791
258725	791
258726	791
258747 to 258753	755
258755	755
258757	755
258758	755
258768 to 258774	755
258776	755
258778	755
258779	755
258882	677

STYLE NUMBER INDEX—Continued

Style No.	Page
259160	903
259161	903
259162	903
259164	236
259166	236
259167	236
259168	236
259346	1058
259347	1058
259431	606
259610	112
259612	112
259658	112
259660	112
259682	112
259684	112
259946	112
259954	112
259978	112
259994	112
260106	112
260110	112
260122	112
260130	112
260202 to 260205	112
260218 to 260221	112
260266 to 260269	112
260298 to 260301	112
260394 to 260397	112
260410 to 260413	112
260458 to 260461	112
260490 to 260493	112
260586	208
260587	208
260588	208
261058	276
261068	270
261069	270
261076	270
261077	270
261107	270
261194	270
261195	270
261471 to 261477	756
261479	756
261481	756
261482	756
262040	78
262041	78
262042	35, 45
262046	35
262048	79
262049	79
262050	35, 36, 47
262051	35, 36, 45
262052	78
262053	78
262054	17
262055	52
262058	35
262060	79
262061	79
262062	52
262063	17, 21
262064	78
262065	78
262066	35, 36, 44
262067	17
262070	35, 48
262072	79
262073	79
262076 to 262079	74
262080 to 262083	75
262084 to 262087	74
262088	75
262089	75
262090	75
262091	75
262101	76
262102	76
262103	76
262108 to 262111	76
262113	76
262114	76
262115	76
262120 to 262123	77
262136 to 262139	78
262144 to 262147	79
262148 to 262151	78
262156 to 262159	79
262410	1374
262925 to 262934	902
262939 to 262944	901
263045	19
263096	635
263097	635
263232 to 263254	253
263255 to 263265	254
263266 to 263267	253
263268	253
263269 to 263284	254
263328	1085
263329	1085
263330	1085
263383	847, 848
263384	847, 848
263528	870
263529	870
263532	1085
263543	1374
263545	938
263546	938
263614	253
263621	803
263765 to 263779	652
W264040	1177
W264060	1177
264093	879
264094	879
W264200	1177
W265040	1177
265047 to 265060	338
W265060	1177
265061 to 265106	338
W265150	1177
265227 to 265316	338
265317 to 265376	338
265956	854, 855
265957	854
265958	854
266321	1074
266372	1032
266412	204
266413	204
266414	204
266426	204
266565	204
266740	34, 36
266743	34, 36
266746	34, 38
266749	34, 38
266752	34, 36, 43
266755	34, 36, 43
266757	34, 36, 43
266821	34, 36
266931 to 266934	1272
266935 to 266938	1273
266939	1275
266940	1275
266945	1278
266946	1278
266947 to 266950	1274
266955	1276
266956	1276
266959	1279
266960	1279
266963	1250
266965	1250
266968	1254, 1286
266970	1254, 1286
266972	1254
266974	1254
266984 to 266991	787
267034 to 267038	204
267047	1177
267052	1177
W267060	1177
W267075	1177
267075	756
267076	756
267095	756
267096	756
267111	765
267112	765
267113	765
267132	756
267133	756
267134 to 267140	757
267141	765
267142	765
W267150	1177
267156 to 267160	757
267162 to 267185	757
267187	757
267188	757
267189 to 267199	759
267201	759
267202	759
267204 to 267223	757
267224 to 267232	759
267234	759
267235	759
267236 to 267253	758
267255	758
267256	758
267257 to 267264	759
267266	759
267267	759
267287 to 267305	758
267306 to 267316	765
267337 to 267341	757
267342	759
267361 to 267370	760
267372	760
267373	760
267384 to 267387	761
267389 to 267393	761
267395	761
267396	761
267407	761
267408	761
267410 to 267414	761
267416	761
267417	761
267428	761
267429	761
267431 to 267435	761
267437	761
267438	761
267449 to 267456	762
267458	762
267459	762
267489 to 267502	758
267505	758
267508	758
267509 to 267522	765
267525 to 267528	765
267543 to 267546	746
267549 to 267552	764
267555 to 267558	763
267561 to 267564	763
267577 to 267585	767
267586 to 267592	766, 767
267593	767
267594	767
267603	763
267604	763
267616 to 267624	766
267638 to 267660	736
267673 to 267712	764
267713 to 267730	765
267737 to 267740	765
267749 to 267752	765
267778 to 267782	204
267793 to 267798	270, 277
267799	277
267804	277
267806	277
267808	277
267810 to 267816	277
267817	270, 277
267818	277
267819	277
267820	277
267821	270, 277
267822	277
267823	277
267824 to 267835	270, 277
267846	277
267847 to 267855	277
267866 to 267875	277
267889	277
267900	277
267901	277
267915 to 267970	277
267985 to 267998	277
268016 to 268032	278
268047 to 268060	278
268078 to 268094	278
268174 to 268177	272
268179 to 268182	272
268184 to 268187	272
268189 to 268192	272
268194 to 268197	272
268199 to 268202	272
268208 to 268215	762
268216	763
268224 to 268227	763
268250 to 268255	944
268281 to 268300	469
268340 to 268345	851
268346 to 268350	945
268395 to 268410	715
268455 to 268462	763
268481 to 268483	1300
268484	756, 1300
268485 to 268492	756
268527	855
268530 to 268571	516
268572	762
268573 to 268586	756
268588	870
268589 to 268596	1300
268599	947
268639 to 268680	487
268681 to 268687	488
268688 to 268715	511
268716 to 268739	512
269231	1280
269473	221, 228
269573	6
269643	681
269650	261
269651	261
269652 to 269659	260
269917	605
269923	606
269929 to 269947	726
269948 to 269959	739
270305	276
270412	204
270413	204
270414	204
270436 to 270441	639
270449	220
270450	220
270452	274
270466	274
270467	219
270468	219
270528	606
270529	606
270532	606
270533	606
270568 to 270573	52
270574	52
270575	52
270576	52
270701	1255
270732	1329
270795	1240
270796	1240
270797	1242
270798	1240
270799	1240
270809 to 270822	255
271177	617
271456 to 271499	256
271667 to 271682	739
271785 to 271788	564
271880	946
271881	946
271882	947
272153	1076
272214	606
272253 to 272277	1124
272493 to 272527	700
272537	954
272608	1321
272660 to 272665	905
272702	274
272705	274
272706	274
272852	1233
272853	1233
272854	1233
272860	274
272861	273
272862	273
272863 to 272870	274
272880	274
272881	274
272884 to 272890	274
272891	275
272892	275
272893	275
272900	643
272901	644
272913	641
272920	653
272921	653

STYLE NUMBER INDEX—Continued

Style No.	Page
272922 to 272929	653
272931 to 272934	273
272935 to 272938	653
272939 to 272942	654
272947	221
272948 to 272956	688
272957	663
272958	663
272959	690
272960	690
272961	690
272962	687
272963	687
272967	34, 36, 38
272969	34, 36
272985	14
272987 to 272996	114
272999 to 273003	651
273019	568
273020	568
273021	568
273150	1296
273175	665
273438	938
273472	953
273473	953
273474	951
273475	951
273963 to 273966	1381
274228	1088
274425	1289
274427	1289
274433	1289
274435	1289
274440 to 274443	1289
274448 to 274451	1289
274733	1231
274734	1233
274735	1233
275177	854
275529	854
275607 to 275610	871
275930	1321
275976	14
275984	622
276015	131
276089	131
276090 to 276164	139
276225	535
276310	37
276311	37
276312	37
276338 to 276343	635
276387	635
276449 to 276526	667
276529 to 276534	667
276669	36
276671	36
276672	36
276674	635
276675	635
276676	635
276746	36
276749	36
277211	1348
277212	1348
277215	1348
277217	1348
277640	1296
277641	1296
277806	35, 36, 46
277807	53
277808	35, 36, 46
277809	52
277810	35, 48
277811	35, 36, 44
277813	35
277814	17
277816	53
277817	21, 17
277827	1329
277954	52
277955	53
277956	52
277957	947
277958	947
278006	855
278401	1287
278402	1287
278604 to 278607	1273
278617	1278
278618	1278
278673	1285
278674	1285
278758	1258
278759	1258
279054 to 279079	231
279082 to 279085	231
279087	704
279088	231, 704
279090 to 279105	231
279110 to 279119	231
279122 to 279131	231
279145 to 279149	889
279151	889
279264	791
279361	884
279453 to 279458	787
279468 to 279486	502
279487 to 279511	503
279512 to 279518	504
279970	606
280026	766
280061 to 280086	504
280112 to 280115	1252
280174 to 280177	756
280229	884
280279	622
280452	901
280453	901
280480	35, 36, 47
280498	37
280499	35, 36, 46
280532 to 280537	1259
280541	536
280598	1231
280737	1249
280788 to 280791	37
280837	14
280844	34, 36
280845	34, 36
280847 to 280853	34, 36
280910 to 280917	102
280918 to 280924	103
280925	103
280926 to 280933	106
280934 to 280941	107
280943	635
280944 to 280947	1289
280948 to 280951	1323
280952 to 280955	1289
280956 to 280959	1323
281134	947
281135	947
281138	954
281139	950
281140	950
281154	1093
281155	1094
281156	1094
281441	622
281442	622
281443	622
281691	756
281692	756
281694	757
281695	757
281697	757
281698	757
281700	757
281701	757
281703	758
281704	758
281706	758
281707	758
281780	942
281781	942
281786	606
281996	995
282087	606
282115	861
282246	35
282247	35
282632	1296
282633	1296
282634 to 282652	661
282799 to 282809	621
283009	1076
283010	1076
283128	484
283129	484
283367	1285
283395	1265
283429 to 283432	1246
283536	1329
283537	1329
283697	1283
283700	1283
283701	1283
283702	1283
283717	1283
283720	1283
283721	1283
283722	1283
283725	1283
283726	1283
283837	1249
283874	1249
283876	1249
283881	1249
283921	1257
283922	1257
283923	1257
284615	1264
284908	1081
284989 to 284992	213
284918 to 284942	641
285000 to 285007	213
285016	213
285017	213
285018	213
285024 to 285027	213
285032 to 285039	213
285235 to 285242	1325
285268 to 285271	1289
285272 to 285275	1323
285352	1289
285353	1289
285354	1323
285355	1323
285356	1289
285357	1289
285358	1323
285359	1323
285360	1289
285361	1289
285362	1323
285363	1323
285371	52
285372	52
285373	53
285374	52, 53
285375	52
285376	52
285459 to 285463	621
285471	885
285472	885
285631	855
285999 to 286003	481
286004 to 286007	484
286016	954
286220	114
286649	114
286886 to 286893	114
286895	114
286896	114
286902	114
286906	114
286908	114
286909	114
286911	114
286912	114
286914	114
286918	114
286920	114
286921	114
286960	270
286985 to 286993	114
286996	71
286997	71
287016 to 287022	1321
287547	946
287548	948
287549	948
287554	864
287556	955
287557	949
287558	949
287630 to 287709	595
288348 to 288427	594
288428 to 288443	596
288444 to 288459	594
288730	1088
288926	728
288927	728
288990	728
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